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Research article

## Improper disposal practice of unused and expired pharmaceutical products in Indonesian households



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### ABSTRACT

**Background:** Improperly disposed medicines could adversely affect the environment and increase the risk of drug misuse or accidental poisoning.

**Objective:** To evaluate the disposal practices of unused and expired medicines among the general population in Bandung, Indonesia.

**Method:** This was a descriptive cross-sectional survey conducted among 497 respondents in Bandung, Indonesia. Data were collected through interviews using a prevalidated structured questionnaire. Descriptive statistics were calculated using the Statistical Package for Social Science (SPSS) version 23. Ethics approval was obtained.

**Main outcome measure:** General public knowledge and attitude regarding unused and expired medication disposal practice.

**Results:** Approximately 95% of the respondents had unused medicines stored in their homes, with nonsteroidal anti-inflammatory drugs (NSAIDs), vitamins/nutritional supplements, and antibiotics were the most common types of medicines left unused. The majority of the respondents checked the expiration date of the drugs before purchasing (72.8%). The most common disposal method of unwanted medicines was throwing away in household garbage (82.1%). A significant percentage of them never received information about proper medication disposal practice (79.5%). Furthermore, more than half of the respondents were unaware that unsafe medication disposal practices could harm the environment and population health (53.1%).

**Conclusion:** Disposal of unwanted pharmaceutical products through environmentally unsafe route was prevalent among the respondents. There is also a lack of awareness of the impact of improperly disposed of medicines for the ecosystem. These findings call upon the strategies to strengthen the pharmaceutical waste management program.

### 1. Introduction

Pharmaceutical products have been used in increasing quantities globally [1]. However, studies have shown that a large number of these products eventually went unused or expired [2, 3, 4]. Patients' poor adherence to medication, excessive prescribing by the physicians, resolution of the medical condition, or altering the therapy regimen contributed to medication wastage [5, 6].

Inappropriate storage and disposal of unused pharmaceutical products could cause adverse consequences. Improperly stored medicines may provide an opportunity for misuse and accidental poisonings, which can result in serious health threats [7]. Pharmaceutical waste may pose a striking risk to the environment and cause health

issues due to subsequent exposure to the population. Evidence has shown that antibiotics that accumulated in the aquatic system worsened antibiotic resistance and affected microorganisms' virulence [8]. Ethinyl estradiol, an active compound of common oral contraceptives, was shown to cause endocrine disruption in the population of the roach [9]. Trace concentrations of organic contaminants from pharmaceutical products were also detected in conventional drinking water treatment facilities [10]. With this condition, concern has been raised regarding the environmental impact of pharmaceuticals, which stimulate the establishment of a new science called ecopharmacovigilance. It is defined as the science and activities related to detecting, evaluating, understanding, and preventing adverse effects of pharmaceutical products in the environment [11].

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Consumers must be aware of the appropriate practice of disposing of pharmaceuticals. Nevertheless, an environmentally unsafe medication disposal practice is common in several regions of the world. Studies conducted in the United States found that more than 50% of the patients flushed their medicines down the toilet [12] and less than 1% returned unused medication to pharmacy [13]. Other surveys in China, India, Bangladesh, and Ghana also found that the most common method of disposing of unused medication was throwing in the garbage, which ended up in landfills [14, 15, 16, 17]. No study has been conducted regarding the disposal practices of unwanted pharmaceutical products in Indonesia. Such information is necessary for developing effective measures to increase public awareness of medication disposal and harms associated with its improper practices. This study evaluated the disposal practice of unused and expired medicines among Indonesian consumers.

## 2. Methods

### 2.1. Study design, setting, and recruitment of respondents

A descriptive cross-sectional study was conducted in Bandung, Indonesia, from November 2017–January 2018. Bandung is the administrative capital of West Java Province and the third-largest city by population in Indonesia. All respondents were considered for inclusion if they were aged over 18 and can communicate in the Indonesian language. Ethics approval was obtained from the Health Research Ethics Committee, Faculty of Medicine, Universitas Padjadjaran, Indonesia (No. 1155/UN6.C.10/PN/2017). Written consent was obtained from the respondents if they were willing to participate in the study.

### 2.2. Data collection

Data were collected through interviews using a structured questionnaire that was used in a previous study [18]. The questionnaire validity was pre-test on 20 respondents. Following the pilot study, the minor revision was created, e.g., amending the word selection to ensure clarity and understanding. The questionnaire comprised two sections: demographic characteristics of respondents (age at the completion of the questionnaire, gender, level of education completed, occupation, and income) and information related to medication disposal (e.g., whether they had unused medicines stored in their home, how these medicines were procured, class of drugs, the reason for non-usage, whether they checked expiration date before buying, what they did with unused and expired medicines, whether they ever received information regarding proper medication disposal practice, and whether they knew the effect of improper disposal practice on the environment and population health).

### 2.3. Sample size calculation

Using the Slovin formula to determine the minimum sample size, a minimum of 400 respondents was required to obtain a 95% confidence level and a margin error of 0.05. A non-probability sampling technique (accidental method) was used to select the respondents.

### 2.4. Data analysis

Data extracted from the questionnaire were presented in number and proportions. Descriptive statistics were used to categorize the variables. The analysis was performed using Statistical Package for Social Science (SPSS) version 23.

## 3. Results

### 3.1. Demographic data

A total of 497 respondents completed the questionnaire of which many were female (n = 366, 73.6%) and aged between 18–30 years (n =

424, 85.3%). More than half of them completed secondary education (n = 326, 65.6%) and about a third (n = 167, 33.6%) were university graduates. A large proportion of respondents were students/university students (n = 342, 69.0%). Table 1 shows the demographic characteristics of the respondents.

### 3.2. General knowledge on unwanted medication

We found that 95.5% (n = 475) of the respondents had at least one unused medication in their home. The majority of the respondents revealed that the reason for medicines non-usage was patients improved medical condition (n = 411, 82.7%), followed by the drugs were expired (n = 31, 6.2%) and alterations in prescription (n = 25, 5%). Few respondents had unused medicines due to nonadherence (n = 9, 1.8%), adverse events (n = 8, 1.6%), and unsure of medication purpose (n = 5, 1.0%). NSAIDs were the most common medicines left unused (n = 372) followed by vitamins and nutritional supplements (n = 215), and antibiotics (n = 171). The majority of the respondents checked the expiration date of drugs before buying (n = 362, 72.8%) (Table 2).

### 3.3. Medication disposal practice

A significant proportion of the respondents kept the unused medicines at their home until expired (n = 320, 64.4%). The most common disposal method of expired medicines was disposal in the household garbage (n = 408, 82.1%), followed by flushing the medication to the toilet or sink (n = 26, 5.3%). About 8% (n = 40) of the respondents did not know what to do with their expired medicines. The majority of the respondents never received information about proper medication disposal practice (n = 395, 79.5%). Less than half of them believed that improper practice could have harmful effects on the environment and population health (n = 233, 46.9%). Almost all (n = 478, 96.2%) of the respondents considered that education on the proper medication disposal method was necessary (Table 3).

Table 1. Demographic characteristics of the respondents (n = 497).

Characteristics	n (%)
<b>Sex</b>	
Male	131 (26.4)
Female	366 (73.6)
<b>Age</b>	
18–30 years	424 (85.3)
31–40 years	19 (3.8)
41–49 years	38 (7.7)
50–59 years	16 (3.2)
<b>Education</b>	
Primary school	4 (0.8)
Intermediate/secondary school	326 (65.6)
Diploma/bachelor degree	150 (30.2)
Postgraduate degree	17 (3.4)
<b>Occupation</b>	
Students/university students	342 (69.0)
Employed	74 (14.8)
Entrepreneur	20 (4.0)
Unemployed	23 (4.6)
Others	38 (7.6)
<b>Income (in Indonesian Rupiah)</b>	
≤1.000.000	229 (46.1)
1.000.000–3.000.000	180 (36.2)
3.000.000–5.000.000	43 (8.7)
≥5.000.000	45 (9.0)

**Table 2. General knowledge on unwanted medication.**

Categories		n (%)
Did you have unused medicine at home	Yes	475 (95.5)
	No	22 (4.5)
The number of unused medicines at home	0	22 (4.5)
	1–5	327 (65.7)
	6–10	84 (16.9)
	>10	64 (12.9)
The reason for non-usage	Improved medical condition	411 (82.7)
	The drug was expired	31 (6.2)
	Changes in therapy	25 (5.0)
	Nonadherence to medication	9 (1.8)
	Adverse drug reactions	8 (1.6)
	Did not know/sure about the purpose of medication	5 (1.0)
	Instruction for use was unclear	4 (0.8)
	Kept for reoccurring condition	1 (0.2)
	The patient was pregnant	1 (0.2)
	The patient was passed away	1 (0.2)
	Did not know	1 (0.2)
	Method for procuring unused medicines*	Prescription drugs
Over the counter drugs		308
Received from relatives/friends		13
Purchased based on the recommendation from relatives/friends		68
Class of drugs*	NSAIDs	372
	Vitamins and nutritional supplements	215
	Antibiotics	171
	Herbal drugs	59
	Antihypertensive drugs	26
	Cough medication	12
	Antiallergy drugs	7
	Antidiabetic drugs	7
	Antiulcer drugs	7
	Others	30
	14 Did you check the expiration date of the medicines before procuring?	Yes
No		98 (19.7)
Did not know		37 (7.4)

Note: \*Could be more than one option.

Abbreviation: NSAID: Nonsteroidal anti-inflammatory drugs.

**Table 3. Medication disposal practice.**

Categories		n (%)
13 What did you do with unused medicines?	Kept in home until expired	320 (64.4)
	Threw away in household garbage	144 (29.0)
	Gave to friends/relatives	22 (4.4)
	Flushed down to the toilet or sink	9 (1.8)
	Donated to the hospital	2 (0.4)
What did you do with expired medicines?	Threw away in household garbage	408 (82.1)
	Did not know	40 (8.0)
	Flushed down to the toilet or sink	26 (5.3)
	Burned the medicine	20 (4.0)
	Gave to friends/relatives	2 (0.4)
	Returned it to pharmacy	1 (0.2)
Did you ever receive information about proper medication disposal practice?	Yes	102 (20.5)
	No	395 (79.5)
7 Did you know that improper medication disposal could harm the environment and population health?	Yes	233 (46.9)
	No	264 (53.1)
Did you think education on proper medication disposal methods was necessary?	Yes	478 (96.2)
	No	4 (0.8)
	Did not know	15 (3.0)

#### 4. Discussion

3 This is a cross-sectional study investigating the medication disposal practice of unwanted medicines. A limited understanding of several aspects of the pharmaceutical disposal methods among the respondents was observed.

A significant percentage of respondents stated that the reason for having unwanted medicines was improved medical conditions (82.7%). This finding is similar to studies conducted in New Zealand and Ethiopia [4, 19]. Excessive prescribing might contribute to this condition. Good medicine management and appropriate use of clinical guidelines are important to reduce medication waste [20]. In this study, relatively few respondents (6.2%) stated that the reason for medicines non-usage was the drug reached the expiration date. A large portion of the respondents (72.8%) checked the drug expiration date before buying, which is similar to the finding of the other [18]. It is critical to be alert with a product expiration date to ensure full potency and safety of the drugs and avoid treatment failure [21].

We also found that self-medication was prevalent among respondents. 5 Pharmacists play a central role in providing customers with assistance and sound advice on medicine to facilitate its rational use to help reduce preventable medication waste [22]. Furthermore, we observed that most patients kept the unused medicines at home until they expired. This can be partly explained by the intention of respondents to share the unused medicines to their relatives or friends based on a similar medical problem. Medication sharing may help patients reduce treatment costs and inconvenience, such as waiting for a medical appointment [23]. However, studies on medication sharing largely focused on its adverse consequences, such as the increased risk of adverse effects and allergies, antimicrobial resistance, and decreased efficacy [24, 25, 26].

We found that the most common unused medicine was NSAIDs, followed by vitamins or nutritional supplements, and antibiotics. Nearly a fifth of the respondents had antibiotics in their homes. Storing the medicines for recurring symptoms is appropriate, but keeping antibiotics to consume for different infections can result in the progression of antibiotic resistance and a higher risk of therapeutic ineffectiveness [22].

An environmentally unsafe disposal method was used by the majority of the respondents, indicating a very poor awareness of pharmaceutical waste management issues. A high rate of medication disposal through household waste was observed in this study (82.1%). Our finding is slightly higher than studies conducted in the United States and Saudi Arabia (63%–73%) [27, 28], but relatively similar to that of Serbia (82.8%) [29]. Very few respondents returned their unwanted medicines to pharmacy or hospital, which contradicted the studies conducted in Sweden, New Zealand, and Australia [30, 31, 32]. This may be due to the unavailability of a system that encourages a safe medication disposal method. In Australia, the medication take-back program called Return Unwanted Medicines campaign successfully collected 700 tons of unwanted medicines in 2015–2016, helping in preventing them from being disposed of inappropriately and cause environmental damage [33]. However, such a system needs to be painstakingly implemented to ensure its uptake and sustainability. In Romania, the medication take-back program was considered ineffective by pharmacists due to incomplete legislation, lack of procedures, and high cost [34].

12 Over half of the respondents were unaware that improperly disposed medicine could harm the ecosystem and population health (53.1%). Many of them also never received information on safe medicine disposal practices (79.5%). Government and health-care professionals should be more proactive in educating the public about the appropriate use, storage, and disposal of pharmaceutical products. 3 The results from this study can provide a reference for competent authorities to implement a system and policy that urge the public to dispose of unwanted medicines safely. Furthermore, conducting relevant training and continuous education for health-care professionals, as well as medical, pharmacy, and nursing students, are strongly encouraged [4, 18].

Presumably, this is the first study that thoroughly evaluates the disposal practices of unused and expired medicines among Indonesian consumers. However, this study has several limitations. This study was conducted in one region in Bandung, thus its generalization for the Indonesian population is limited. Also, the predictors associated with disposal practice were not identified.

#### 5. Conclusion

The disposal of unwanted pharmaceutical products through environmentally unsafe route was prevalent in Bandung, Indonesia. Poor awareness of the harms associated with inappropriate disposal practice was observed. These findings call upon the strategies to strengthen the pharmaceutical waste management program.

#### Declarations

##### Author contribution statement

Widya N. Insani: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Nabilla A. Qonita, Siti S. Jannah, Nisa M. Nurliyah, Woro Supadmi, Vesara A. Gatera: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Sofa D. Alfian: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Rizky Abdulah: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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##### Competing interest statement

The authors declare no conflict of interest.

##### Additional information

No additional information is available for this paper.

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