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KNOWLEDGE, ATTITUDE, AND PRACTICES REGARDING ECOPHARMACOLOGY AMONG NURSING STUDENTS IN MANDYA

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ABSTRACT: Background: Pharmaceuticals released into the environment pose ecological and public health concerns. Ecopharmacology, which addresses the adverse effects of pharmaceuticals on the environment, remains underexplored among healthcare students. This study aimed to assess the knowledge, attitude, and practices regarding ecopharmacology and safe drug disposal among nursing students. **Materials and Methods:** A cross-sectional study was conducted among 172 nursing students in Mandya city. The responses were collected using a pre-tested structured questionnaire that comprised demographics, knowledge (7 items), attitude (8 items), and practice (7 items). Data were analysed using descriptive statistics. **Results:** Among the 172 nursing students who participated in the study, awareness of ecopharmacology and existing guidelines for drug disposal was limited. Although attitudes towards environmental protection were largely positive, unsafe disposal practices were commonly reported. **Conclusion:** The present study showed that nursing students had a positive attitude towards ecopharmacology, but demonstrated limited knowledge and engaged in unsafe drug disposal practices. Enhancing awareness programmes and establishing accessible drug disposal facilities are essential to promote safe drug disposal practices.

INTRODUCTION: The global use of pharmaceutical products is steadily increasing, leading to their continuous release into the environment. Due to their chemical stability and persistence, many pharmaceuticals tend to accumulate in the environment. Even drugs that are easily degradable may still pose environmental risks due to their constant introduction from multiple sources [1]. Ecopharmacology refers to the entry of pharmaceuticals into the environment through various routes and at concentrations that may disrupt ecological balance. Major sources of pharmaceutical entry include industrial activities, as well as human and veterinary use.

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Green chemistry focuses on designing chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Green pharmacy is an approach that evaluates and manages the entire lifecycle of pharmaceutical products to minimize environmental impact, from research and manufacturing to their use and final disposal [2]. Contaminants of emerging concern (CECs) include synthetic or natural chemicals and biological agents that are newly detected in the environment and are known or suspected to pose risks to human health and ecosystems [3].

Pharmaceuticals and personal care products such as analgesics, antibiotics, antidepressants, antiepileptics, hormones, anticancer agents, veterinary medicines, and cosmetic ingredients are regarded as contaminants of emerging concern. Approximately 4,000 pharmaceuticals are currently in use worldwide, of which about 600 have been detected in the environment. The highest environmental risks are associated with hormones,

antibiotics, analgesics, antidepressants, anticancer agents, and veterinary antiparasitic drugs [1]. India is one of the major global suppliers of pharmaceuticals. However, the absence of effective CEC management has resulted in the detection of high levels of pharmaceutical residues in wastewater treatment plants [4]. Pharmaceuticals have also been detected in several major rivers in India such as Cooum, Ganga, and Yamuna [5]. A landmark study by Larsson *et al.* reported exceptionally high antibiotic concentrations in industrial effluents from Patancheru, near Hyderabad, India [6].

Human and veterinary use of pharmaceuticals results in the release of drug residues into the environment through the excretion of parent compounds and active metabolites in urine and faeces [2, 7]. In addition, improper drug disposal practices contribute to environmental contamination [1]. Environmental exposure to pharmaceuticals has been associated with several adverse biological effects, including feminization of male fish due to estrogen exposure, decline of vulture population following exposure to diclofenac, development of resistant bacteria, and aggressive behaviour in lobsters exposed to antidepressants [8, 9].

Recognizing the growing environmental and public health concerns associated with improper drug disposal, the Central Drugs Standard Control Organization (CDSCO) issued official guidelines in May 2025 for the safe disposal of expired and unused drugs. These guidelines recommend various drug disposal methods such as engineered sanitary landfills, encapsulation, inertization, and incineration. Community-level initiatives, such as authorized drug take back programmes and a small flush list for certain high-risk drugs are also recommended. Open dumping and uncontrolled burning are strongly discouraged due to their potential to cause soil, water, and air contamination [10].

The effectiveness of these guidelines depends on public awareness, stakeholder commitment, and the availability of appropriate disposal infrastructure. As frontline healthcare providers, nurses play a key role in patient education, and promotion of safe drug disposal practices.

Hence, this study was designed to assess and describe the knowledge, attitude, and practices related to ecopharmacology among nursing students.

MATERIALS AND METHODS: A cross-sectional study was carried out over a period of two months among nursing students studying in nursing colleges in Mandya city, Karnataka. A total of 172 nursing students participated in the study. The sample size was determined based on a previously published similar study [11]. Participants were recruited using convenience sampling.

Inclusion Criteria: Nursing students willing to give written informed consent to participate in the study.

Exclusion Criteria: Students who were on long-term leave or not available during the data collection period.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee of MIMS, Mandya (IEC No: MIMS/IEC/2025/1137). Written informed consent was obtained from all participants after explaining the purpose and voluntary nature of the study prior to data collection.

Data Collection: Data were collected using a predesigned, structured, self-administered questionnaire. The questionnaire was developed based on relevant literature and adapted from previously published studies on ecopharmacology [2, 11, 12]. The questionnaire was reviewed by subject experts to establish content validity and was pilot tested among a small group of nursing students to ensure clarity and ease of understanding. Necessary modifications were made prior to final administration.

The questionnaire comprised four sections: demographic details, knowledge (7 items), attitude (8 items), and practice (7 items) related to ecopharmacology and safe drug disposal. Participants completed the printed questionnaire under the supervision of the researcher. Completed questionnaires were collected immediately after completion and securely stored for further analysis.

Statistical Analysis: The collected data were entered and analyzed using Microsoft Excel. Descriptive statistics like frequencies and percentages were used for categorical data such as demographic characteristics like age, gender, year of study, and responses to knowledge, attitude, and practice questions.

RESULTS: A total of 172 nursing students participated in the study, with a mean age of 20.27 ± 1.37 years. The majority of participants were female (95.3%).

Knowledge about Ecopharmacology: Overall knowledge regarding ecopharmacology and related concepts was limited among the participants. Awareness of the term ecopharmacology, green pharmacy, and drug take back programmes was low, while awareness of official government guidelines for the safe disposal of unused or expired medicines was comparatively better (**Table 1**).

Most participants were aware that improper disposal of medicines can lead to environmental pollution. However, awareness regarding the role of improper drug disposal in the development of antimicrobial resistance was relatively poor (**Table 2).**

Regarding the sources of pharmaceutical entry into the environment, improper disposal was considered a major contributor (**Fig. 1).**

TABLE 1: KNOWLEDGE REGARDING ECOPHARMACOLOGY AND RELATED CONCEPTS

Sl. no.	Questions	Yes (%)	No (%)
1.	Have you ever come across the term "ecopharmacology"?	14	86
2.	Have you heard about the concept of 'green pharmacy'?	37.8	62.2
3.	Are you aware of drug take back programme?	26.7	73.3
4.	Are you aware of any official government guidelines in India regarding the safe disposal of unused or expired medicines?	49.4	50.6

TABLE 2: KNOWLEDGE REGARDING ENVIRONMENTAL IMPACT OF IMPROPER DRUG DISPOSAL

Sl. no.	Questions	Yes (%)	No (%)	Don't know (%)
1.	Do you think that improper disposal of unused or expired drugs can result in environmental pollution?	91.9	3.5	4.7
2.	Can improper disposal of drugs into the environment lead to the development of antimicrobial resistance?	46.5	16.9	36.6

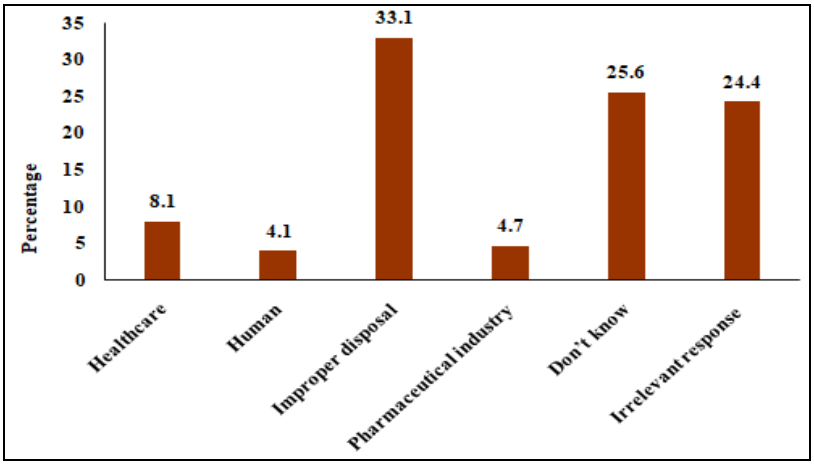

FIG. 1: SOURCES OF PHARMACEUTICAL ENTRY INTO THE ENVIRONMENT

Attitude towards Ecopharmacology: Assessment of attitude revealed an overall positive attitude towards safe drug disposal and environmental protection. Most participants supported the establishment of dedicated collection facilities, and a strong sense of personal responsibility towards environmental protection was also evident (**Table 4)**. Additionally, the majority (76.2%) expressed willingness to participate in awareness programmes related to pharmaceutical waste management. With regard to measures required for stricter implementation of existing disposal guidelines, increased public awareness (45.3%) was the most commonly suggested approach.

TABLE 3: CONCERN REGARDING DISPOSAL OF UNUSED AND EXPIRED DRUGS

Sl. no.	Questions	Never (%)	Rarely (%)	Sometimes (%)	Often (%)	Always (%)
1.	Does the thought of disposing of unused or expired drugs bother you?	9.9	14	54.1	3.5	18.6

TABLE 4: ATTITUDE TOWARDS SAFE DRUG DISPOSAL

Sl. no.	Questions	Strongly disagree (%)	Disagree (%)	Neither agree nor disagree (%)	Agree (%)	Strongly agree (%)
1.	Do you believe healthcare professionals have a responsibility to educate the public about safe medicine disposal?	2.3	0.6	5.2	51.2	40.7
2.	Do you think there should be specific collection facilities for returning unused or expired medicines?	1.7	3.5	22.7	52.9	19.2
3.	Do you feel it is your personal responsibility to protect the environment from harm caused by improper drug disposal?	1.2	3.5	10.5	54.7	30.2
4.	Do you believe improper disposal of pharmaceuticals can harm animal life and biodiversity?	1.7	1.2	8.7	43	45.3
5.	Should pharmaceutical manufacturers and pharmacies be actively involved in collecting unused or expired medications?	4.1	8.1	23.3	48.3	16.3

Practices Related to Ecopharmacology: Drug disposal practices among the participants were poor. The most common drug disposal method was discarding in household waste. Other unsafe methods of disposal such as burning the medicines were also noted. Environmentally safer practices, including returning medicines to pharmacies or authorized collection facilities were infrequently followed (**Fig. 2)**. Participation in formal training programmes, workshops, or awareness campaigns related to ecopharmacology was also minimal (**Table 6).**

TABLE 5: PRACTICES RELATED TO MEDICINE DISPOSAL

Sl. no.	Questions	Never (%)	Rarely (%)	Sometimes (%)	Often (%)	Always (%)
1.	Do you purchase medicines in bulk for your family, even when there is no immediate need?	72.1	19.8	7	1.2	0
2.	Do you store leftover or unused medicines at home for future use?	48.3	16.9	29.1	4.1	1.7
3.	Do you remove medicines from their original packaging before discarding them in the trash or garbage?	52.3	20.3	22.7	0.6	4.1
4.	Do you pour leftover syrups, drops, or lotions down the sink or wash basin?	63.4	14	14.5	2.9	5.2

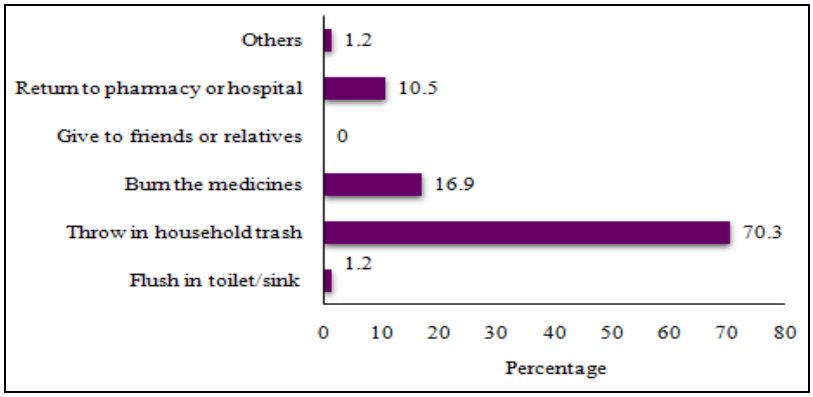

FIG. 2: METHODS OF DISPOSAL OF UNUSED AND EXPIRED MEDICINES

TABLE 6: TRAINING AND AWARENESS RELATED TO ECOPHARMACOLOGY

Sl. no.	Questions	Yes (%)	No (%)
1.	Have you ever received any instructions on how to safely dispose of unused or expired medicines?	37.8	62.2
2.	Have you ever participated in any campaign, seminar, or workshop related to safe drug disposal or ecopharmacology?	5.2	94.8

DISCUSSION: The present study assessed the knowledge, attitudes, and practices related to ecopharmacology among nursing students and identified a clear gap between knowledge, attitudes, and actual drug disposal behaviours. Overall, the findings indicate poor knowledge, largely positive attitudes, and inadequate drug disposal practices.

Awareness of ecopharmacology and related concepts such as green pharmacy and drug take back programmes was low among the participants. This level of awareness was lower than that reported in several studies conducted among nursing students and other healthcare professionals across India [11-14]. These differences likely reflect regional variation in curricular exposure and institutional emphasis on ecopharmacology. Similarly, awareness regarding official government guidelines in India for the safe disposal of unused or expired medicines was limited in the present study. This finding was comparable to that reported by Khanavkar *et al.*[12] In contrast, Nagarajan *et al.* reported comparatively higher level of awareness among their study participants [15]. Such variation may be attributed to differences in dissemination of regulatory guidance among healthcare students. Despite limited conceptual knowledge, most participants recognized that improper disposal of medicines could lead to environmental pollution. A similar finding has been reported in previous studies [16, 17]. However, awareness regarding the link between improper drug disposal and antimicrobial resistance was lower in the present study compared with reports by Dhapola *et al.* and Javed *et al.*[11, 18] This highlights a significant gap in understanding an important public health concern related to pharmaceutical waste management.

Attitudes toward safe drug disposal were generally positive. Most participants acknowledged their responsibility in protecting the environment from the harmful effects of improper drug disposal. However, this finding was lower than that reported in some earlier studies [11, 19]. This suggests the need for additional measures to cultivate a stronger sense of responsibility towards the environment. Support for stakeholder involvement, including pharmaceutical manufacturers and pharmacies in medicine collection programmes, was comparatively lower than that reported in other studies [11, 20]. This highlights the importance of educating students about the collaborative roles of various stakeholders in safe medicine disposal. Although a majority of participants expressed willingness to participate in pharmaceutical waste management awareness campaigns, this was lower than that observed in previous studies [11, 13]. This underlines the potential gaps in promoting active participation and the need for strategies to increase student involvement.

Regarding medicine purchasing practices, most students avoided bulk purchase of medicines, reflecting cautious medicine purchasing behavior. This finding was higher compared to reports by Javed *et al.* and Sriman *et al.*[18, 21] Only a minority of participants reported receiving instructions on safe medicine disposal, with levels lower than those reported in some studies and higher than in others [11, 22]. This suggests that existing educational approaches may be insufficient in promoting adequate knowledge regarding proper medication disposal among healthcare students. Disposal practices were largely inappropriate, with most participants discarding unused or expired medicines in household trash. Similar disposal patterns have been consistently reported among healthcare students [11, 14]. Studies by Menon *et al.* and Narasimhaiah *et al.* also identified household trash as the predominant method of drug disposal [23, 24].

Limitations: The cross-sectional design restricts the ability to determine the relationship between knowledge, attitudes, and practices. The use of convenience sampling and small sample size limits the representativeness and generalizability of the findings. Additionally, the sample was confined to nursing students in a particular city, which may not reflect the perspectives of students in other regions

or healthcare disciplines. Furthermore, the study relied on self-reported responses, which may be subject to recall bias and social desirability bias. The analysis was limited to descriptive statistics, and the absence of inferential analysis restricts the ability to identify statistically significant associations between variables.

CONCLUSION: The present study identified notable gaps in knowledge and practices related to ecopharmacology and safe drug disposal among nursing students, despite generally positive attitudes. Awareness of core concepts such as ecopharmacology, green pharmacy, and official disposal guidelines was limited. Unsafe disposal methods, particularly disposal in household trash, were commonly practiced. Integrating ecopharmacology into the nursing curriculum, strengthening institutional awareness programmes, and establishing accessible drug disposal facilities are essential to translate positive attitudes into appropriate practices.

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REFERENCES:

1. Gómez Oliván LM: Editor Ecopharmacovigilance: multidisciplinary approaches to environmental safety of medicines. 1st ed. Cham (Switzerland): Springer 2019; 1(5-16): 238-240.
2. Fenn AAG, Rakesh KR, Parokaran AV, Raju AR, Aneesha PK and Aswathy KS: Ecopharmacology-is it a necessity for human survival? Int J Pharm Pharm Res 2021; 21(3): 505-32.
3. Wang F, Xiang L, Leung KS-Y, Elsner M, Zhang Y and Guo Y: Emerging contaminants: a one health perspective. The Innovation 2024; 5(4): 100612.
4. Feng W, Deng Y, Yang F, Miao Q and Ngien SK: Systematic review of contaminants of emerging concern (CECs): distribution, risks, and implications for water quality and health. Water 2023; 15: 3922.
5. Ranjan N, Singh PK and Maurya NS: Pharmaceuticals in water as emerging pollutants for river health: a critical review under Indian conditions. Ecotoxicol Environ Saf 2022; 247: 114220.
6. Larsson DGJ, de Pedro C and Paxeus N: Effluent from drug manufacturers contains extremely high levels of pharmaceuticals. J Hazard Mater 2007; 148(3): 751-55.
7. Malmqvist E, Fumagalli D, Munthe C, Larsson DGJ. Pharmaceutical pollution from human use and the polluter pays principle. Public Health Ethics 2023; 16(2): 152-64.
8. Hester RE and Harrison RM: Editors. Pharmaceuticals in the environment. Issues in Environmental Science and Technology. Cambridge: Royal Society of Chemistry 2015; 41: 98.
9. Dutta A, Banerjee A and Chaudhry S: Ecopharmacovigilance: need of the hour. Indian J Pharm Pharmacol 2022; 9(2): 77-80.
10. Central Drugs Standard Control Organisation (CDSCO). Guidance document on disposal of expired/unused drugs [Internet]. New Delhi: Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India; 2025 May 27 [cited 2025 Jul 21]. Available from: https://cdsco.gov.in/opencms/opencms/en/Notifications/Public-Notices/
11. Dhapola VS, Kumari P, Maithani A and Ahmed AA: Unveiling ecopharmacology: insights into knowledge, attitude, and practices among medical and nursing students in a tertiary care teaching hospital of district Almora, Uttarakhand. Recent Trends Pharmacol 2025; 3(1): 1-7.
12. Khanavkar RP, Hannan A, Dhodi D, Chawre SM, Bhure AS and Raj D: An assessment of knowledge, attitude, and practices toward ecopharmacology among healthcare professionals at a tertiary care center: a cross-sectional study. Natl J Physiol Pharm Pharmacol 2024; 14(6): 1198-203.
13. Bhadoriya SS and Wadagbalkar P: A questionnaire-based study on the knowledge, attitude, and the practice of ecopharmacology among healthcare professionals in Amaltas Medical College and Hospital, Dewas, Madhya Pradesh. Int J Basic Clin Pharmacol 2024; 13(1): 101-06.
14. Kavitha VD, Deolekar P, Patil A, Signapurkar S, Naseem A and Ghosh S: Medical students and ecopharmacology: understanding knowledge, attitudes, and practices. Biomed Biopharm Res 2025; 22(2): 83-9.
15. Nagarajan SV, Gosavi PA, Vinay KM, Pandit S and Pawar S: Knowledge, attitude and practice about ecopharmacology among healthcare professionals in a tertiary care teaching hospital. Int J Med Pharm Res 2025; 6(3): 88-95.
16. Patel M, Mistry C and Gaekwad V: Knowledge, attitude and practice study of safe disposal of medications among medical post-graduate students, interns and nursing staff of a tertiary care hospital of central Gujarat, India. Int J Pharm Pharm Sci 2025; 17(4): 24-30.
17. Nagothkar SK, Waghmare CS, Shirure PA, Bansode A, Mukadam FM and Ali DP: Knowledge and awareness of disposal of unused and expired medicines among healthcare professionals in a tertiary care hospital: a brief report. J Pharm Care 2024; 12(1): 55-9.
18. Javed A, Farooq M and Imran S: Assessment of knowledge, attitude and practice of ecopharmacology among MBBS students in a tertiary hospital in North India. Int J Health Clin Res 2021; 4(10): 15-7.
19. Bhatt S and Kumar H: Knowledge, attitude and practice of medical personnel on ecopharmacology. Int J Basic Clin Pharmacol 2022; 11(5): 419-24.
20. Anuradha CR, Subashree A and Saran PS: A cross-sectional study on the knowledge, attitude, and practice of the eco-pharmacology among undergraduate medical students in a tertiary care teaching hospital in South India. Res J Pharm Biol Chem Sci 2023; 14(1): 194-7.
21. Sriman A, Karuna Sree N and Srikanth C: Assessment of knowledge, attitude and practice of ecopharmacology among MBBS students at a tertiary care teaching hospital in Hyderabad – a cross-sectional study. Int J Sci Res 2023; 12(6): 65-6.
22. Kaur K and Bansal N: Knowledge, attitude and practice on safe disposal of medicines among medical personnel. IP Int J Compr Adv Pharmacol 2021; 6(2): 79-82.

23. Menon AS, Agrawal A, Chaudhary MM and Jani CK: Use, storage, and disposal of unused medicines among medical students: a survey-based study. Int J Pharm Sci Res 2025; 16(2): 549-54.

24. Narasimhaiah MG, James A and Kalaburgi RA: Eco-pharmacology: awareness and practice of drug disposal among medical students. Int J Basic Clin Pharmacol 2020; 9(7): 1007-10.

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