International Journal of Scientific Reports
Bude A et al. Int J Sci Rep. 2026 Jun;12(6):241-245
https://www.sci-rep.com
pISSN 2454-2156 | eISSN 2454-2164
DOI: https://dx.doi.org/10.18203/issn.2454-2156.IntJSciRep20261490

Original Research Article

Assessment of knowledge, attitudes and practices of ecopharmacology among Indian medical undergraduates in a tertiary care teaching hospital in Goa

Amog Bude*, Sunita De Sa

Department of Pharmacology, Goa Medical College, Goa, India

Received: 31 March 2026
Revised: 09 May 2026
Accepted: 11 May 2026

***Correspondence:**
Dr. Amog Bude,
E-mail: amogbudea2b@gmail.com

ABSTRACT

Background: Improper disposal of unused and expired medications from households poses significant environmental concerns due to Active Pharmaceutical Ingredients (APIs). These persist in the environment and bioaccumulate, disrupting ecological balance through various mechanisms. This cross-sectional study aimed to evaluate the knowledge, attitudes and practices (KAP) regarding ecopharmacology among MBBS students at Goa Medical College.
Methods: A total of 270 participants were surveyed using a semi-structured questionnaire covering demographic information and KAP related to ecopharmacology. The collected data was transcribed into spreadsheets and analyzed using descriptive statistics.
Results: Results indicate a satisfactory level of awareness among students, with the majority acknowledging the environmental implications of improper medication disposal, including pollution and antibiotic resistance. However, a significant gap was observed in awareness of guidelines for proper disposal. Despite positive attitudes towards raising awareness and implementing regulatory guidelines, many students reported engaging in improper disposal practices, such as throwing medications in household trash without segregation or flushing them down sinks or toilets. Proposed strategies for improvement include the establishment of pharmacy take-back programs and designated bins for pharmaceutical waste with waste collection systems.
Conclusions: MBBS students at Goa Medical College have adequate knowledge and positive attitudes towards ecopharmacology; however, awareness of specific disposal guidelines is lacking. Integrating relevant content into the medical curriculum can help bridge this gap and promote eco-friendly healthcare practices among future physicians.

Keywords: Antibiotic resistance, Environmental pollution, Ecopharmacology, Safe disposal practices

INTRODUCTION

Ecopharmacology describes 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.[1] The worldwide increase in pharmaceutical use has raised global concerns about the problem of unused and expired medications in households and the harmful effects on the environment and health when they are not disposed properly.[2,3] Excess medications stored in households result from various factors such as patients' non-adherence, unnecessary acquisition of medications, repeat prescribing without checking existing supplies, complex polypharmacy regimens and inappropriate dispensing by pharmacists. These factors can contribute to increased wastage and improper disposal practices.[4] When pharmaceuticals in solid waste are not properly managed in landfills, they pose risks. Additionally, when flushed down sinks or toilets, they contaminate sewage waters and freshwater

systems. Some residues, although partially removed by treatment plants, persist in sewage sludge, often spread on land for agricultural use or composting. This improper disposal results in adverse effects on ecosystems, public health risks and economic losses. Raising awareness and implementing safe disposal methods can help reduce the negative environmental impact.[5]

This study aims to evaluate the KAP of ecopharmacology among MBBS students at Goa Medical College. By assessing their current understanding, attitudes and practices, this study seeks to identify areas for improvement and promote the integration of ecopharmacology into the medical curriculum. The results of this study will help encourage medical students to adopt environmentally friendly healthcare practices.

METHODS

Study design

This study utilized a cross-sectional, questionnaire-based approach to assess the KAP of ecopharmacology among medical undergraduates at Goa Medical College, Bambolim. To ensure participants had sufficient exposure to clinical pharmacology, specific criteria were applied.

Inclusion criteria

Currently enrolled MBBS students in their second, third and final years were included in the study.

Exclusion criteria

First-year MBBS students (due to limited pharmacology exposure) and students from all allied health sciences, nursing or dental streams were excluded from the study.

Sample size and sampling technique

To ensure statistical validity, the minimum required sample size was determined using Cochran's formula for finite populations. Based on a total population (N) of 540 students, comprising approximately 180 students each from the second, third and final years, the calculation utilized a confidence level (Z) of 1.96 (corresponding to a 95% confidence interval), a maximum variability (p) of 0.5 and a margin of error (e) of 0.05. While the formula indicated a minimum requirement of 225 participants, the total sample was increased to 270 to account for potential non-responders and to ensure equal representation across academic tiers. A stratified random sampling technique was subsequently employed, selecting 90 students from each of the three eligible academic years to maintain a balanced and representative cohort.

Data collection

Data was collected using a semi-structured questionnaire. The questionnaire comprised two sections.

Demographic information

It includes age, gender, year of study.

Knowledge, attitudes and practices

This section of the questionnaire aimed to gather insights into participants' knowledge, attitudes and practices regarding ecopharmacology. Furthermore, the questionnaire included an open-ended question prompting participants to suggest strategies for the safe disposal of unused or expired medications. Informed consent was obtained from all participants prior to their inclusion in the study. The questionnaire was then distributed and responses were collected through online surveys conducted over 1 month duration from 15 March 2024 to 19 April 2024.

Ethical considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of Goa Medical College. Participation was voluntary and written informed consent was obtained from all participants.

Data analysis

The collected data was transcribed into spreadsheets and analyzed. The results are expressed as descriptive statistics.

RESULTS

A total of 270 students participated in the study, with 90 students from each of the second year, third year and final year MBBS. Of these participants, 166 were female (61.5%) and 104 were male (38.5%). All respondents satisfactorily completed the questionnaire, which were included for evaluation. In terms of knowledge, the majority of students (71%) demonstrated a correct understanding of the definition of Ecopharmacology. Moreover, a significant majority acknowledged the negative impact of improper medication disposal, with 95% recognizing its contribution to environmental pollution, 81% linking it to antibiotic resistance and 90% understanding its potential for cumulative toxicities. However, a significant disparity was noted in awareness of guidelines or laws concerning the proper disposal of pharmaceutical waste products, as only 20% of respondents were aware of them. Additionally, around 67% of the students stated that their curriculum doesn't cover the proper disposal of unused and expired medications in households. The analysis of attitude questions revealed a significant level of concern among students regarding medication disposal. The majority of respondents, comprising 71% expressed being bothered by the thoughts of disposing unused or expired medications. Approximately 98% of the participants believed that raising awareness about the safe disposal of unused and expired medications is necessary. Similarly,

99% of the respondents emphasized implementing regulatory guidelines and setting up a proper disposal system. Additionally, 92% of participants agreed that current methods of medication disposal are unsafe.

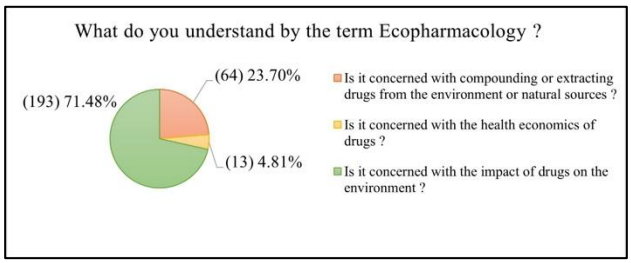

Figure 1: Definition of ecopharmacology.

Assessment of common disposal practices among MBBS students revealed that the majority, 89.7%, disposed of medications by throwing them in the dustbin, while 9.3% returned them to the pharmacy. A smaller proportion, 6.0%, reported burning them and only 3.5% admitted to flushing medications down the toilet or sink. Additionally, 1.7% opted for alternative methods such as burying them or giving them away to waste recycling plants. With regards to purchasing and utilizing medications, most students (65.9%) stated they don't buy medicines in bulk, while 24.8% do so occasionally and 9.3% do it often. On average, students reported completing their prescribed medication course frequently, with a mean score of 3.91 (SD=0.84). As per participants' input, the following strategies were proposed for the safe disposal of unused or expired medications.

Pharmacy take-back programs

Participants recommended that pharmacies should have provisions to accept unused or expired drugs. This could be enhanced by offering incentives to the public to encourage this practice, ensuring appropriate disposal.

Designated bins for pharmaceutical waste

Respondents proposed the creation of separate bins specifically for pharmaceutical waste. These bins could be collected by municipal or panchayat authorities as part of existing waste collection programs. Additionally, health centers could also have designated bins to collect waste medications.

Informative packaging

Printing disposal techniques on medication packaging was suggested to help inform the public on how to properly dispose of medications.

Table 1: Evaluation of knowledge.

Questions (knowledge)	Yes (%)	No (%)	Not sure (%)
Can improper disposal of unused and expired drugs contribute to environmental pollution?	259 (95.93)	9 (3.33)	2 (0.74)
Can environmental pollution by drugs lead to antibiotic resistance?	219 (81.11)	5 (1.85)	46 (17.04)
Can environmental pollution by drugs lead to cumulative toxicities?	245 (90.74)	3 (1.11)	22 (8.15)
Does your curriculum address the proper disposal of unused or expired medications at home?	89 (32.96)	181 (67.04)	_
Are you aware of any guidelines or laws for the proper disposal of pharmaceutical waste?	55 (20.37)	114 (42.22)	101 (37.41)

Table 2: Evaluation of attitudes.

Questions (attitude)	Yes (%)	No (%)
Have you been bothered by the thought of disposing unused or expired medication?	194 (71.85)	76 (28.15)
Do you believe there is a need to raise awareness about the safe disposal of unused or expired medication?	267 (98.89)	3 (1.11)
Do you think there should be a medication disposal system and regulatory guidelines for public?	268 (99.26)	2 (0.74)
In your opinion, are the current methods of disposing of unused or expired medications (such as throwing in the garbage or flushing down the toilet or sink) safe?	19 (7.04)	251 (92.96)

DISCUSSION

The study reveals adequate and satisfactory knowledge about ecopharmacology among MBBS students of Goa Medical College, with results consistent with similar studies conducted by Narsimhaiah et al, Javed et al and Bhadoriya et al.[6-8] Additionally, the current study demonstrates a lack of awareness regarding guidelines or laws for the proper disposal of pharmaceutical wastes. Students also showed concerns that their curriculum doesn't include topics emphasizing proper pharmaceutical waste disposal, providing scope for improvement in the curriculum. Students' outlook towards raising awareness among people about environmental safety and appropriate disposal of unused and expired medications indicates a positive attitude. A study done among

healthcare professionals by Advani et al reflected similar results.[9] Global concerns about pharmaceutical pollution are rising, especially due to cumulative toxicities and antibiotic resistance. The highest API concentrations are reported in water bodies of Sub-Saharan Africa, South Asia and South America. At around 25.7% of sampling sites, API concentrations were greater than levels considered safe for aquatic organisms or concerning for antimicrobial resistance.[10]

The UN environment programme has raised concerns about environmentally persistent pharmaceutical pollutants (EPPPs). These products being non-degradable, even small amounts bioaccumulate, harming wildlife and ecosystems, exacerbating issues like antimicrobial resistance.[11] A Lancet study in India found drug-resistant bacteria at pharmaceutical sites in Hyderabad, New Delhi and Chennai, exacerbated by minimal regulations and inadequate sewage treatment. This situation fosters the spread of resistant bacteria, posing a major public health threat globally.[12] The WHO (2022) report calls for urgent global action to tackle antimicrobial pollution, emphasizing stringent regulations, improved waste management and responsible antimicrobial use to mitigate environmental impact and protect public health.[13] Pharmaceutical discharge into the environment profoundly harms aquatic ecosystems, disturbing their equilibrium and functioning. Aquatic organisms suffer cytotoxic and genotoxic harm, oxidative stress and behavioral and reproductive changes. Endocrine-disrupting chemicals in pharmaceuticals further disrupt reproductive physiology, leading to reduced reproductive rates and intersex characteristics.[14]

Improper disposal methods of unused or expired medications, such as throwing them in household trash without segregation or flushing them down sinks or toilets, directly introduce pharmaceuticals into landfill leachate or domestic wastewater. This bypasses any opportunity for removal or degradation before these compounds enter the environment. In this study, we found that the majority of students reported disposing of medications by throwing them in the dustbin. Other practices included returning medications to the pharmacy or opting for alternative methods such as burning or flushing them in sink or toilet. US FDA has given guidelines on how to dispose unused or expired medications, similarly Swaccha Bharat Abhiyan mentions guidelines for disposal of household medical waste but majority of the students weren't aware of it.[15,17] Improper methods of drug disposal are often used due to several factors, including a lack of education or inadequate education in this field, the absence of appropriate systems or programs for the return of unused drugs, habitual behaviors, convenience and the lack of punishment or accountability. In many countries, there are no legal mandates specifying the entities responsible for collecting unwanted drugs from residential areas, with regulations typically focusing on health care institutions and pharmacies rather than households. In some countries, unused and expired antibiotics are classified as hazardous waste and should be collected separately from other household waste, but this is not commonly practiced and public awareness of these rules is low.[17] This situation is same in most of the low-income countries. Emphasizing education and raising awareness is crucial in changing these practices. While some high-income countries have initiated programs to address this issue, the disposal of unused and expired medications into household trash remains prevalent needing more research to find the cause of it.

Even though students were aware of negative impact on environmental, many carelessly adopted improper disposal practices, this may be due to unawareness and unavailability of proper disposal system in place, despite guidelines being present. In India, a separate Black bin is allotted for hazardous waste which includes household medical waste, including discarded medications. Responsibility of the public is to segregate at source and municipal/panchayat authorities will then collect waste it (atleast once in 15 days) and further dispose them as per guidelines but this awareness is lacking among public at large. In some countries, drug manufacturers must assess environmental impacts and include disposal instructions for pharmaceuticals, including genetically modified organisms (GMOs), in Summaries of Product Characteristics (SmPCs) and Patient Information Leaflets (PILs). Eco-pharmacovigilance is crucial due to the gradual environmental effects of pharmaceuticals.[18] Amidst the recognized global concern about the subject, educational awareness initiatives will be advantageous in involving the public as well as healthcare workers to emphasize proper waste disposal. Including adequate syllabus on Ecopharmacology into the curriculum will enhance this drive towards an environmentally friendly approach to waste disposal at the household level. Advanced technology treatment plant linked to pharmaceutical companies, laying stringent laws for effluent discharge by pharmaceutical manufacturing plants. Government and administrative bodies will be key role players in this endeavor, setting up various rules, regulations and drug take-back programs to minimize improper drug disposal and guide the public at large. Further studies are warranted to evaluate factors leading to improper drug disposal practices and efficiency of programmes in place.

Limitations

While the study offers valuable insights into the knowledge, attitudes and practices of MBBS students at Goa Medical College, it's essential to recognize its limitations. The exclusive focus on a single institution may limit the generalizability of findings to other populations. Additionally, the use of a self-administered questionnaire might introduce biases in participant responses. Furthermore, the cross-sectional design prevents establishing causal relationships between variables.

CONCLUSION

MBBS students of Goa Medical College, Bambolim - Goa, have fair adequate knowledge and concerning attitude towards ecopharmacology. Though there exist a deficit about awareness of guidelines and laws regarding proper disposal of used and expired medications at home. Furthermore, inclusion of appropriate matter in the syllabus will help to bridge this gap. As future doctors they will be key personnel to adopt and propagate environment friendly healthcare practices.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Kummerer K. Pharmacoenvironmentology–a component of pharmacovigilance. Drug Saf. 2006;29(5):371–7.
2. Tong AY, Peake BM, Braund R. Minimizing the environmental impact of unused pharmaceuticals: Review focused on prevention. Front Environ Sci. 2022;10:1077974.
3. Mitkidis P, Chrysochou P, Obolevich V, Mitkidis K. Effectiveness of environmental health and loss framing on household pharmaceutical take-back schemes. Waste Manag. 2022;143:61–8.
4. Makki M, Hassali MA, Awaisu A, Hashmi F. The prevalence of unused medications in homes. Pharmacy (Basel). 2019;7(2):61.
5. OECD. Management of pharmaceutical household waste: Limiting environmental impacts of unused or expired medicine. Paris: Organisation for Economic Co-operation and Development. 2022.
6. Sharma R, Gupta P, Singh S, Verma A, Kumar N, Singh R, et al. 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(15):1–5.
7. Narasimhaiah MG, James A, Kalaburgi RA. Eco-pharmacology: Awareness and practice of drug disposal among medical students. Int J Basic Clin Pharmacol. 2020;9(7):1007–10.
8. Bhadoriya SS, Wadagbalkar P. A questionnaire-based study on the knowledge, attitude and practice of ecopharmacology among healthcare professionals in Madhya Pradesh. Int J Basic Clin Pharmacol. 2024;13(1):101–6.
9. Advani M, Jadhao TR. A questionnaire-based study on the knowledge, attitude and practice of ecopharmacology among healthcare professionals in a teaching hospital in India. Int J Basic Clin Pharmacol. 2019;8(6):1413–8.
10. Wilkinson JL, Boxall ABA, Kolpin DW. Pharmaceutical pollution of the world's rivers. Proc Natl Acad Sci. 2022;119(8):2113947119.
11. United Nations Environment Programme. Environmentally persistent pharmaceutical pollutants (EPPPs). 2020.
12. Ahmad A, Patel I, Khan MU, Babar ZU. Pharmaceutical waste and antimicrobial resistance. Lancet Infect Dis. 2017;17(6):578–9.
13. World Health Organization. World leaders and experts call for action to protect the environment from antimicrobial pollution. 2022.
14. Kumar S, Yadav S, Kataria N, Chauhan AK, Joshi S. Recent advancement in nanotechnology for the treatment of pharmaceutical wastewater: sources, toxicity, and remediation technology. Curr Poll. 2023;9(2):110-42.
15. U.S. Food and Drug Administration. Disposal of unused medicines: What you should know. Available at: https://www.fda.gov/drugs/safe-disposal-medicines/disposal-unused-medicines-what-you-should-know. Accessed on 21 December 2025.
16. Banjar H, Alrowithi R, Alhadrami S, Magrabi E, Munshi R, Alrige M. An intelligent system for proper management and disposal of unused and expired medications. Int J Env Res Public Health. 2022;19(5):2875.
17. Rogowska J, Zimmermann A. Household pharmaceutical waste disposal as a global problem: a review. Int J Environ Res Public Health. 2022;19(23):15798.
18. Lunghi C, Valetto MR, Caracciolo AB, Bramke I, Caroli S. Call to action: Pharmaceutical residues in the environment: threats to ecosystems and human health. Drug Safety. 2025;48(4):315-20.

Cite this article as: Bude A, Sa SD. Assessment of knowledge, attitudes and practices of ecopharmacology among Indian medical undergraduates in a tertiary care teaching hospital in Goa. Int J Sci Rep 2026;12(6):241-5.