

Unveiling Ecopharmacology: Insights Into Knowledge, Attitude, and Practices Among Medical and Nursing Students in Tertiary Care Teaching Hospital of District Almora, Uttarakhand

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ABSTRACT

Objective: Ecopharmacology, a field emerging at the intersection of pharmacology and environmental science, focuses on the impact of pharmaceuticals on ecosystems and public health. Given the increasing recognition of environmental issues associated with pharmaceutical waste, understanding the knowledge, attitudes, and practices (KAP) of health-care students toward Ecopharmacology is crucial. This study aims to assess KAP toward ecopharmacology among medical and nursing student at a tertiary care centre.

Methods: This descriptive and cross-sectional study employed a pre-validated self-administered structured online questionnaire conducted between December 2024 and January 2025. The questionnaire consisted of 22 questions to assess the knowledge, attitude, and practices of medical and nursing students regarding ecopharmacology. The data were subsequently analysed and presented as percentages.

Results: Out of 468 consenting participants 453 (291 Bachelor of Medicine, Bachelor of Surgery [MBBS] students and 162 nursing students) satisfactorily completed the questionnaire. The mean age was found to be 21.31±1.76 years. The result showed that in response to knowledge both MBBS and nursing students had good knowledge of certain aspects of ecopharmacology while knew less about drug-take back system. Regarding attitude they were empathetic towards the issue and worried about safe disposal of the drugs. The majority (89.3% medical and 97.5% nursing students) of participants agreed regarding the need for guidelines for ecologically safe disposal of drugs by people, whereas 77.3% of medical students reported discarding of excess medicines in the household trash.

Conclusion: The present study highlights a significant level of awareness and concern regarding pharmaceutical waste management among medical and nursing students.

Keywords: Ecopharmacology, Environmental Pharmacology, KAP study, Medicine Disposal, Unused Medicines

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Introduction

The presence of medicinal products in the environment is a globally emerging issue. Ecopharmacology is the science concerned with the entry of chemicals or drugs into the environment through any route and at any concentration disturbing the balance of ecology (ecosystem), as a consequence (Rahman et al., 2007). Ecopharmacology is also referred to as environmental pharmacology or ecopharmaco-stewardship. The unused or expired medicines can pose a hazard to public safety and to the environment, if they are not safely disposed of, as many drugs lead double lives: one within the body of animal/humans and one in the environment (Ling et al., 2024).

These drugs pass out of the system either as metabolites or unchanged through excretion. These drugs are found in traces in environment, mostly in water (Joss et al., 2006).

Drugs enter the environment due to various factors, including consumption, improper disposal, and pharmaceutical company effluents. There are pharmaceutical waste management guidelines, such as Good Manufacturing Practice (GMP) and Food and Drug Administration (FDA) regulations, which apply to manufacturing units, pharmacists, and consumers (Kadam et al., 2016).

Though the consumption phase is considered to be the biggest contributor to the emissions of medicinal products into the environment, through excretions and incorrect disposal of unused medicines through sinks and toilets, there is unawareness of correct disposal methods. Cocaine, oral contraceptives, carbamazepine and iodine contrast media are some of the examples of drugs found in traces in environment mostly in water (Zuccato et al., 2005, Kolpin et al., 2002). Cocaine has been detected in the Po River in Italy, while antidepressants, antiepileptics, and lipid-regulating agents (statins) have been found in the Niagara River (Castiglioni et al., 2004, Heberer, 2002). These drugs then have impact on human beings and animals through environment. The example of this is study from Pakistan which revealed that due to the use of diclofenac in treatment of livestock and consumption of their dead bodies by vultures led to the kidney failures of these vultures (Oaks et al., 2004). Similarly in India also the population of vultures declined so drastically that they were declared endangered species. Because of this Government of India banned diclofenac in India for veterinary use (Taggart et al., 2007).

To ascertain the potential environmental impact of improperly disposed medications in Almora district, it is necessary to determine the number of unused medications that are not currently returned to a pharmacy and disposed of via the landfill or water systems. Educating medical and nursing students about pharmaceutical waste management could serve as a significant catalyst for instigating change. To optimize the clinical proficiency medical and nursing students and cultivate environmentally conscious health-care practitioners, the integration of ecopharmacology appears to be a crucial prerequisite. To achieve this objective, a prior assessment of medical and nursing students' knowledge, attitudes, and practices (KAP) concerning drug disposal is imperative. Hence, this study was planned with the objective to assess KAP among medical and nursing students toward ecopharmacology. This will help in formulating and executing strategies to empower future Doctors and Nursing staff in assuming a more substantial responsibility for the safe disposal of

pharmaceutical waste, as well as for educating the public about this matter.

Methods

Study design

A descriptive cross-sectional study was conducted from December 2023 to January 2024 using a pre-validated self-administered structured online questionnaire. The questionnaire was formulated in English, adapted, and modified from previous studies (Khanavkar et al., 2024, Advani et al., 2019). A pilot study involving a subset of medical and nursing students was conducted to assess the reliability and validity of the questionnaire. The findings from the pilot study were not included in the final analysis. Medical and nursing students of either gender from tertiary care hospitals were included in the study. Participation in the study was voluntary. Informed consent was obtained from the participants electronically before administering the questionnaire. Approval was obtained from the Institutional Ethical Committee of Soban Singh Jeena Government Institute of Medical Science and Research Almora. Date of approval 12/07/2024. IEC approval number – 560/GMC/ IEC/ Reg. No. 518/ IEC/ R- 12-05-2024.

Sample size and sampling method

A non-probability sampling technique (convenience method) was employed to reach a representative population within our institute.

Study instrument

The questionnaire consisted of two sections. Section one was about respondent's personal information including gender, age and education. Section two of the questionnaire included questions related to participants knowledge, attitude and practices regarding ecopharmacology. The questionnaire consisted of 22 questions. After explaining the study objectives and obtaining consent, Participants were given 20–25 minutes to complete the questionnaire, which was provided in English only. Data was collected using Google Forms, recorded in Microsoft Office Excel 2007, and analysed using appropriate analytical software.

Results

In this study, out of 468 consenting participants 453 (291 MBBS students and 162 nursing students) satisfactorily completed the questionnaire and were included for evaluation. The mean age was found to be 21.31 ± 1.76 years

(Table 1). Among the 453 participants, the majority were female. The response of participants regarding knowledge of “Ecopharmacology” was as summarised in table 2. The result showed that in response to knowledge both MBBS and nursing students had good knowledge about few aspects of ecopharmacology while knew less about drug-take back system. Table 3 depicted attitude of the respondents and found out that they were empathetic towards the issue and worried about safe disposal of the drugs. Table 4 depicted the practices of respondents towards ecopharmacology and found that MBBS students were involved in not stocking drugs than nursing students.

Table 1. Socio - demographic of the respondents (n= 453)

Variables	No. (%)
Age	<21 years
	149
	≥21 years
	304
Mean ± SD	21.31±1.76
Gender	Male
	155 (34.2)
	Female
	298 (65.8)
MBBS Students	Batch 2021
	96 (21.2)
	Batch 2022
	98 (21.6)
	Batch 2023
	97 (21.4)
Nursing Students	2 nd Year
	40 (8.8)
	3 rd Year
	39 (8.6)
	4 th Year
	42 (9.3)
	Intern
	41 (9.1)

Table 2. Knowledge of Respondent regarding Ecopharmacology (n= 453)

Questions	Yes (No.%)		No (No.%)	
	MBBS Students	Nursing Students	MBBS Students	Nursing Students
1. Have you heard of the term Ecopharmacology?	194 (66.7)	131 (80.9)	97 (33.3)	31 (19.1)
2. Do you feel drugs that you consumed can cause environmental (soil and water) pollution?	254 (87.3)	156 (96.3)	37 (12.7)	06 (3.7)
3. Do you think environmental pollution caused by drugs can be a reason for antibiotic resistance?	241 (82.8)	146 (90.1)	50 (17.2)	16 (9.9)
4. Can the expired/unused medicines which are not properly disposed, cause hazard to public safety?	281 (96.6)	160 (98.8)	10 (3.4)	02 (1.2)
5. Do you know about the drug-take back system?	91 (31.3)	70 (43.2)	200 (68.7)	92 (56.8)
6. Have you heard the terms “Green Chemistry” and “Green Pharmacy”?	207 (71.1)	66 (40.7)	84 (28.9)	96 (59.3)
7. Do you think use of Ayurvedic, Homeopathic, and Veterinary drugs can affect environment?	197 (67.7)	87 (53.7)	94 (32.3)	75 (46.3)

Table 3. Attitude of Respondent regarding Ecopharmacology (n= 453)

Questions	Yes (No.%)		No (No.%)	
	MBBS Students	Nursing Students	MBBS Students	Nursing Students
1. Have you been taught the proper disposal of medication in college or have you received information from healthcare professionals?	202 (69.4)	129 (79.6)	89 (30.6)	33 (20.4)
2. Has it ever bothered you, what to do with excess medicine?	206 (70.8)	132 (81.5)	85 (29.2)	30 (18.5)
3. Do you think there should be guidelines for public for ecologically safe disposal of drug?	282 (96.9)	156 (96.3)	09 (3.1)	06 (3.7)
4. Do you think there should be safe medicine disposal location?	281 (96.6)	155 (95.7)	10 (3.4)	07 (4.3)
5. Do you think manufactures and pharmacist should have drug take back system?	274 (94.2)	150 (92.6)	17 (5.8)	12 (7.4)
6. Do you feel its your responsibility to protect environment from pharmaceutical waste?	284 (97.6)	160 (98.8)	07 (2.4)	02 (1.2)
7. Would you like to participate in activities like campaign for this issue?	260 (89.3)	158 (97.5)	31 (10.7)	04 (2.5)
8. Do you think Ecopharmacology knowledge will be relevant in your medical practice?	280 (96.2)	158 (97.5)	11 (3.8)	04 (2.5)

Table 4. Practice of Respondent regarding Ecopharmacology (n= 453)

Questions		MBBS Students	Nursing Students
1. Do you buy drugs in bulk for your family members?	Yes (Yes.%)	79 (27.1)	18 (11.1)
	No (No.%)	212 (72.9)	144 (88.9)
2. Do you store leftover unused /unwanted medications in your house?	Yes (Yes.%)	151 (51.9)	39 (24.1)
	No (No.%)	140 (48.1)	123 (75.9)
3. Do you remove drug from its container before throwing in the garbage?	Yes (Yes.%)	86 (29.6)	129 (79.6)
	No (No.%)	205 (70.4)	33 (20.4)
4. Do you pour leftover syrup/lotion from the bottle in the wash basin?	Yes (Yes.%)	67 (23)	95 (58.6)
	No (No.%)	224 (77)	67 (41.4)
5. Are you willing to dispose of unused medications through proper collection programs?	Yes (Yes.%)	278 (95.5)	150 (92.6)
	No (No.%)	13 (4.5)	12 (7.4)
6. How do you dispose of your unused medication?	Down the toilet	11 (3.8)	12 (7.4)
	Down the sink	09 (3.1)	50 (30.9)
	Returned to pharmacy	46 (15.8)	21 (13)
	With household rubbish	225 (77.3)	79 (48.8)
7. Why do you keep unused medications?	Do not want to waste them	29 (10)	06 (3.7)
	In case they needed later	165 (56.7)	85 (52.5)
	To keep a stockpile in case of emergency	97 (33.3)	71 (43.8)

Discussion

Ecopharmacovigilance highlights the importance of controlling the sources of pharmaceutical waste to prevent environmental contamination. Improper disposal of medications poses significant risks, leading to environmental pollution, disruption of the food chain, and harm to various life forms, including microorganisms (Kümmerer et al., 2006). The present study provides insights into the knowledge, attitudes, and practices (KAP) of medical and nursing students regarding ecopharmacology and medication disposal. The high response rate of 96.75% from the 468 participating HCPs indicates a strong interest and engagement in the topic among the study population. In the present study, in terms of knowledge, the majority of participants (66.7% medical and 80.9% nursing students) correctly defined the term 'ecopharmacology,' indicating a solid understanding of the concept among the respondents. This finding is similar to the studies conducted by Khanavkar where 84% of correctly defined the term 'ecopharmacology' (Khanavkar et al., 2024).

Most of our participants (87.3% medical and 96.3% nursing students) felt that the drugs they consume could cause environmental pollution and were aware of the hazardous environmental and health impact of improper disposal of unused and expired medicines. Studies of drug disposal practices in university students from Kabul and general population from Serbia have also reported of awareness on this issue (Bashaar et al., 2017, Seehusem et al., 2006). In present study 82.8% medical and 90.1% nursing participants agreed that environmental pollution by drugs can be reason for antibiotic resistance. This finding is similar to the studies conducted by Advani and Jadhao (Advani et al., 2019) and Bhadoriya and Wadagbalkar (Bhadoriya et al., 2014), where 88% of medical students expressed the belief that environmental pollution caused by drugs could contribute to antibiotic resistance. In present study 96.6% medical and 98.8% nursing students agreed that the expired/unused medicines which are not properly disposed, pose hazards to public safety. This finding is similar to the studies conducted by Advani and Jadhao (Advani et al., 2019).

The present study also revealed some gaps among nursing students in knowledge, particularly regarding specific terms such as "Green Chemistry" and "Green Pharmacy," with approximately half of the nursing participants (40.7%) familiar with these concepts. However, the majority of medical students (71.1%) have recognized

this term. This result is consistent with other studies conducted in Saudi Arabia (Alhomoud et al., 2021) and Bangladesh (Shakib et al., 2022). Green chemistry is an area of chemistry and chemical engineering focused on the design of products and processes that minimize or eliminate the use and generation of hazardous substances (Srivastava et al., 2022). Whereas, Green pharmacy is a concept that has evolved as a response to the increased insight into the harmful effects of pharmaceuticals. Included in the concept are measures to minimize the environmental footprint during all stages of the medicine's life cycle, from research and development via prudent prescribing and dispensing to safe disposal (Daughton et al., 2011).

However, the majority of participants (67.7% medical students) have recognized the potential environmental impact of Ayurvedic, Homeopathic, and Veterinary drugs. This percentage are lesser with the findings of a study conducted by Khanavkar where 75% of medical students had recognized the potential environmental impact of Ayurvedic, Homeopathic, and Veterinary (Khanavkar et al., 2024). But these observations are consistent with the findings of a study conducted in Kosovo (Shuleta-Qehaja et al., 2022). In this study, we observed that majority of participants (69.4% medical and 79.6% nursing students) had been taught about proper disposal of pharmaceuticals in medical school or by health professionals, which is much higher than the study conducted by Gubae et al. (2023) where only (27%) had been taught about proper disposal practices (Gubae et al., 2023).

The Majority of respondents (70.8% medical and 81.5% nursing students) expressed concern about the presence of unused or unwanted medications in the home and supported the implementation of policies to safely dispose of such medications (96.9% medical and 96.3% nursing students). Almost all the participants (96.6% medical and 95.7% nursing students) were willing to dispose of medications in specific locations or in an appropriate place. These observations are Consistent with study conducted among health care students in Gaza (Tabash et al., 2016). Almost all the participants (97.6% medical and 98.8% nursing students) agree that it's their responsibility toward environmental protection. Also, the majority (89.3% medical and 97.5% nursing students) expressed willingness to engage in proper medication disposal programs. These observations are consistent with the findings of a study conducted by Advani and Jadhao (2019), Gubae et al. (2023) and Khanavkar (2024).

The present study identified positive response of

participants regarding medication management and disposal practices. Very few (27.1% medical and 11.1% nursing students) of participants disclosed buying drugs in bulk for family members, while 58.6% nursing students admitted to pouring leftover syrup/lotion into the wash basin. Similar result was reported in studies from Kuwait, UK and USA (Tong et al. (2011), Avahussain et al. (2007). But these findings are significantly higher than those reported in the study conducted by Advani and Jadhao (2019). Present study participants were willing about the disposal of the excess medicines at home but were unaware of safe disposal methods. There are world health organization (WHO) guidelines for 'safe disposal of unwanted pharmaceuticals' (WHO guideline, 1999). This is a finding reflected in our study where majority (89.3% medical and 97.5% nursing students) of participants agreed regarding the need for guidelines for ecologically safe disposal of drugs by people. Responses from 77.3% of medical students showed that they throw away the excess medicines in the household trash. This is similar to findings of the study an Asian study in which most of the respondents (234/301; 77.7%) were throwing the expired medicine in household trash while 21.3% of the respondents returned unused and expired pharmaceuticals to medical stores. Returning expired and unused medicines to medical stores is community practice in the USA (23%) and UK (22%) (Bashaar et al., 2017; Azad et al., 2012; Kuspis, 1996). Whereas in present study, only few (15.8% medical and 13% nursing students) of the participants have done this. In this study the most common reasons that unused medications were keeping for future use (56.7% medical and 52.5% nursing students). These observations are consistent with other studies conducted among healthcare students (Auta et al., 2012; Khalid Labu et al., 2013).

Limitations of the study

Because this is a cross-sectional study, causal relationships cannot be established. Results are based on self-report and therefore may be biased by recall. Our decision to include only health care students may have affected the external validity of the results. However, this study is the first to assess medication disposal practices from the perspective of knowledge and attitudes toward ecopharmacology.

Conclusion

From the questionnaire it was observed that the knowledge of medical personnel and student about ecopharmacology and problems associated with it was good. Attitude of medical personnel and students was also

very empathetic, but this is not transforming into practices. Gaps exist in knowledge and practices, therefore robust, safe and cost-effective pharmaceutical waste management program supported with media campaign is needed.

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Ethical approval: Approval from Institutional Ethical Committee of Government Medical College Almora was taken. Date of approval 12/07/2024. IEC approval number – 560/GMC/ IEC/ Reg. No. 518/ IEC/ R- 12-05-2024.

Informed Consent: Before starting the study, written and verbally informed consent was obtained from the participants.

Peer-review: Externally peer-reviewed.

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