



Disposal practices and awareness of medicine waste management among general population of Delhi-National Capital Region, India

Rashmi Zalpuri^{1,2}, Jai Kishore Sharma¹, Rakhi Singh^{2*}, Laxmi Rawat²

¹Amity Business School, Amity University, Noida, U.P., India.

²Bio-Analytical Science Division, Shriram Institute for Industrial Research, Delhi, India.

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ABSTRACT

Not all the medicines manufactured every year are consumed and adversely vast amount of medicines go unused or expired. Unsafe handling and disposal practices of unused and expired medicines results in environmental hazards which is a source of concern. A cross-sectional survey was performed in Delhi-NCR, India among 500 respondents that reflected their awareness, behaviors and disposal practices for unused and expired drugs. Despite the fact that the majority of respondents were optimistic about disposing of unused and expired drugs, nearly more than half of the survey population were unsure of proper disposal procedures. A total of 268 (53.6%) were aware of the problem of medicine waste; about 236 (47.2%) read the directions for disposing of medications, and 121 (24.2%) respondents were aware of drug take back system. The most common practice of disposal of unused and expired medicines among people surveyed were dumping in household garbage. With respect to the level of public awareness regarding the legal disposal management and destruction of the medicine wastes, the results revealed an urgent need of public information creating awareness using ecofriendly methods of disposing unwanted medicines among community.

INTRODUCTION

In today's culture, medicines are the most often available means of therapy on a regular basis to cure or avoid illnesses, as well as to improve physical and mental health. People take medications even for social comfort and psychological reasons. For the past century, medical innovation has resulted in a substantial improvement in life expectancy and quality of life. With the huge influx of information on health stories in magazines, newspaper, media, people are getting more involved in wellness and health items. As a result, it influence in stocking large number of medicines at home that may results in unused/unwanted and expired medicines. The waste created from these drugs is extremely high. Today the disposal of medication waste is too risky and difficult, especially in highly populated developing country like India. The toxic discharge of improper and unsafe disposal of medications affects the environment and creates health

concern like bio-medical wastes created during or after human or animal care in any hospitals (Pandey *et al.*, 2020; Salgado *et al.*, 2021). Unlike other forms of waste, it is particularly harmful to the organism's wellbeing.

Medicines are often tossed into dustbins and viewed as household waste due to a lack of legislation and understanding. The irresponsible disposal of unused and expired medicines may have inconvenience to children and animals by means of risky health issues. Not having the proper site for disposing the medicine waste, these waste may spread into groundwater and results in prominent source of pollutants in an aquatic environment (Komijani *et al.*, 2021). Many efforts are being done around the world to determine proper disposal techniques.

Studies unveiled that due to improper discard of medicines wastes in toilet or sink may enter and can pollute the nature hood (Comeau *et al.*, 2008; Ruhoy and Daughton, 2007). Also can be discharged into the environment when are disposed-off in the household garbage or dustbins that eventually ends up as leachates in landfills (Barnes *et al.*, 2004).

A random survey in Sweden (Persson *et al.*, 2009) revealed that the storage of unused medicines are preferred rather

*Corresponding Author

Rakhi Singh, Shriram Institute for Industrial Research, Delhi, India.
E-mail: rakhis1973@gmail.com

disposing by flushing down into toilet or sinks and are returned directly to the pharmacy. Even in a Dutch study carried in 1990s, more than 80% of the participants returned unused medicines either to pharmacy or chemical waste facility as their concern towards environment pollution (Blom *et al.*, 1996). Studies conducted in the United States (Kotchen *et al.*, 2009) stated that about 45% of participants were aware of environmental pollution and returned unwanted medications to pharmacies. However, prevalence of improper disposal practice suggested issues of environmental awareness accounts for disposal patterns partially with respect to disposal of medicines. Also, from the study carried in Kuwait, it is evident that education status may not be associated with the awareness about the environment (Abahussain and Ball, 2007).

In Middle Eastern nations, Asian and most African countries, number of health and environmental issues is increasing day by day as a result of improper and unsafe disposal of medicines (Nepal *et al.*, 2020). In another surveys, it was found that in developing countries like India, China, Bangladesh, and Ghana, the commonly found practice for disposal of unwanted medicines was discarding in the household garbage, eventually ending up in dumping area (Ferronato and Torretta, 2019; Insani *et al.*, 2020).

General population must be aware of the pertinent practice of disposing of unused and unwanted medicines. Yet, improper drug disposal practice is common among different parts of the world. No exhaustive study has been conducted around the management of disposal for unwanted medication in India. Such kind of data is inevitable to develop proper measures with increase in community awareness with respect to drug disposal along with its related harmfulness. This study will evaluate the disposal practice and awareness of management systems of unwanted medicines in common population of Delhi NCR (National Capital Region), India.

MATERIALS AND METHODS

Study design and study population

This was a questionnaire-based cross-sectional survey. The study was conducted in the local population of Delhi-NCR, India from November 2020 to January 2021. The sample included people over the age of 18 (248 males and 252 females) who were in good mental health. There was no upper age limit. As seen in Table 1, respondents provided potential responses to the question of whether they were mindful of the proper disposition of unused and outdated medications. According to the results of this report, approximately 53.6% of respondents have good knowledge

Study instrument

Two parts were there in the questionnaire, of which first part consisted of participants' information regarding age, gender, level of education and marital status, ways of acquiring different types of medicines. Second section carried questionnaire on the disposal practices and attitudes concerning disposal of unused and expired medications. The respondents were required to choose from the given descriptive questionnaires on their disposal practices. The questionnaires were made in English language. The questionnaires were translated to native language and back

to English wherever required to avoid any confusion. Cronbach's alpha test was performed to check the reliability assessment.

Method for collection of data and analysis

A structured questionnaire was prepared to investigate the knowledge with respect to the disposition of expired and left over drugs. The purpose of the study was explained to every participants and ensuring their confidentiality. All questionnaires filled were checked thoroughly for collected data and later fed into a spreadsheet dataset. For analysis of the data, Statistical Package for Social Science version 22 was used.

RESULTS AND DISCUSSION

Socioeconomic information

After interviewing many people, 500 participants decided to take part in the study. Response rate of the participant was found to be 100%. Out of 500 participants, 136 (27.2%) women and 364 (72.8%) were found to be men. Most of the (269; 53.7%) participants were more than 46 years. Participants having secondary education were 60 (21.4%), graduates 258 (68.4%) and illiterate 10 (1.8%) (Table 1). Cronbach's alpha was found to be 0.70.

Analysis of respondents practice on unused medication disposal

Throwing unused drugs in garbage bins was the most common method of disposal (61.2%), accompanied by offering them to friends or relatives (9%). Some respondents (5.6%) retain leftover medications until they expire at home. Respondents (3.8%) burn the medicines along with household garbage, and 6.6% of respondents donate medicines to hospitals. Returning of unused drugs to pharmacies was thought to be the safest choice by around 7.6% respondents. Table 3 lists the disposal of unused medicines value given by respondents.

In this study, population type gender, age, marital status, education, and occupation were analyzed. The outcome of this study was evaluated by means of manual statistics using analysis of variance *p*-value and *f*-value where *p*-value was found to be less than 0.01 and *f*-value to be between 2.0 and 9.0. Graphical presentation of questionnaire-based cross-sectional survey w.r.t. study design is as given in Figure 1.

Analysis of respondents practice on expired medication disposal

Throwing expired drugs in garbage bins (71.4%) was the most common method of disposal, followed by flushing them down toilets (14.8%). Few respondents (2.8%) said they were unsure what to do with expired medications, whereas 3.2% and 4.6% said they would return drugs to the pharmacy and send medicines to friends or family meanwhile. Table 4 shows the disposal of expired medicine value given by respondents.

Awareness of disposal system

The usual practice of discarding the unwanted left-over and expired medicines is by throwing it into the household garbage or dustbins or flushed into toilet or sink. These impractical ways ends up in polluting the environment. In this survey, major

Table 1. Respondents’ knowledge of how to dispose of unused and expired medications.

Variables	Demographic parameters	Number of responses	(%) of responses
Gender	Male	364	72.80
	Female	136	27.20
Age	19–30	104.5	20.90
	31–45	127	25.40
	46-above	268.5	53.70
Marital status	Single	207.5	41.50
	Married	292	58.40
Level of education	Illiterate	10	1.80
	Primary	33	8.40
	Secondary	60	21.40
	University	258	68.40
Occupation	University students	77	15.40
	Unemployed	13	2.60
	Employed	253.5	50.70
	Others	156.5	31.30

population evaluated was above age group of 46 years (53.7%) and predominantly male gender (72.8%). Level of education of more than half of the participants (68.4%) was university graduates. Considerable sizes of the participants were literate (98.2%). About 15.2% of the respondents were university graduates; 50.7% of

them were employed and 31.3% were having different occupation. Being literate helps the population to perceive and decipher the significance of proper disposing of unused and expired medicines. Moreover, being literate can help in understanding the adverse effect to the environment. This survey reflects that half of the

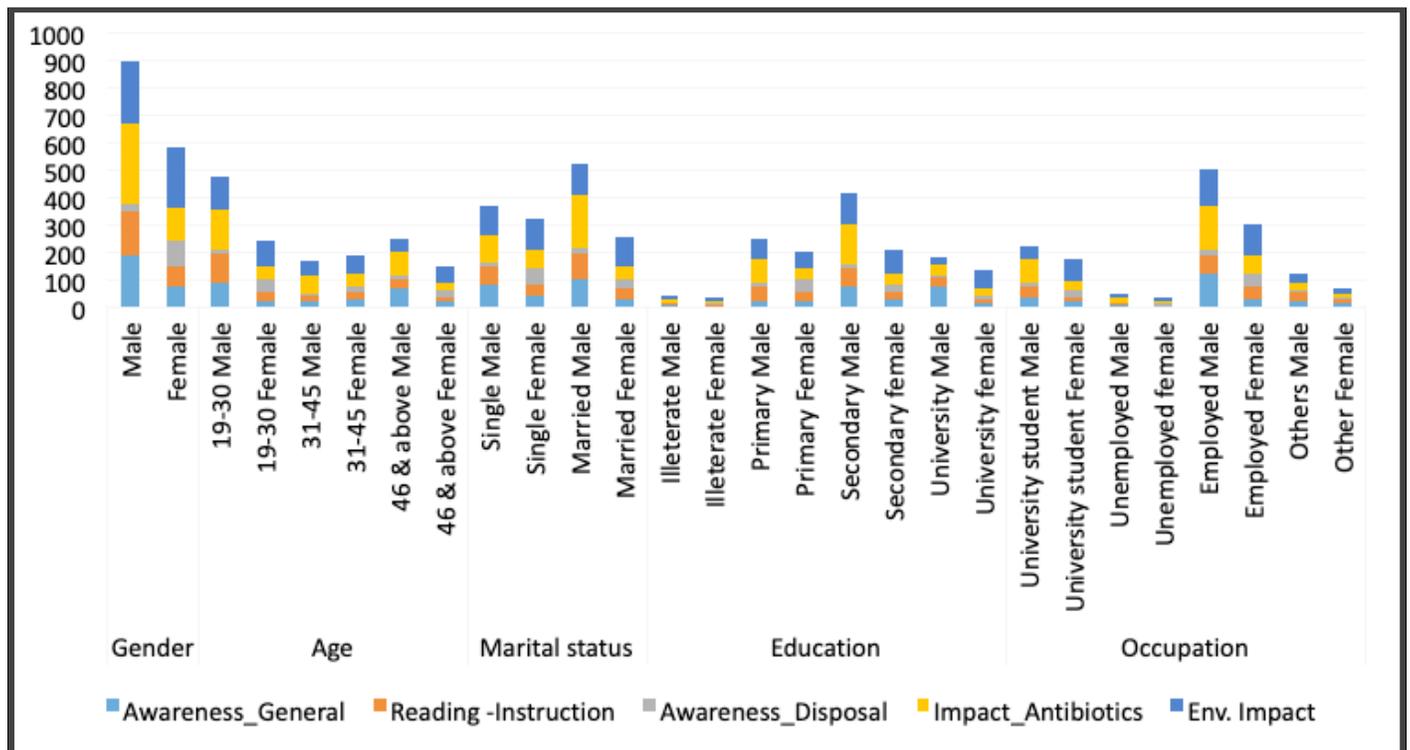


Figure 1. Graphical presentation of questionnaire-based cross-sectional survey w.r.t. study design.

Table 2. Respondents' knowledge of how to dispose of unused and expired medications.

No	Questions	Responses nos. (%)	
		Yes	No
1	Are you aware of the problem of medication waste?	268 (53.6%)	232 (46.4%)
2	Have you ever read the directions for disposing of medications?	236 (47.2%)	264 (52.8%)
3	Are you know about the "drug-take-back system?"	121 (24.2%)	379 (75.8%)
4	Do you know that changing antibiotics often or not completely will lead to drug resistance?	415 (83%)	85 (17%)
5	Are you conscious that unsafe storage of unused and expired drugs may have a negative impact on the atmosphere and your health?	446 (89.2%)	54 (10.8%)

respondents (53.6%) were aware of the problem with medical waste. Out of 500, only 236 participants have read the directions of medicines disposal. Hardly 24.2% respondents were aware of the "drug take back program." However, majority of them with more than 80% were having the knowledge of antibiotics resistance and are conscious of the negative impact of unsafe storage on the health and environment (Table 2).

Penalty for violation of disposal system

"As per Government of India, Ministry of Health and Family Welfare (Department of Health), The Drugs and Cosmetics Act and rules disposal of sewage and effluents (solid, liquid, and gas) from the manufactory shall be in conformity with the requirements of Environment Pollution Control Board. As per Environment Protection Act 1986, chapter III (PREVENTION, CONTROL AND ABATEMENT OF ENVIRONMENTAL POLLUTION) whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made or orders or directions issued thereunder, shall, in respect of each such failure or contravention" (Environment Protection Act, 1986):

1. Punishable with detention to 5 years or fine of 1,00,000 rupees, in case the failure continues, additional fine of 5,000 rupees will be imposed.
2. The lawbreaker shall be indictable with imprisonment which may extend to 7 years, in case if the infringement continues past 1 year after the date of judgment.

Table 3. Disposal of unused medicines.

Disposal practice of unused medicines	Nos.	%
Throwing medicines away in household garbage	306	61.2
Donating medicines to hospital	33	6.6
Giving medicines to friends or relatives	45	9
Returning medicines back to pharmacy	38	7.6
Keeping medicine at home until expired	28	5.6
Flushing medicines in toilet	31	6.2
Burning medicines	19	3.8
Total	500	100

Practice of disposal system in academic institutes as per the regulations

Waste management related to the collection of wastes and educational-projects represent key steps in fostering the sustainability concept. Regulations pertaining to academic institute waste, "Bio-medical Waste (Management and Handling) Rules, 1998 were notified by the Ministry of Environment and Forests under the Environment (Protection) Act, 1986" (Bio-Medical Waste Management). Some of the provisions, which are applicable to academic institutions, viz., teaching hospitals and non-profit research institutes including nursing homes/clinics, hospitals, animal specialty institutions, pathological and diagnostic laboratories, research institutions/labs, forensic laboratories are:

- a) Determination of requirement for hazardous waste to be made by professionals
- b) In institutes removal of harmful waste as per the respective disposal management.
- c) Segregation of waste as per the waste category (Coded bags).
- d) Academic entities should decide the duration for hazardous waste determinations
- e) Framing of Laboratory Management Plan, for waste management practices.

Prospective waste management systems for expired and unused medicines

Various strategical methods like landfills; return to donor or manufacturer; waste immobilization; burning in open containers; incineration at high temperatures and chemical decomposition are set around the world to manage solid wastes. Dumping must be sited at appropriate place with highly engineered sanitary landfills to minimize entry possibility of leachates into the environment. Burning of pharmaceuticals in open containers can release toxic pollutants contaminating the atmosphere. Pharmaceutical waste immobilization can be carried out by mixing with lime, cement and water using unsophisticated equipment (WHO, 1999). Incineration at high temperature cannot be afforded by many countries as it is expensive and require sophisticated chemical waste disposal facilities. Moreover, chemical inactivation can be time consuming and tedious.

Shelf life extension program, established by department of Defense, USA and United States Food and Drug Administration (USFDA) in 1986 with the goal to conserve resources by

Table 4. Disposal of expired medicines.

Disposal practice for expired medicines	Nos.	%
Placing medicine in the household garbage	357	71.4
Flushing medicine in toilet	74	14.8
Giving medicines to friends or relatives	23	4.6
Returning medicines back to pharmacy	16	3.2
Do not know	14	2.8
Other	16	3.2
Total	500	100

increasing the shelf life of medication stocks in army (Diven *et al.*, 2015; Khan *et al.*, 2014). Such programs may not tackle the global problem related to pharmaceutical wastes but can reduce the volume of burden. Take-back program of prescription drug also reduces environmental pollution by facilitating a safe disposal of unwanted medicines from the community. Drug take back programs are being followed in developed countries like United States, Sweden, Germany, United Kingdom, and Australia successfully and achieving the goals (Kadam *et al.*, 2016). Recycling programs of medicine wastes containing expensive Active Pharmaceutical Ingredient (API) can be highly effective economically. Such an approach could be promising, whereby the API can be extracted from medicine wastes and formulated again to regain its value (Alnahas *et al.*, 2020).

To overcome the adverse outcome of environment contamination, there is a need for educating the consumers and issuing the minimal prescribed medicines during clinic visit. Yet, in developing countries like India, the availability of over the counter medicines contribute in the major proportion of medicine wastes. As a one-off issue, there is a need of preliminary surveys at various levels with proper feedback to understand and customizing programs as per local need. An ideal practice may not be feasible as the option of disposal methods may vary according to the situations. Government should implement proper channeled system in association with drug regulatory bodies, pollution control board, NGOs and other civil societies regarding utilization, storage and disposal of left over drugs and drug take back programs.

In context to the future prospective and extension of work on large scale for educating people on proper disposal procedures of unused and expired medicines, the proper awareness programs and trainings among the mass population should be organized by respective agencies along with the increase in number of service provider for waste management. Various reasons contributing to the root cause of unawareness among population are lack of knowledge about the health hazards due to health-care waste, absence of systemic waste management and disposal systems, inadequate training, insufficient financial and human resources and minimum concern to proper disposition of health-care waste.

CONCLUSION

The study revealed that the practice of medicine disposal majorly depends on socio-economic culture and prevalence of regulatory guidelines of the country. In the study, large percentages of the respondents were unaware of drug-take back programs. On

the other hand, the majority of respondents were positive about the dangers of unused or expired drugs. A pressing process is the need to raise general consciousness on how to dispose properly the unwanted and expired drugs. Community pharmacists can play an important role in promoting proper waste management in the major cities of India. Implementation of different disposal programs and awareness regarding the disposal of unused and expired pharmaceuticals should be improved in developing country like India which is also a major center for manufacture of pharmaceuticals.

AUTHOR CONTRIBUTIONS

Data gathering and idea owner of this study is Rashmi Zalpuri. All other authors contributed to data construal, framing the article, and reviewing it. They also agreed to submit in the current journal and finally giving the consent for publication.

CONFLICTS OF INTEREST

The authors report that there is no conflict of interest.

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