



The Impact Of Disposal Of Expired Medicines On The Environment

Meshari. S al-otabi^{1*}, Maha A .AL sharif², Fayez .M. Alhuzali³ Abdulmajeed. A. Alghamdi⁴,
Moataz.A.Awaji⁵, Abdullah.S.Alzahrani⁶, Essa.H.Al-Amri⁷, Hassan.O.Assiri⁸,
Hamdi.A.Alamri⁹, Sultan.J.Al-Harbi¹⁰, Fahad.A.Al-Faridi¹¹, Abdullah.S.Waznah¹²,
Basim.M.Alhazmi¹³.

^{1*}Pharmacy technician at King Faisal Hospital

²Pharmacy technician at the primary healthcare center in Al-Otaibiah

³Pharmacist at Health Affairs licensing department

⁴Pharmacist at the ministry of Health in Sharqia

⁵Pharmacist at the ministry of Health in Sharqia

⁶Pharmacy technician at the ministry of Health in Sharqia

⁷Pharmacy technician at the Armed Forces Hospital in Dhahran

⁸Pharmacy technician at the Armed Forces Hospital in the South (Pharmaceutical Purchasing Representative)

⁹Pharmacy technician at the ministry of Health in Sharqia

¹⁰Pharmacy technician at ministry of health in Riyadh

¹¹Pharmacy technician at ministry of health in Alsharqiah

¹²Pharmacist at king Abdulaziz Hospital in Jeddah

¹³Pharmacist technician at the Al-Fera primary health care center in Al-Najil, Taif Health Cluster

*Corresponding Author: Meshari. S al-otabi

*Pharmacy technician at King Faisal Hospital

Abstract: the aim of the current study is, what are the types of expired medications that affect the environment? What are the effects of disposing of expired medications on the environment? What are the safe ways to dispose of expired medications, The questionnaire was created electronically via the Google Drive program, and then it was distributed via mobile phone on the social networking program (WhatsApp). Using e-mail for all participants to respond to the questionnaire. 600 questionnaires were distributed to all mobile groups, and 550 questionnaires were received on the researcher's e-mail. (The target group is residents of the Holy City of Mecca, aged 25-60 years).

Keywords: risk, wasting, unused medicine, patient, society

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⁾. 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. ion of topical medications during showering.⁽¹⁸⁾ However, inappropriate disposal of unused and expired pharmaceuticals accounts for the largest share.⁽¹⁹⁾ Developing countries, with unknown quantities

of (and capacity for) medicinal wastes, have recently significantly increased in pharmaceutical product consumption.^(20,21) This leads to global apprehensions associated with the production of pharmaceuticals waste, which in turn necessitate the advancement of knowledge and awareness on safe disposal of the wastes for the general public.^(22,23) These global concerns include inappropriate self-medication, accidental consumption by children, accumulation of active pharmaceutical ingredients in streams as environmental pollutants, a risk of antimicrobial resistance, and accidental poisoning of wildlife.⁽²³⁾ For example, diclofenac, a nonsteroidal anti-inflammatory drug, has been shown to induce renal failure in vultures following the uptake of the flesh of oxen treated with this drug.¹¹ Expired tetracycline is also confirmed to cause renal tubular damage.⁽²⁴⁾ Thus, any damaged or expired medicinal product ought to be processed directly into specialized waste bins following their removal from pharmacy stock or return from patients. If pharmaceuticals waste cannot undergo immediate processing, they should be separated from the other pharmaceutical products, and tags should be attached by specifying “medicines for destruction” and stored under the control of authorized personnel in a specified quarantine, pending timely processing for disposal. There should be no accumulation of such medicinal waste at the pharmacy. ⁽²⁵⁾ Pharmaceuticals reach the environment mainly through three routes: It is excreted by humans and animals, as is or metabolized, mainly in urine, and is transported into the environment directly or via wastewater treatment plants. Unused pharmaceuticals reach the environment either through domestic wastewater or through treated urban solid waste. Manufacturing plants producing active ingredients may unintentionally release pharmaceuticals into the environment. Pharmaceuticals can be detected today through improved measurement methods, at concentrations that may have already existed decades ago but could not be measured. Many pharmaceutical preparations are excreted or washed off (post-consumer): studies have shown excretion rates for between 30% and 70% of orally administered substances, and even higher rates for externally used ointments or gels ⁽²⁶⁾⁽²⁷⁾. Some pharmaceuticals are reduced to different levels in wastewater treatment plants, but others leave the plant in their active chemical form. Active residues of pharmaceuticals have been detected in surface waters, which may persist in the environment for long periods of time. Large quantities of antibiotics and other pharmaceuticals have been found at the outfalls of wastewater treatment plants in sub-watersheds where hospital wastewater discharge plays a major role or in watersheds into which pharmaceutical industries drain. Soy absorbs persistent environmental pharmaceutical contaminants from treated sewage sludge used as fertilizer, and antibiotics have also been found in plant leaves ⁽²⁸⁾. The ways pharmaceutical substances enter drinking water vary. Drinking water is mostly provided through drinking water reservoirs, groundwater and natural filtration through river banks. Unremoved pharmaceuticals may be detected in the drinking water treatment process if treated wastewater is discharged into watersheds that provide drinking water. For example, the Netherlands supplies 37% of its drinking water from surface water, mainly from natural filtration via the banks of the Rhine and Meuse rivers. In this case some attention is given to the treatment of pharmaceutical residues ⁽²⁹⁾.

2-Material and Methods:

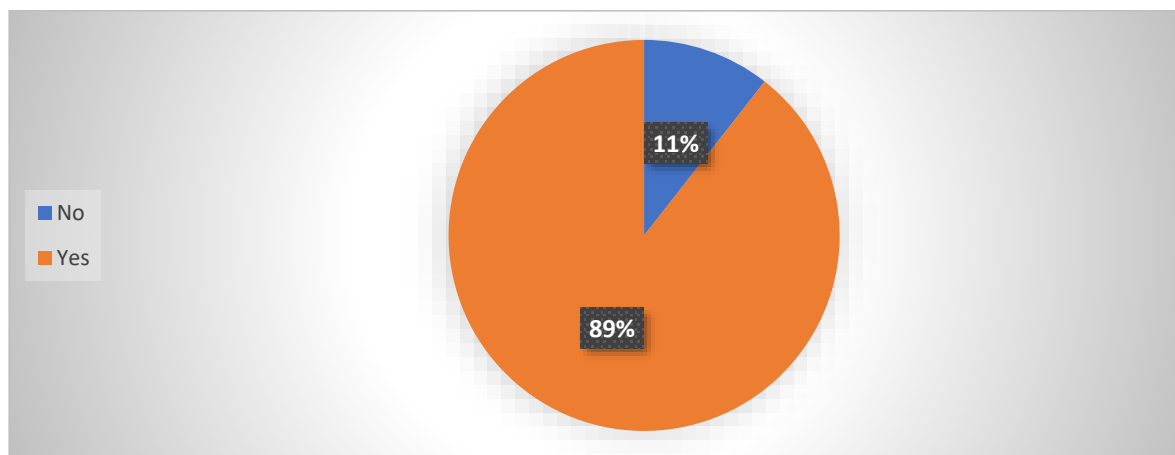
The study started in (the holy city of Mecca in Saudi Arabia), began writing the research and then recording the questionnaire in June 2023, and the study ended with data collection in September 2023. The researcher used the descriptive analytical approach that uses a quantitative or qualitative description of the social phenomenon (The impact of disposal of expired medicines on the environment). This kind of study is characterized by analysis, reason, objectivity, and reality, as it is concerned with individuals and societies, as it studies the variables and their effects on the health of the individual, society, and consumer, the spread of diseases and their relationship to demographic variables such as age, gender, nationality, and marital status. Status, occupation ⁽³⁰⁾, And use the Excel 2010 Office suite histogram to arrange the results using: Frequency tables Percentages ⁽³¹⁾. A questionnaire is a remarkable and helpful tool for collecting a huge amount of data, however, researchers were not able to personally interview participants on the online survey, due to social distancing regulations at the time to prevent infection between participants and researchers and vice versa (not coronavirus participation completely disappearing from society). He only answered the questionnaire electronically, because the questionnaire consisted of nine questions, all of which were closed. The online approach has also been used to generate valid samples in similar studies in Saudi Arabia and elsewhere ⁽³²⁾

3- Results:

The percentage of approval to participate by those targeted in the research questionnaire was expected to be 100%, and the percentage of their ages was as follows: from 25-34 years: 47.8%, and their percentage among those aged 35-44 years was 34.8%, and from the ages of 45-54 years it was 15.2%, and from the age of 55 -60 years 2.2%. As for the gender and percentage of participants, the percentage of males was 78.3%, and the percentage of females was 21.7%. As for their nationalities, the percentage of non-Saudis was 19.6%, while the percentage of Saudis was 80.4%. As for their professions, they were as follows: student 0%, government employee 60.9%, private sector employee 30.4%, housewife 4.3%, entrepreneur 4.4%, freelancer 0%. As for their educational status, it was as follows: neither read nor write 0%, primary 0%, intermediate 2%, secondary 0%, diploma 19.6%, university 63%, master's 6.7%, doctorate 8.7%. When moving on to participate in answering the research questionnaire, it was as follows: The first question: Is disposing of medicines through toilets or sinks dangerous and considered an environmental and health disaster? Yes 93.5% and no 6.5%. The second question: Is laboratory wastewater containing pharmaceutical chemical compounds likely to mix with river and sea water, affecting the river and marine environment and various organisms? Yes 95.7% and no 4.3%. The third question: Does unsafe disposal of medicines increase the spread of antibiotic resistance? Yes 84.4% and no 15.6%. The fourth question: About many medications that are not completely absorbed or received by the body and may enter the

environment after passing through wastewater treatment plants? Yes, 86.7% and no, 13.3%. The fifth question: What is the percentage of household medicines that turn into medical waste that can reach up to 50% globally? Yes 84.8% and no 15.2%. The sixth question: Can pharmaceutical waste affect the environment by leaking into groundwater unless it is treated properly? Yes 89.6% and no 10.6%. The seventh question: Can pharmaceutical waste be classified into four categories? 1- Flammable waste 2- Pharmaceutical waste that includes acidic or alkaline materials 3- Pharmaceutical waste that interacts negatively with other chemicals 4- Toxic pharmaceutical waste such as mercury? Yes 95.7% and no 4.3%. Question 8: Does the random disposal of antibiotics cause mutations in animals and stimulate bacteria to develop resistance to antibiotics? Yes 89.1% and no 10.9%. The ninth question: Can mechanisms be developed to redistribute unused medicines that are close to their expiration date to improve the balance between supply and demand and prevent waste? Yes 91.3% and no 8.7%. (figure No.1).

Figure No.1: Opinions of the targets (residents of the city of Mecca) and their attitudes regarding the impact of disposal of expired medicines on the environment



4-Discussion:

We found from this study that, the expired medicines have an impact on the environment, especially if they are not disposed of in a safe, sound and correct manner, and if they leak into groundwater and rivers, they represent a great danger to the environment and therefore humans.

Acknowledgment:

To start with, I would like to Praise God and thank Dr. Anas S. Dablood, from Umm Al-Qura University (Public Health Department, Faculty of Health Sciences Al-leeth), Mecca, Saudi Arabia. And the researchers who make the project come to light.

References:

- 1- S. Sonowal, C. Desai, J.D. Kapadia, M.K. Desai, A survey of knowledge, attitude, and practice of consumers at a tertiary care hospital regarding the disposal of unused medicines, *J. Basic Clin. Pharm.* 8 (2016) 4–7.
- 2- World Health Organization, Challenges in Expanding Access to Essential Medicines, 2004. <http://apps.who.int/medicinedocs/en/d/Js5571e/2.html>. Accessed 16.04.28.
- 3- T. Atinafu, A. Takele, A. Kassie, A. Yehualaw, G. Tesfaw, T. Desseno, et al., Unused medications disposal practice: the case of Patients visiting university of Gondar specialized teaching Hospital, Gondar, Ethiopia, *Int. J. Pharma Sci. Res.* 5 (2014) 995–1005.
- 4- Y. Ayele, M. Mamu, Assessment of knowledge, attitude, and practice towards disposal of unused and expired pharmaceuticals among community in Harar city, Eastern Ethiopia, *J Pharm Policy Pract* 11 (2018) 27.
- 5- C.G. Daughton, T.A. Ternes, Pharmaceuticals and personal care products in the environment: agents of subtle change? *Environ. Health Perspect.* 107 (1999) 907.
- 6- J.P. Bound, N. Voulvoulis, Household disposal of pharmaceuticals as a pathway for aquatic contamination in the United Kingdom, *Environ. Health Perspect.* 113 (2005) 1705–1711.
- 7- T.M. Beirens, E.F. van Beeck, R. Dekker, J. Brug, H. Raat, Unsafe storage of poisons in homes with toddlers, *Accid. Anal. Prev.* 38 (2006) 772–776.
- 8- P.K. Thai, L.X. Ky, V.N. Binh, P.H. Nhung, P.T. Han, N.Q. Hieu, et al., Occurrence of antibiotic residues and antibiotic-resistant bacteria in effluents of pharmaceutical manufacturers and other sources around Hanoi, Vietnam, *Sci. Total Environ.* 645 (2018) 393–400.
- 9- S. Jobling, R. Williams, A. Johnson, A. Taylor, M. Gross-Sorokin, M. Nolan, et al., Predicted exposures to steroid estrogens in UK rivers correlate with widespread W.N. Insani et al. *Heliyon* 6 (2020) e04551 4 sexual disruption in wild fish populations, *Environ. Health Perspect.* 114 (2006) 32–39.

- 10-P.E. Stackelberg, E.T. Furlong, M.T. Meyer, S.D. Zaugg, A.K. Henderson, D.B. Reissman, Persistence of pharmaceutical compounds and other organic wastewater contaminants in a conventional drinking-water-treatment plant, *Sci. Total Environ.* 329 (1) (2004) 99–113.
- 11-B. Media, R.K. Sewal, Ecopharmacovigilance: an issue urgently to be addressed, *Indian J. Pharmacol.* 44 (2012) 547–549.
- 12-D. Seehusen, J. Edwards, Patient practices and beliefs concerning disposal of medications, *J. Am. Board Fam. Med.* 19 (2006) 542–547.
- 13-C. Bates, R. Laciak, A. Southwick, J. Bishoff, Overprescription of postoperative narcotics: a look at postoperative pain medication delivery, consumption and disposal in urological practice, *J. Urol.* 185 (2011) 551–555.
- 14-X. Wang, P. Howley, A.B. Boxall, et al., Behavior, preferences and willingness to pay for measures aimed at preventing pollution by pharmaceuticals and personal care products in China, *Integrated Environ. Assess. Manag.* 12 (2016) 793–800.
- 15-S. Sasu, K. Kümmerer, M. Kranert, Assessment of pharmaceutical waste management at selected hospitals and homes in Ghana, *Waste Manag. Res.* 30 (2012) 625–630.
- 16-S. Aditya, Safe medication disposal: need to sensitize undergraduate students, *Int J Pharm Life Sci* 4 (2013) 2475–2480.
- 17-M.M. Hassan, S.A. Ahmed, K.A. Rahman, T.K. Biswas, Pattern of medical waste management: existing scenario in Dhaka City, Bangladesh, *BMC Publ. Health* 8 (2008) 36.
- 18-Sue I, Daughton CG. Types and quantities of leftover drugs entering the environment via disposal to sewage—revealed by coroner records. *Sci Total Environ.* 2007;388:137-148.
- 19-Tong AYC, Peake BM, Braund R. Disposal practices for unused medications in New Zealand community pharmacies. *J Prim Health Care.* 2011;3:197-203.
- 20-Teelavath M, Teelavath V, Teelavath K. Pharmaceutical waste and public health—a review. *Int J Pharm Educ Res.* 2014;1:22-27.
- 21-Windfeld ES, Brooks MS. Medical waste management—a review. *J Environ Manage.* 2015;163:98-108.
- 22-Nipa NY, Ahmed S, Shahriar M, Rahman M, Haider B, Uddin MB. Improper management of pharmaceutical waste in South and South-East Asian regions. *J Environ Stud.* 2017;3:1-7.
- 23-Ruhoy IS, Daughton CG. Beyond the medicine cabinet: an analysis of where and why medications accumulate. *Environ Int.* 2008;34:1157-1169.
- 24-Anastasios K, Paridis D, Kozyrakis D, et al. Fanconi syndrome in adulthood. The role of early diagnosis treatment. *J Musculoskeletal Neuronal Interact.* 2017;17:303-306.
- 25-Pharmaceutical Society of Ireland. Guidelines on the disposal of medicinal products for a retail pharmacy business. https://www.thepsi.ie/Libraries/Folder_Pharmacy_Practice_Guidance/01_5_Disposal_of_Medicinal_Products_for_Retail.sflb.ashx. Accessed December 10, 2018.
- 26-Eco-directed sustainable prescribing: feasibility for reducing water contamination by drugs, 2014 Archived August 21, 2008 on the Wayback Machine website.
- 27-BIO Intelligence Service (2013), Study on the environmental risks of medicinal products, Final Report prepared for Executive Agency for Health and Consumers” Archived 5 March 2016 on Wayback
- 28-NoPILLS in waters, 2015 Archived April 13, 2020 on the Wayback Machine website.
- 29-Human Pharmaceuticals in the Water Cycle, STOWA 2013" (PDF). Archived from the original (PDF) on September 25, 2015. Retrieved September 24, 2015.
- 30-Alserahy, Hassan Awad, et al (2008), The thinking and scientific research, Scientific Publishing Center, King Abdul-Aziz University in Jeddah, the first edition
- 31-Al Zoghbi, Muhammad and AlTalvah, Abas (2000), Statistical system understanding and analysis of statistical data, first edition, Jordon- Amman
- 32-Kadasah, N.A.; Chirwa, G.C.; et al. Knowledge, Attitude, and Practice Toward COVID-19 Among the Public in the Kingdom of Saudi Arabia: A Cross-Sectional Study. *Front. Public Health* 2020, 8, 217.