UDC: 628.4.045/.046:615.2
Professional paper

KNOWLEDGE, ATTITUDES AND DISPOSAL PRACTICES OF UNUSED PHARMACEUTICAL PRODUCTS

Faton AHMETI[1], Edita ALILI-IDRIZI[2], Hanife RUSTEMI-AHMETI[1,2], Paulina APOSTOLOVA[1], Emilija JANEVIK-IVANOVSKA[1*]

[1]*Faculty of Medical Sciences, Goce Delcev University, Stip*
[2] *Department of Pharmacy, Faculty of Medical Sciences, University of Tetova, Tetovo*
[*]*Corresponding Author: e-mail: emilija.janevik@ugd.edu.mk*

Abstract

The improper disposal of unused or expired pharmaceutical products is a global problem, with serious implications on public health, environmental safety, and water quality. Therefore, the aim of this study is to investigate and determine the level of knowledge, attitudes, and practices of the population regarding the management of pharmaceutical waste. This is a cross-sectional study conducted among residents of North Macedonia, using a Google Forms prepared questionnaire. A total of 1,046 respondents participated in the survey. Almost 50.0% declared they store more than 6 pharmaceutical products at home, mainly analgesics (60.2%) and antibiotics (57.6%). High percentage of respondents (86.4%) declared that they throw pharmaceutical products in the trash bin, while 84.7% gave a negative response regarding a designated collection point for unused or expired pharmaceutical products. Majority of respondents, 68.2%, were not aware of the existence of laws and guidelines for the safe disposal of pharmaceutical products. It is of great importance to intensify efforts to raise public awareness about the safe pharmaceutical disposal, as well as strengthening the rule of law and inspection mechanisms. Training and educational programs for the safe disposal of pharmaceutical products should be organized, with pharmacies identified by respondents as the most appropriate location for such initiatives.

Keywords: Unused pharmaceutical products, disposal practice, questionnaire, law for the safe disposal

1. Introduction

The environmental impact of pharmaceutical preparations and personal care products has recently become a major focus of research. Personal care products include substances used for personal health or cosmetic purposes, and it is estimated that around 20 million tons of these products are produced annually (Wang & Wang, 2016). According to World Health Organization, all these products that have not been consumed by the patient, have not passed their expiry date, and have not been returned to a healthcare professional or a take-back program, are known as unused medicines (World Health Organization, 1999).

Unfortunately, these products have been detected in water sources across the globe. While the effects of these chemical preparations on humans and the environment are not yet fully understood, there is still no conclusive scientific evidence proving a specific impact on human health (Doerr-MacEwen & Haight, 2006).

Since the 1990s, water contamination with pharmaceutical preparations has been a sensitive issue concerning environmental pollution (Doerr-MacEwen & Haight, 2006). It is also particularly important to note that public health professionals in the United States began reporting the presence of pharmaceuticals in water sources as early as the 1970s (WHO, 2012). Guided by recommendations from poison control centers—or based on their own personal beliefs—healthcare workers, as well as consumers themselves, have disposed of pharmaceutical preparations by flushing them down the toilet or simply discarding them into the public sewage system (McCullagh MC *et al*, 2012). This practice was standard until measurable quantities of pharmaceutical and chemical substances were detected in the environment, raising alarms about

the consequences of pharmaceutical pollution and its negative impact on human health (Blair *et al*, 2013). The presence of antidepressants and hormones in water has been shown to impact fish, (Hughes *et al*, 2013) while the presence of antibiotics in water contributes to the emergence of antibiotic resistance, leading to gene abnormalities in both humans and aquatic life (Costanzo *et al*, 2004).
The high use of pharmaceutical products also increases the possibility of improper disposal, requiring the development of appropriate interventions. In our country, public awareness of the proper management of pharmaceutical waste is low, therefore this study aims to investigate and determine the level of knowledge, attitudes, and practices of the population regarding the management of pharmaceutical waste.

2. Material and Methods

This is a cross-sectional study conducted among residents of North Macedonia, from July 8, 2019 to July 21, 2019. The study population included permanent residents at least 18 years old, who have used at least one medication in the past two years.
A questionnaire prepared using the Google Forms web application, in both Albanian and Macedonian languages, was used to collect data. The questionnaire was constructed in three main parts. Part one included socio-demographic information about the study participants, such as age, gender, residence, ethnicity and educational level. Part two included 4 questions about the obtained medicines. Part three consists of 7 questions about medication disposal and the last part included questions about laws and guidelines for the safe disposal of pharmaceutical preparations.
The sample size was computed using a population proportion formula, with 95% confidence interval, as presented in Table 1.

Table 1. The sample size calculation

Confidence interval	95%
***Population**	1,808,131
Sample	1,046
Margin of error	3.03%
** In the absence of new data on the resident population of the Republic of North Macedonia, the population in this study represents the number of persons who are citizens of the Republic of North Macedonia over the age of 18 (the number of voters in the 2019 Presidential Elections was taken as the number).*	

The form link was distributed via a web platform (Facebook Pages), where two sponsored pages were created for the purpose of the survey. The page was uniformly promoted with random targeting during the study period.
The collected data was stored in a database, exported to Excel for initial processing, and subsequently transferred to SPSS for further analysis.

3. Results

Socio-demographic characteristics

A total of 1,046 respondents participated in the survey conducted over a two-week period (from July 8 to July 21, 2019). Since the survey was distributed throughout the Republic of North Macedonia, and the criteria for participation required respondents to be permanent residents of

the Republic of North Macedonia over 18 years the reference population size was taken as 1,808,131.
The study included 50.2% male and 49.8% female participants. The average age of the respondents was 37.2 years and the most represented age group was 28–32 years with 20.5%. Regarding ethnicity, 55.4% were Albanians, and according to the educational level, almost 50.0% of them had a university degree. The most represented geographical areas were Skopje (26.5%) and Tetovo (25.2%) (Table 2).

Table 2. Socio-demographic data

Gender	**Frequency**	**Percentage**
Male	525	50.2%
Female	521	49.8%
Age group	**Frequency**	**Percentage**
18-22	61	5.8%
23-27	129	12.3%
28-32	214	20.5%
33-37	181	17.3%
38-42	173	16.5%
43-47	113	10.8%
48-52	70	6.7%
53-57	48	4.6%
>57	57	5.4%
Average age	37.2	
Ethnicity	**Frequency**	**Percentage**
Albanian	579	55.4%
Macedonian	393	37.6%
Turkish	38	3.6%
Roma	11	1.1%
Bosnian	8	0.8%
Serbian	11	1.1%
Other	6	0.6%
Education level	**Frequency**	**Percentage**
Primary	14	1.3%
Secondary	264	25.2%
University	520	49.7%
PhD	232	22.2%
Other	16	1.5%

Obtain of pharmaceutical products

Respondents obtain pharmaceutical products mainly based on a doctor prescription (85.2%), while 47.5% declared that they store more than 6 of these products at home. Most of the respondents in the study reported using and storing analgesics (60.2%) and antibiotics (57.6%). A significant percentage of respondents (73.0%) were aware of the importance of the expiration date (Table 3).

Table 3. Distribution of respondents based on their practice to obtain pharmaceutical product

Variables	Categories	Percentage
How did you most recently obtain your pharmaceutical products?	Based on a doctor's prescription	85.2
	OTC drugs (drugs that are given without a prescription)	54.0
	Medicines that you have purchased based on advice received from a family member or relative	15.7
	Medicines that a family member or relative gave you	13.7
	Other	1.0
How many pharmaceutical products do you currently store at home?"	0	1.0
	1	3.4
	2	9.7
	3	13.1
	4 to 5	25.3
	More than 6	47.5
What type of pharmaceutical have you used and stored recently?"	Analgesics	60.2
	Nonsteroidal anti-inflammatory drugs	30.8
	Antibiotics	57.6
	Antihypertensives	9.8
	Antidepressants	9.2
	Antidiabetics	6.3
	Other	7.1
Do you check the expiration date when purchasing pharmaceutical products from a pharmacy?	Yes	73.0
	No	23.3
	Don't know	3.6

Knowledge about the disposal of pharmaceutical products

Table 4 summarizes the data about the knowledge of the respondents on the disposal of pharmaceutical products. In response to the question "What method do you most often use to dispose of unused or expired pharmaceutical products?", 86.4% declared that they throw them in the trash bin along with other household waste, while 17.5% dispose them in the toilet or sink (sewage system)"

A majority of respondents (84.7%) reported that there is no designated collection point for unused or expired pharmaceutical products in their residential, and the remaining percentage (13.4%) were not aware.

In response to the question **"**If such a place exists, is it easily accessible?", 83.3% answered "Such a place does not exist", further confirming the lack of infrastructure and public knowledge regarding proper pharmaceutical waste disposal.

Almost 40.0% of respondents consider that pharmaceutical companies are responsible for the safe disposal of unused or expired pharmaceutical products, followed by 33.2% of them who consider it is individual responsibility. Majority of the of respondents (90.3%) agree for the negative effect of improper and unsafe disposal of these products on human health and 71.9% of them are very willing to dispose unused or expired pharmaceutical products in a proper

disposal site. Almost 59.0% of the respondents chose the nearest pharmacy as the preferred easily accessible place.

Table 4. Knowledge of the respondents on the disposal of pharmaceutical products

Variables	**Categories**	**Percentage**
What method do you most often use to dispose of unused or expired pharmaceutical products?	I throw them in the bathroom sink (sewage)	17.5
	I throw them in the bathroom or kitchen sink	10.5
	I return them to the pharmacy	4.5
	I threw them in the trash (along with other household waste)	86.4
	I keep them at home, for possible future use	11.9
	Other	3.3
Is there a designated collection point for unused or expired pharmaceutical products in your residential area?	Yes	1.9
	No	84.7
	Don't know	13.4
If such a place exists, is it easily accessible?	Yes, it's easy	7.6
	It takes a little bit to get there	4.7
	It's impossible to get there	4.5
	There's no such place	83.3
In your opinion, who is responsible for the safe disposal of unused or expired pharmaceutical products?	Pharmaceutical companies	39.4
	Pharmacies	29.9
	Doctors and other healthcare professionals	10.1
	Directorate for drinking water or wastewater management	7.3
	Directorate for the environment and Inspectorate for the environment	27.7
	Center for Public Health and Institute for Public Health	26.4
	Health and Sanitary Inspectorate	31.1
	Municipality and local community	16.2
	Any individual	33.2
	Other	3
Do you believe that improper and unsafe disposal of pharmaceutical products can have a negative effect on human health?	Yes	90.3
	No	2.2
	I don't know	7.5
How willing are you to dispose of unused or expired pharmaceutical products in a proper disposal site?	Very willing	71.9
	Somewhat willing	19.9
	Neither willing nor unwilling	2.8
	Somewhat unwilling	1.1
	Not willing	2.9
	Not sure	1.4
Where would you be willing to dispose of unused or expired pharmaceutical products?	At the nearest pharmacy	58.9
	At a clinic, hospital, private practice	19.3
	At a household hazardous waste collection facility	38.7
	At a supermarket / store	11.5

	In the garbage / trash	20.7
	At the premises of the Department of Public Health or the Institute of Public Health	14.3
	Other	1.9

Attitudes on Regulations and guidelines for the safe disposal of pharmaceutical products

More than a half of the respondents (68.2%) were not aware about the existence of laws and guidelines for the safe disposal of pharmaceutical products, while 82.2% of them did not have any information about promotional materials with instructions on safe medication disposal (Table 5).

Table 5. Attitudes of respondents on regulations and guidelines for the safe disposal of pharmaceutical products

Variables	**Categories**	**Percentage**
Do you have any information about the existence of laws and guidelines for the safe disposal of pharmaceutical products?	Yes	17.6
	No	68.2
	Don't know	14.2
Do you have any information about promotional materials (brochures, pamphlets) provided to patients/users with instructions on safe medication disposal?	Yes	5.4
	No	82.2
	Don't know	12.3

4. Discussion

The present study assessed knowledge, attitudes and disposal practice of unused pharmaceutical products among the residents in Republic of North Macedonia.

Analgesics (60.2%) and antibiotics (57.6%) are the major classes of pharmaceutical products reported by the study participants to be used and found in their homes as leftover drugs. This is similar with the findings in Brewerville, Liberia where the classes of drugs found were antibiotics (76%), non-steroidal anti-inflammatory drugs (NSAIDS) (22%) and anti-hypertensive drugs (Toe J *et al*, 2023**)**. The storage and retrieval of these classes of drugs could be related to the most common health conditions.

The most common disposal method for unused pharmaceutical products was throwing them in the trash bin (86.4%), followed by disposing them into the toilet or sink (17.5%). These poor results are in coherence with the study conducted in Turkey and Gondar City (Köksoy S, 2024; Yohannes L et al, 2025) where 81% and 60.04% of the study participants, had improper disposal behaviors for unused and expired medicines. In contrast, only 4.5% of the respondents in the study declared that they return unused pharmaceutical products to pharmacies. This practice is a preferred disposal method in Australia (Kelly F et al, 2018).

A significant percentage of the respondents in the study agree for the negative effect of improper and unsafe disposal of pharmaceutical products on human health. The findings from the potential correlations between current disposal practices and knowledge about the impact of pharmaceutical waste on the environment and human health, revealed that 77.7% of respondents who stated that they dispose pharmaceutical products in the household trash (along with other domestic waste) also believe that improper and unsafe disposal of pharmaceutical products can have a negative effect on human health. This was followed by 16.8% of respondents who held

the same belief but reported disposing of pharmaceutical products via the sink or toilet (sewage system).

Regarding awareness of the existence of laws and guidelines, 73.3% of those who dispose pharmaceutical products in the trash bin, reported having no information about the existence of such laws or guidelines. This was followed by 14.2% who had the same lack of information, despite disposing of pharmaceutical products via the sewage system. The need for a guideline for expired and unwanted medication handling at homes is also reported by 90% of the respondents in Liberia (Toe J *et al*, 2023**)** while 96% of the participants in Ethiopia suggest initiation of an outreach awareness program about how proper disposal of unused or expired medicines (Gidey M.T *et al*, 2020**)**.

When analyzing current disposal practices and awareness of any promotional materials (such as brochures or pamphlets) that provide guidance to patients/users on the safe disposal of pharmaceutical products, it was found that 82.6% of those who dispose pharmaceutical products in the trash reported having no information about such promotional materials. This was followed by 16.4% of respondents who also lacked such information but disposed of their pharmaceutical products in the sink or toilet.

In the analysis of current disposal practices and the availability of disposal options for pharmaceutical products – specifically the question "In your area of residence, is there a designated collection site for unused or expired pharmaceutical products?", 85.2% of those who dispose pharmaceutical products in the household trash stated that there is no such designated site in their area highlighting the need for improved public awareness as well as health consequences of such practices.

5. Conclusions

The study revealed inadequate knowledge and suboptimal disposal practice of unused pharmaceutical products among majority of respondents. The most common disposal practices found in the study were disposing in the trash bin along with other household waste and flushing them in the toilet or sink. Therefore, the relevant institutions of the Republic of North Macedonia, particularly those responsible for environmental protection and public health, should intensify efforts to raise public awareness regarding the issue of safe pharmaceutical disposal. It's also imperative to strengthen the rule of law and inspection mechanisms. This includes the development and enforcement of comprehensive legislative frameworks at all levels - national, local, and regional, particularly in matters concerning environmental and public health protection. Programs for the safe disposal of pharmaceutical products should be organized, including the establishment of return points for unused pharmaceutical products, with pharmacies identified by respondents as the most appropriate location for these initiatives.

References

[1]. Blair BD, Crago JP, Hedman CJ, Klaper RD. 2013. Pharmaceuticals and personal care products found in the Great Lakes above concentrations of environmental concern. Chemosphere. 93(9):2116-23. doi: 10.1016/j.chemosphere.2013.07.057. Epub 2013 Aug 23. PMID: 23973285.

[2]. Costanzo, SD, Murby, J, and Bates, J. 2005. Ecosystem response to antibiotics entering the aquatic environment. Mar Pollut Bull. 51:218–23. doi: 10.1016/j.marpolbul.2004.10.038

[3]. Doerr-MacEwen NA, Haight ME. 2006. Expert stakeholders' views on the management of human pharmaceuticals in the environment. Environ Manage. 38(5):853-66. doi: 10.1007/s00267-005-0306-z. Epub 2006 Sep 2. PMID: 16955232.

[4]. Gidey M.T., Birhanu A.H., Tsadik A.G., Welie A.G., Assefa B.T. 2020. Knowledge, attitude, and practice of unused and expired medication disposal among patients visiting Ayder comprehensive specialized hospital. Biomed Res Int. 20:9538127. doi: 10.1155/2020/9538127.

[5]. Hughes, SR, Kay, P, and Brown, LE. 2013. Global synthesis and critical evaluation of pharmaceutical data sets collected from river systems. Environ Sci Technol. 47:661–77. doi: 10.1021/es3030148
[6]. Kelly F, McMillan S, Spinks J, Bettington E, Wheeler AJ. 2018. 'You don't throw these things out:'an exploration of medicines retention and disposal practices in Australian homes. BMC Public Health. 18:1–12. doi: 10.1186/s12889-018-5753-6
[7]. Köksoy S. 2024. Unused, expired pharmaceuticals and their disposal practices among the general public in Burdur-Türkiye: a cross-sectional study. BMC Public Health. 24:1303. doi: 10.1186/s12889-024-18788-0, PMID: [DOI] [PMC free article] [PubMed] [Google Scholar]
[8]. McCullagh MC, Schim S, Ortner P. 2012. Drug disposal among hospice home care nurses: a pilot study of current practice and attitudes. J Pain Symptom Manage.43(2):287-92. doi: 10.1016/j.jpainsymman.2011.03.024. Epub 2011 Sep 14. PMID: 21917416.
[9]. Toe J, Orok E, Erah P. 2023. Assessment of knowledge and disposal practices of unused and expired household medicines in a community in Liberia. Explor Res Clin Soc Pharm.12:100369. doi: 10.1016/j.rcsop.2023.100369. PMID: 38058360; PMCID: PMC10696106.
[10]. Wang, J., & Wang, S. 2016. Removal of pharmaceuticals and personal care products (PPCPs) from wastewater: A review. Journal of Environmental Management. Volume 182, Pages 620-640
[11]. World Health Organization. 1999. Guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies. Geneva: World Health Organization
[12]. World Health Organization. 2012. Pharmaceuticals in drinking-water. Geneva, CH: World Health Organization.
[13]. Yohannes L, Tegegne AA, Genet G, Workie Limenh L, Mohammed Seid A, Alemayehu TT, Ayenew W, Simegn W. 2025. Disposal practice and determinants of unused medicines among the general public in Gondar City, Northwest Ethiopia. Front Public Health. 13:1516809. doi: 10.3389/fpubh.2025.1516809. PMID: 40084200; PMCID: PMC11904836.