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Original article

Public perception and behavior on the disposal of unused and expired drugs

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Abstract: Evidence demonstrates that inappropriate drug disposal creates a significant risk to global environmental safety. Study participants' knowledge, attitude and practice regarding the disposal of unwanted and expired medications were assessed. The study was carried out at Sebha city, in southwestern Libya, from October 2021 to April 2022. A self-administered questionnaire designed explicitly to be completed by a respondent without an interviewer's assistance was used. Out of 650, only 500 completed questionnaires was returned. The majority of the respondents admitted they have at least one medication stored at home (71.6%). Keeping expired drugs were reported by 28.2% of the respondents compared with unused medications in their house (51.2%). Almost half of the respondents (47.4%) declared that their medication were taking from the private pharmacies. “I’ll need it in the future” (48.8%), "Medicines change" (37.2%) and "Symptoms improve and recover" (32.6%) were the top three explanations given by participants. The majority of drugs reported were antibiotics (41.0%). This is followed by antipyretic and analgesic drugs, which were used by 29.8% and 27.8% of respondents, respectively. 52.2% of the respondents agreed that disposing of medicines in the garbage is the most appropriate method. Concordantly, the majority of them indicated they discarded unused or expired medicines whether they were solid (82.6%), liquid (58.4%), or semisolid (79.6%). The majority of participants indicated they were aware of the negative impact of drug waste on the environment (80.6%). More than three quarters of the participants said they had never been given instructions on how to properly dispose of medications and 60.8% thought a medical team would be the best source of knowledge. Despite acknowledging being aware of the harmful effects on the environment, the majority of participants admitted to keeping unneeded pharmaceuticals in their homes and throwing them out in the trash. The government should support the pharmacists' role in educating the public about how to properly dispose of their medications and establish the Return Unwanted Medicines Project in order to raise awareness and create cost-effective medication waste management programs.

Introduction

Medicines found in households are commonly sourced from health institution dispensaries through prescriptions or from community pharmacies with or without prescriptions. Besides their substantial lifesaving importance, medications can also be disastrous when inappropriately taken and managed. The increase in the quantities and varieties of pharmaceuticals and promotion of these products worldwide eases the accessibility of medicine by consumers and thereby gives options for misuse and discard of them improperly. Evidence showed that more than half of all medications are inappropriately prescribed, dispensed or sold and that globally only about 50.0% of patients take their medications correctly [1]. In fact, the accumulation of unused medications leads to medication wastage and wastage of economic resources of countries. According to a research done in England, community pharmacies alone were responsible for the disposal of £37.6 million worth of pharmaceuticals annually [2]. Emerging contamination of pharmaceuticals as expired and unused medications in the natural environment lead to concern for environmental and health researchers because of their serious biological - toxicological impacts [3]. These expired or unused medicines are potentially toxic substances that should be managed effectively to avoid accumulation of potentially toxic pharmaceuticals in the environment [4]. Unused medications include expired, spilt and contaminated pharmaceutical products, drugs, vaccines and sera that are no longer required and need to be disposed of appropriately, discontinued, deteriorated and/or not intended for any future use [2]. Improper disposal system is a global problem and occurs in developing and developed countries but may in developing countries this problem is enormous and not well documented. Human pharmaceuticals have increasingly been detected in environment in the recent years in surface water since disposal in household waste and via the sink/drain is common [5]. Geological survey found low levels of the medications (antibiotics, hormones, contra-ceptives and steroids) in 80.0% of rivers and streams tested [6]. To reduce the negative impact of pharmaceutical compounds on the environment and humanity, it is important to identify and address the challenges related to the improper disposal of unused and expired medicines. Disposal of pharmaceutical waste among patients is a global challenge. Many developed countries have developed policies and programs for the disposal of unused and expired medications. Unfortunately, programs advocating for safe disposal practices of unused medicines are still limited in many developing countries like Libya. Thus, important to assess knowledge and practices employed by consumers in Libya with regard to medicine disposal. Keeping in view these facts, this study carried out to evaluate Libyan consumer's knowledge about disposal of unused medications and to find the reasons for possessing unused medication and its type.

Materials and methods

Cross sectional study was conducted in west southern Libya (Sebha city) during October 2021 to April 2022. A self-administered questionnaire (appendix 1) was developed via expert group discussion based on various literature sources were reviewed [7 - 12]. The survey consisted of mostly 14 close-ended questions excluding questions for demographic data and comments section and some with an option for the respondents to record their own opinion if the choices were not suitable. Sociodemographic characteristics included age, gender, level of education and occupation. Participants were invited to voluntary participate in the anonymous survey and each survey from accompanied by the cover letter, supplied with attached questions. An institutional ethics committee permission was taken before the beginning of the study (5/2021). Informed consent was taken from the participants before the study. 650 self-administered survey was distributed to general public. The investigator requested participants' verbal consent

and used an informative brochure to explain the purpose of the survey. They also explained that the questionnaire was anonymous. The data generated will be used for research purposes only and will kept confidential and not be shared with anybody.

Data analysis: Data were collected and completed questionnaires were coded, reviewed for accuracy to enter in an Excel database by the researchers and were analyzed using Statistical Packages for Social Sciences (SPSS), version 18. A SE β 95% and a lower level of significance α 0.05 were considered.

Results

Out of 650 self-administered survey was distributed to the general public, 67 of the questionnaires were excluded from study and 83 incomplete questionnaires. The remaining 500 completed questionnaires were included in this study with a response rate of 77.0%.

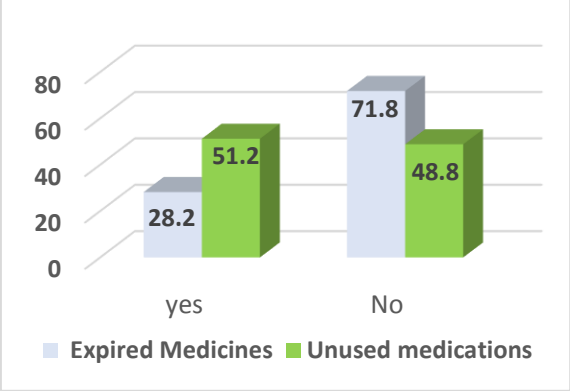
Demographic data: According to the **Table 1**, respondents were divided into four age groups. The largest group of the respondents were represented in age of 26 - 40 and 41 - 64 years which account with 34.8%for each. The youngest age group was 18 - 25 years and accounted for 27.4%. The female participants were greater than to males which account for 51.8% and 48.2% (n = 259 and 241, respectively). Over two thirds of the respondents (69.6%, n = 348) were non -medical profession whereas those have medical vocations were account for just 30.4% (n = 152) with approximately two-thirds of the respondents had have education university level and representing 66.4% (n = 332).

Characteristic of unused or expired medicines: Based on **Figure 1**, over one-quarter of the participants (28.2%, n = 141) admitted they kept expired medicines at home compared with those (359, n = 71.8%) who denied that. For unused medicine, just over one-half of the respondents (256, n = 51.2%) declared they have unused medicines at home while those who declared they did not keep unused medications were 48.8% of the respondents.

Table 1: Characteristic of the Libyan participants

Age	Frequency	Percent
18 - 25	137	27.4
26 - 40	174	34.8
41 - 64	174	34.8
≥ 65	15	03
Gender		
Male	241	48.2
Female	259	51.8
Occupation status		
Medical profession	152	30.4
Non-medical profession	348	69.6
Education level		
Elementary education	19	03.8
Intermediate education	149	29.8
University education	332	66.4

Figure 1: Type of medications at home



Based on data presented in **Table 2**, nearly equal of participants who declared the medicines accumulated in their home were sourced from public pharmacies and participants who reported that the source of their medications was from private pharmacies which represented by 52.6% and 47.4%, respectively. Regarding the amount of medication stored at home, the majority of respondents (71.6%, n = 358) admitted they have at least one medication stored at home compared with over a quarter of participants (28.4%, n = 142) indicated that they do

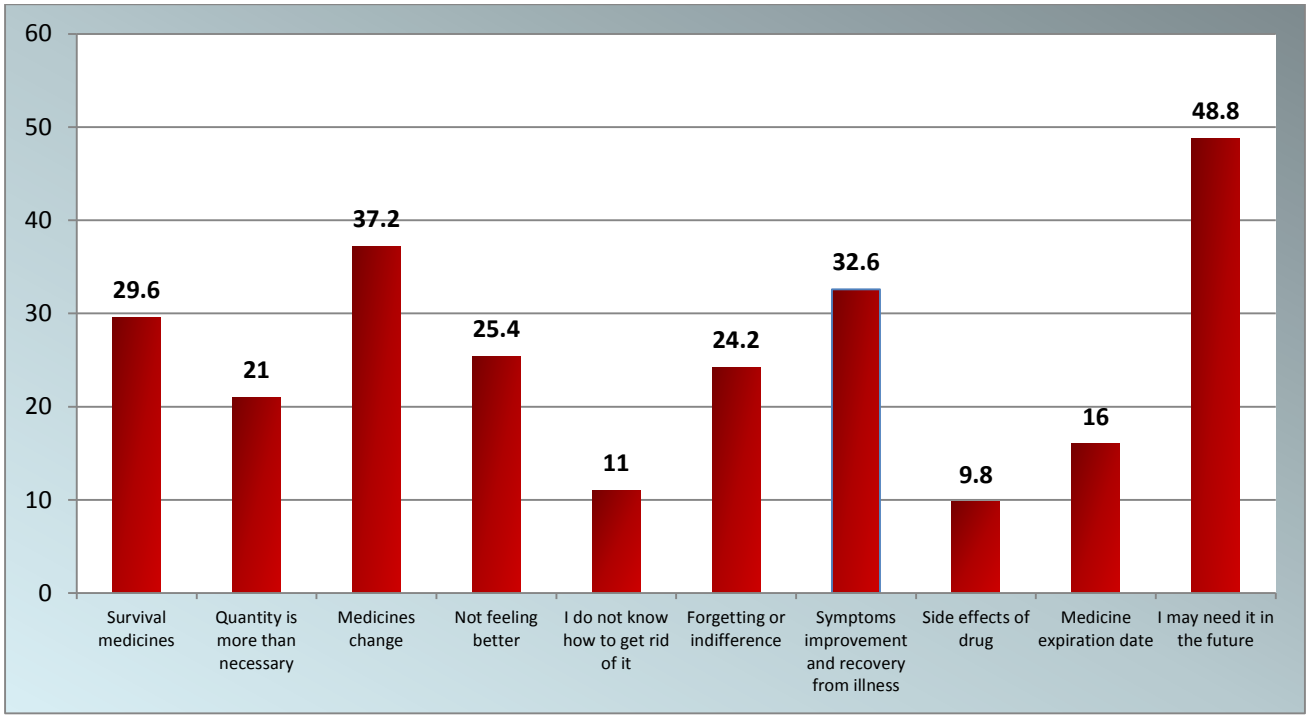
not have medicines at home. In the same rate, respondents who reported they have one and/or two medicines in their homes which was accounted for 29.8% (n = 249). Moreover, nearly of one-fifth of respondents (19.2%, n = 96) declared they have medicines of 3 - 5. For the type of dosage form, over the half participants (59.0%, n = 259) were tablet or capsules dosage form. Over one-third of the participants (36.2%, n = 181) indicated they have medication as syrup dosage form. Similarly, nearly one -third of the saved ointment or cram type respondents (30.0%, n = 150). The largest class of drugs that kept at home was antibiotics which were represented by 41.0% (n = 205) and then followed by antipyretic and analgesic medications which were accounted for 29.8% and 27.8% of the respondents, respectively. Similarly with antipyretics, ointment and drops were reported by 29.8% (n = 149) of the participants. While allergic medications and vitamin were represented by 18.8% and 18.6% of the participants, respectively, however, a minority of the respondents reported gastrointestinal medicines (17.0%, n = 85) and anti-hypertension medications (12.2%, n = 61).

Table 2: Characteristic of medications

Quantity of medications at home	Frequency	Percentage
No	142	28.4
1 - 2	249	49.8
3 - 5	96	19.2
≥ 6	13	02.6
Sources of unused or expired medications		
Public pharmacies	263	52.6
Private pharmacies	237	47.4
Dose form		
Tablet or capsule	295	59
Syrup	181	36.2
Ointment or Cram	150	30
Injection	72	14.4
Others	26	05.2
Unused or expired medicines		
Antibiotic medications	205	41
Antipyretic medications	149	29.8
Analgesic medications	139	27.8
Allergy medications	94	18.8
Vitamins	93	18.6
Antihypertension medication	61	12.2
Gastrointestinal medicines	85	17
Ointment and drop	149	29.8

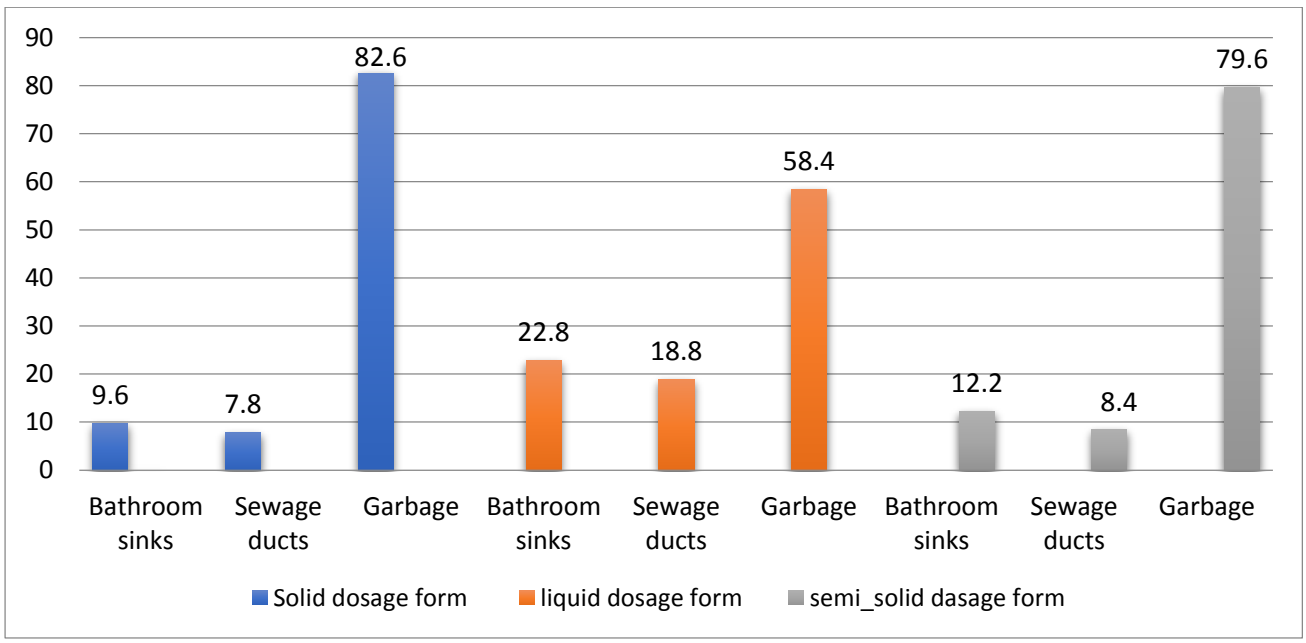
Reasons for unused medicines: In term of the reasons to keep medicines at home, **Figure 2** shows the most common reason cited for possessing the unused and expired medicines at home was " I may need it in the future" which were represented by 48.8%. Following reason was "medicines change" which reported by over one third of respondents (37.2%). Other reasons as “Symptoms improvement and recovery from illness", "Survival medicines", "Not feeling better" and "Forgetting or indifference" were represented by 32.6%, 29.6%, 25.4% and 24.2%, respectively. Just over one fifth of respondents (21.0%) indicated "Quantity is more than necessary is the reason of kept their medicines at home. A minority of respondents reported that “Medicines expiration of data”, “I do not know how to get rid of it “and “Side effects of drug “which they reported by 16.0%, 11.0% and 09.8% of participants, respectively.

Figure 2: Reasons of keeping medicines at home



Methods for disposing of drugs: **Figure 3** depicts the various disposal practices of different types of dosage forms solid, liquid and semisolid dosage forms. In terms of various routes of discarded were through a bathroom sink, sewage duct, and garbage. In general, the majority of participants discarded unused or expired medicines through the garbage way whether the medicines dosage forms were solid, liquid or semisolid which were accounted for 82.6%, 58.4% and 79.6%, respectively. The second major route was the bathroom which was represented by 09.6%, 22.8%, and 12.2%, respectively. Lastly, sewage duct was represented by 07.8%, 18.8% and 08.4% for solid, liquid and semisolid, respectively.

Figure 3: Methods for disposing of drugs that have been stored at home



Participants' opinions about most efficient method to dispose medicines: Regarding personal idea of the correct way of how to dispose of medicines **Figure 4** showed that over one half of the participants (52.2%) agreed that disposing of medicines in the garbage is the most appropriate while a minority of participants (15.2%) they think that bathroom sinks is the best way of disposing followed by sewage ducts with (11.8%) of the respondents.

Participants' knowledge about disposing drugs: In terms of awareness of participants to disposing expired and unused medications, **Table 4** showed that 68.6% of the participants denied they have knowledge about how to dispose of drugs while only 31.4% of respondents declared they have knowledge of it. The majority of the participants (77.0%) did not receive any information on how to dispose of the medication, while just 23.0% of respondents indicated that they have received information regarding disposing of unused or expired medications. Regarding the relationship to the environment, the majority of participants indicated they were aware of the impact of drug waste on the environment (80.6%, n = 403). Based on data in the **Table 4**, only 16.4% of respondents admitted of aware about drug return system. However, nearly half of respondents 44.8% had poor knowledge about drug return systems and 38.8% of the respondents reported they do not have any idea about it. Regarding checking expired date, the majority of participants (79.0%) checked the expiry date of the medicines while minority of respondents reported they do not check the expired date (11.6%).

Preferred method for educating people on how to properly dispose of drugs: Based on the data represented in **Figure 5**, nearly two thirds of participants (60.8%) suggested medical team is appropriate awareness tool for disposing medication. Followed awareness through education mean reported by 58.8% of respondents. Over the one third of respondents (38.6%) suggested leaflets mean, however, minority of respondents (18.4%) reported that religious discourse. Other route reported in a few respondents (05.2%).

Figure 4: Participants' opinions on the best method of drug disposal

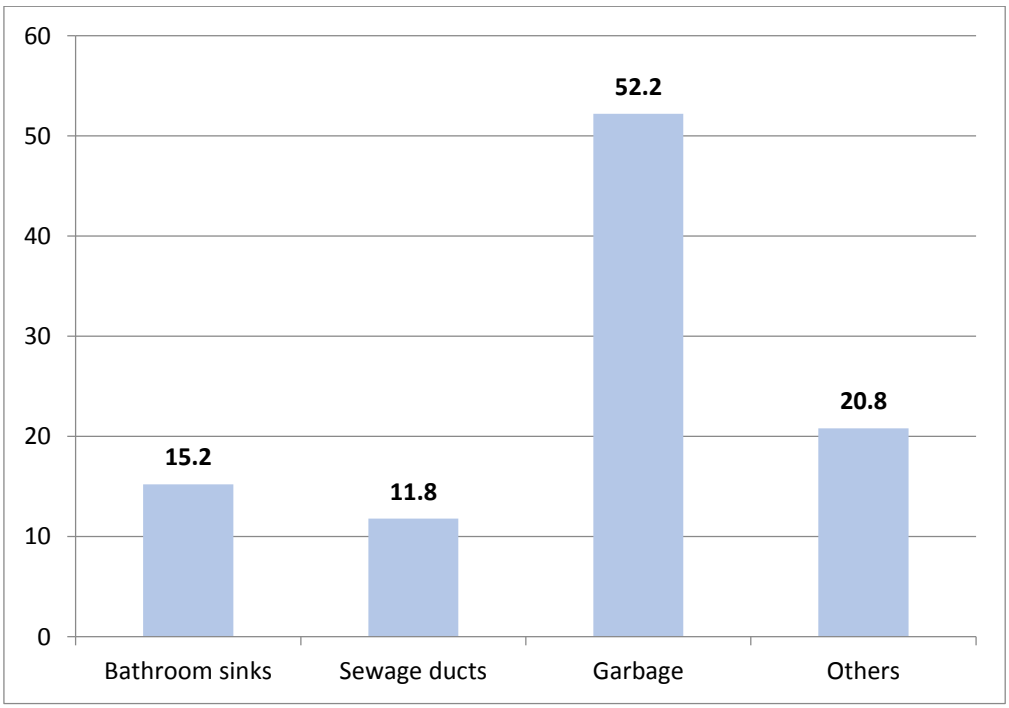
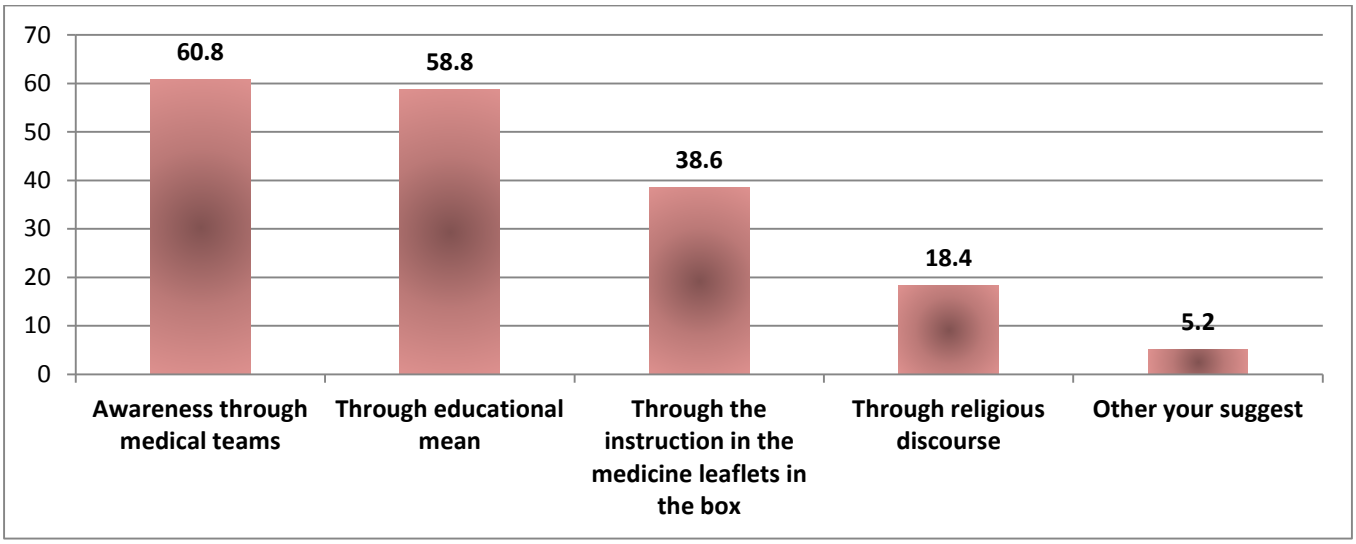


Table 4: Participants' knowledge about disposing drugs

Questionnaire	Yes n, (5)	No n, (%)
Do you know how to dispose?	157 (31.4)	343 (68.6)
Do You have information about proper disposal way for each drug?	115 (23.0)	385 (77)
Relationship to environmental safety?	403 (80.6)	37 (7.4)
Do you know that there is a drug return system?	395 (16.4)	58 (44.8)
Do you check the expiration date?	395 (79.0)	58 (11.6)

Figure 5: Favored means of raising participants' awareness of proper medication disposal



Discussion

This study demonstrates a high prevalence and practice of throwing away unused and expired medications among Libyan public. Increasing awareness of this problem can help to reduce medication waste and the problems associated with improperly disposing of medications in the environment. The response rate of this technique that was applied allowed achieving this acceptable high response rate and motivated respondents to participate for instance simplicity, clarity of the questionnaire and choosing an interesting title of the research [14]. Over two-thirds of the respondents were non-medical professionals with university level education and nearly two thirds were under age of forty years. This might be explained by the fact that society participants tend prominently to be non-elderly individuals and reflect educational advancement in the nation which is a hallmark of developing countries. The majority of respondents acknowledged having at least one drug stored at home. A similar pattern was noted in studies conducted in various nations as Ethiopian, India, Ireland and New Zealand [15 - 18] with variations in the amount of drug storage. These may have resulted from the different cultural characteristics, dispensing practices, drug accessibility and socioeconomic development levels in these areas. Accordingly, nearly half of the participants reported obtaining unused or expired medications from private pharmacies. Several studies have noted a tendency

where a significant portion of the customers keeping their medications at home as in India, Niger and Ghana [11, 19, 20]. The result of keeping unused or expired medications at home could be serious behavior and a risk to the health and safety of the people living there because it could result in accidental poisoning since the drugs become simple for children to access or could be administered incorrectly if the drugs are not disposed of properly. The accidental consumption of medications by children is a daily cause of emergency room visits for about 165 children in the US [21]. There are several reasons why someone can receive medication but not utilize it all. It may be claimed that having medicines on hand at home saves money and time by reducing the need for clinician visits and can be useful in an emergency. Typically, households obtain their medications from pharmacies with or without prescriptions, dispensaries affiliated with healthcare facilities, or both. Storing medications at home encourages self-medication which may have a variety of negative effects. A similar pattern was noted in Kenya where the same rate of respondents said they purchased drugs and kept them at home in case they were sick [22]. A higher risk of unintentional child poisoning results from improperly storing unused drugs in homes [23]. The difficulties of keeping drugs in homes include inadequate storage due to uncontrolled temperature and humidity levels. This raises the possibility of drug degradation and expiration [26]. Nearly, two-thirds of respondents disagreed that the staff ever gave them advice on how to store their medications during their interactions according to a Libyan study on consumers' opinions of community pharmacies [24]. Due to improper storage, exposure to heat, light, humidity and air-flow, home-stocked medications may lose efficacy. Premature treatment course termination when patients feel their symptoms have subsided and keeping the remaining medication for future usage is one of the improper drug uses. In this study, it is revealed that "Symptoms improvement and recovery," which was reported as a third reason for keeping unneeded medications at home. Previous studies came to similar conclusion, which may be one of the key causes [8, 11, 15, 25]. When considering stopping a drug just because clinical symptoms have improved, one typically only considers the issue of adherence which raises the possibility of a return of illness symptoms [26] because such behavior increases the likelihood that organisms may become resistance to the active medicinal compound [27]. The second reason "Medicines change" was cited by more than one-third of respondents, similarly, a study reported 15.0% of their population kept unneeded medications as a result of their clinicians frequently changing their prescriptions [25]. According to the patient's response, it is important to modify and track pharmacological therapy in clinical practice. This strategy might call for moving from one drug to another which might waste some of the original drug. Thus, prescribing lesser amounts of medications enables the clinician to avoid medication waste while adjusting and tailoring patient demands from drug treatment.

Libyan community pharmacies sell affordable, readily available medications for pain and infections [28]. A study conducted in Saudi Arabia [25] and the Sudan [29] reported similar conclusion of antibiotics and antipyretics. Accordingly, salbutamol inhaler, sublingual triglyceride nitrate are example of drug that people may keep on hand for urgent emergency situations but which may expire before it is fully utilized [30]. Most of participants agreed that disposing of drugs in the garbage is the most appropriate and their practice consist with this finding of this attitude, the majority of participants discarded unused or expired medicines through the garbage way whether the medicines dosage forms were solid, liquid or semisolid. Parallel findings were reported in Malaysia which found that the majority of respondents reported throwing away unused medications and expired medications in the garbage [9]. A recent review suggests that consumers use different methods for disposing unused medicines, most commonly throwing medicines in garbage, toilet or sink [31]. This practice can be elucidated

that the consumers had no convenient or safe option for medication disposal and may have been provided conflicting directions on how to properly dispose of medications. The lack of available programs often led consumers to use methods as flushing medications down the toilet to minimize the potential for accidental poisonings. Improper disposal of medicines is associated with environmental pollution and health hazards. Human pharmaceuticals have been detected increasingly in environment in the recent years in surface water since disposal in household waste and via the sink/drain is common [6]. Current study showed the majority were aware of the impact of drug waste on the environment and disposal their unused or expired medications in garbage pin. In Australia, the majority of respondents willing to be unaware of the Return Unwanted Medicines (RUM) Project, but they were willing to use it once informed and accessible [30].

One-fifth of participants had encountered critical situations and denied having knowledge about how to dispose of drugs. Very few of participants surveyed stated they never received counseling on proper methods of disposal [32]. As there is a lack of knowledge and awareness in the general public regarding the safe disposal of unused and expired medicines, the identify factors showed majority did not receive any information on how to dispose of the medication compared with who were knowing. Nearly, two thirds of participants suggested medical team is appropriate awareness tool for disposing medication. Reports have confirmed a lack of knowledge among health care professionals about significant risks of unused or expired medicine, including diversion, abuse and accidental overdose [33]. Unsafe storage of unused drugs in households provides an increased risk of accidental poisoning [23]. Study conducted in Libya on customers view about community pharmacy services which found that nearly two thirds denied that staff provides the medication storage information during their encounters [24]. Thereby, lack of proper advice from medical practitioners had an effect on households' attitude on safe disposal practices. The greater the perception that health professionals give much more information and the availability of disposal programs to their patients, the higher patient practicing a safe disposal method. Previous education was highly associated with the prior "return" of medications to pharmacy or provider for proper disposal [34]. Future prescribers should be knowledgeable about proper medicine disposal procedures and associated harmful effects if medicines are not disposed properly. Knowledge about proper drug practice formed prior to graduation may affect medicine disposal practices later during employment [35].

The practice of self-medication among communities or countries varies which may affect the extent of medication storage. Self-medication and the use of leftover drugs are widespread where drugs are sold without prescriptions [36]. A high number of medicines stored in home is associated with high prevalence of self-medication which may be risky [37]. The acute shortage of many essential subsidized medicines in public healthcare settings leads individuals to tend to rely on their out-packet to get their medication from the private community pharmacies. Libyan study reported public tends to prefer to visit community pharmacies over other healthcare centers because of minor health problems [28]. Community pharmacies manage large numbers of consumers who seek help and advice on different topics regarding their health. Community pharmacy staff have opportunity to implement interventions related. Pharmacists in every setting have an integral role in encouraging safe medication-disposal practices. Advantage of the pharmacist's role able in educate the patient about dispose their medications since the pharmacist's responsibility in close the ensuring the safety of drug use and safe disposal practices reported [37]. Pharmacists have an opportunity to instruct patients on how to dispose of unused drugs and performance counseling patients on drug information therapy including consequence harms associated with retaining or improperly disposing of drugs. This may further encourage the patient's willingness to use an appropriate method of disposal of unused or expired medications and

working with the geriatric population can encourage the removal of unneeded drugs. Pharmacists within community can advertise and regulate the upcoming take-back times of collecting medications intended to be dispose for individuals within their pharmacies local areas [38]. It is substantial to consider increasing in pharmacists' knowledge regarding proper medication disposal practices and its environmental impact. The RUM project is subsidized national scheme that allows unwanted medicines to be collected by community pharmacy and disposed of by high-temperature incineration. A minority of respondents has knowledge about drug return systems. In Australia, RUM project has been operating since July 1998 as a program that provides for unwanted medicines to be returned to community pharmacies at no cost to the consumer [39]. This reverse distribution system enable pharmacies to ship outdated drugs which become waste products and prevent pharmacies to become waste generators of drugs. In a Canadian study, quantified medication returns over two month period and found that people making returns brought back an average of half of the drugs from the original prescription [40]. In USA, federal guidelines for the disposal of drugs was developed [12] and in UK, particular pharmacies accept unwanted medications from patients on behalf of National Health Service or Waste Contractors and were prepared guidelines for pharmacies concerning correct disposal of drugs. Community pharmacies may be an ideal venue to establish programs to collect this reservoir of unused or outdated drugs. The collected drugs from community pharmacies transported national incineration sites where they are disposed of by high-temperature incineration as the disposal method approved by the Environment Protection Authority [40]. Although medication take-back programs are the recommended method of disposal, these programs are not frequently available as result of cost and regulatory issues. In Libya, until this implement will be available, still remain the community pharmacy staff is practical and easier option for education patients and consumers how disposal unused or expired medications properly.

Conclusion: The majority of the Libyans kept the unused medications in their home and disposal them in the garbage even they aware about this method of disposal has negative impact on the environment. Reasons may be linked to the low awareness level and lack of systems instructing the recollection of unwanted household medicines. Introducing such drug-disposal systems would improve the outcomes. This study indicates that government, pharmacist and pharmaceutical industry are responsible to create this awareness. Thus, guidelines must be introduced and policies should be implemented. It is likewise imperative to establishing the Return Unwanted Medicines Project as a vital public service that provides safe, easy and free way for consumers to dispose of unwanted medicines.

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Ethical issues: Including plagiarism, informed consent, data fabrication or falsification and double publication or submission have completely been observed by authors.
Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.
Author declarations: The authors confirm that all relevant ethical guidelines have been followed and any necessary IRB and/or ethics committee approvals have been obtained.

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