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Review

Awareness and Practices of Medicine Waste Disposal in Rural Communities

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Abstract

The improper disposal of leftover and expired medications poses serious risks to both environmental and public health, especially in rural regions where awareness, infrastructure, and proper disposal facilities are limited. This study aimed to assess the knowledge, attitudes, and practices (KAP) related to pharmaceutical waste management among 200 households across selected villages within a gram panchayat. Data were collected using structured questionnaires, focus group discussions, and direct observations to gain a comprehensive understanding of household disposal behaviours. The findings revealed that only 38% of respondents recognized the environmental hazards associated with unsafe disposal of medicines, while 32% believed that discarded medicines were harmless, and 30% were unsure. Common disposal practices included throwing unused or expired medicines in household garbage (45%), burning them along with other waste (25%), and flushing them into drains or toilets (18%). Alarmingly, only 12% of households returned leftover medicines to health centres or pharmacies. Statistical analysis indicated a strong correlation between higher educational levels, previous exposure to health awareness programs, and the adoption of safer disposal practices. The study highlights a significant knowledge gap and unsafe practices that could lead to environmental contamination and antimicrobial resistance. Therefore, the findings underscore the urgent need for implementing community-based educational campaigns, promoting accessible medicine take-back systems, and integrating sustainable pharmaceutical waste management strategies into rural public health initiatives to minimize potential health and ecological hazards.

Keywords: Pharmaceutical waste management; Knowledge, Attitude, and Practice (KAP); Rural households;

1.INTRODUCTION

The survey findings highlighted a substantial gap in community understanding regarding the environmental implications of improper medicine disposal. Only about 38% of participating households were able to correctly recognize that careless disposal of unused or expired medicines could lead to environmental pollution, particularly through contamination of soil and water systems.[1] A considerable segment of the population, approximately 32%, believed that once medicines were discarded from their possession, they no longer posed any form of threat to the environment or public health. This misconception reflects a common perception in rural communities that pharmaceutical responsibility ends at the point of use, rather than encompassing the entire life cycle of the medication.[2] Meanwhile, nearly 30% of respondents admitted uncertainty about whether improper disposal of medicines might cause harm. Their indecisiveness underscores the absence of structured awareness initiatives and educational programs addressing safe disposal practices in rural regions. Many respondents were unaware that even small quantities of pharmaceutical residues can persist in the environment, disrupt aquatic ecosystems, and contribute to the growing problem of antimicrobial resistance. Interestingly, the analysis revealed that educational level and exposure to healthcare outreach programs played a significant role in shaping awareness.[3] Participants who had attained at least a secondary level of education demonstrated a clearer understanding of the risks associated with unsafe medicine disposal. Similarly, individuals who had previously interacted with community health workers (CHWs) or attended health awareness sessions displayed more responsible attitudes toward pharmaceutical waste management. This suggests that direct engagement through local health initiatives has a measurable impact on promoting environmentally responsible behavior. Overall, the data emphasize the urgent need for targeted educational interventions and community-based awareness campaigns to bridge the knowledge gap. Empowering rural households with accurate information and accessible disposal options can significantly reduce the environmental hazards associated with pharmaceutical waste. [4,5]

2.MATERIALS AND METHODS

2.1. Study Design

This study employed a cross-sectional design using a questionnaire administered in selected rural villages falling within the jurisdiction of one gram panchayat. A total of 200 households participated, comprising male and female respondents aged over 18 years.[6]

2.2. Study Area and Population

The selected villages were predominantly agricultural communities equipped with limited healthcare infrastructure, consisting of a Primary Health Centre (PHC), a few sub-centres, and some privately operated pharmacies.[7] The majority of the residents relied on over-the-counter drugs and traditional healing practices to manage routine ailments.

2.3. Data Collection Tool

A pretested semi-structured questionnaire was developed in the local language, consisting of four sections:

- Demographics (age, gender, education, occupation)
- Medicine use and storage practices

- Disposal practices for unused/expired medicines
- Awareness about environmental impact and willingness to adopt safe disposal methods

2.4. Data Collection Procedure

The survey was carried out through door-to-door interviews by trained pharmacy students. Orally informed consent was obtained before participation.

2.5. Data Analysis

Data were entered in Microsoft Excel and analysed using descriptive statistics (frequency and percentage). Results were summarized in tables and charts to identify trends in awareness and disposal behavior.

2.6. Expected Outcomes

- To assess the extent of community knowledge and understanding regarding the proper disposal of unused or expired medications.[8]
- To examine the commonly adopted practices for medicine disposal among households in rural areas.
- To analyze how educational background influences individuals' attitudes and behaviours toward medicine waste management.
- To generate foundational information that can support the formulation of sustainable and eco-friendly pharmaceutical waste management strategies in rural communities.
- To propose locally adaptable interventions such as establishing medicine collection points or conducting health awareness programs to encourage safe and responsible medicine disposal.

This research employed a cross-sectional, mixed-method approach to evaluate the knowledge, attitudes, and practices (KAP) concerning the disposal of medicines in rural areas. The study was conducted in five carefully chosen villages, selected to reflect differences in population size, proximity to primary healthcare centers, and dominant livelihood patterns.[9] By integrating both quantitative and qualitative methods, the study sought to capture a comprehensive understanding of community behavior related to pharmaceutical waste management. The methodology included household surveys, interviews with key stakeholders, focus group discussions (FGDs) with community members, and field-based observations at local waste disposal points and medicine retail outlets. This design ensured the inclusion of diverse perspectives, combining measurable trends with in-depth contextual insights.[10]

2.7. Sampling and Participants

Household selection was carried out using a stratified random sampling technique to ensure adequate representation across various age groups, genders, and socioeconomic categories. In addition to households, local pharmacies, informal medicine sellers, community health workers (CHWs), and primary healthcare providers were intentionally chosen for interviews to obtain a broader understanding of the existing disposal ecosystem. [11,12,13] The sample size was determined to allow precise estimation of awareness levels and enable comparison among different demographic and occupational subgroups. This approach enhanced the statistical reliability and generalizability of the findings across similar rural contexts.

Data collection instruments

1. **Structured KAP Questionnaire:**

Designed for household respondents, the tool captured information on medicine storage habits, reasons for retaining leftover medicines, knowledge about expiry dates and associated hazards, commonly used disposal techniques, awareness of medicine return or take-back programs, and exposure to health education campaigns.[14]

2. **Semi-Structured Interview Guide:** Applied to pharmacists, CHWs, and informal vendors, this guide explored current disposal procedures, challenges faced in implementation, and recommendations for improving community-level practices.[15]

3. **FGD Guide:** Used to facilitate discussions among community members, focusing on cultural beliefs about medicine reuse, traditional waste handling norms, and perceived risks of improper disposal.

4. **Observational Checklist:** Utilized to document visible pharmaceutical waste at the household level, open dumping sites, and pharmacies, including verification of store records, waste segregation practices, and drug return policies.

2.8. Data Analysis

Quantitative findings included the percentage of households employing specific disposal methods, mean awareness scores regarding environmental risks, and correlations between sociodemographic factors and safe disposal behaviours.[16] Qualitative data analysis focused on identifying major themes such as motivations for storing leftover medicines, community trust in pharmaceutical products, barriers to proper disposal, and locally suggested remedial strategies. Both data streams were triangulated to validate outcomes and generate practical, evidence-based recommendations for improving pharmaceutical waste disposal practices in rural communities.[17]

3.RESULTS AND DISCUSSION

3.1. Demographic Details

Out of 200 respondents, 60% were females and 40% males. Most participants (45%) had secondary-level education, and 70% were engaged in agriculture or daily-wage work.

3.2. Storage and Disposal Practices

About 82% of households reported storing medicines at home, mainly painkillers, antibiotics, and cold remedies. Nearly 68% of respondents had at least one expired or unused medicine at the time of the survey.

When asked about disposal methods:

- 45% discarded medicines in household garbage,
- 25% burned them along with other waste,
- 18% flushed them into toilets or drains,
- Only 12% returned medicines to the local health centre or pharmacy.

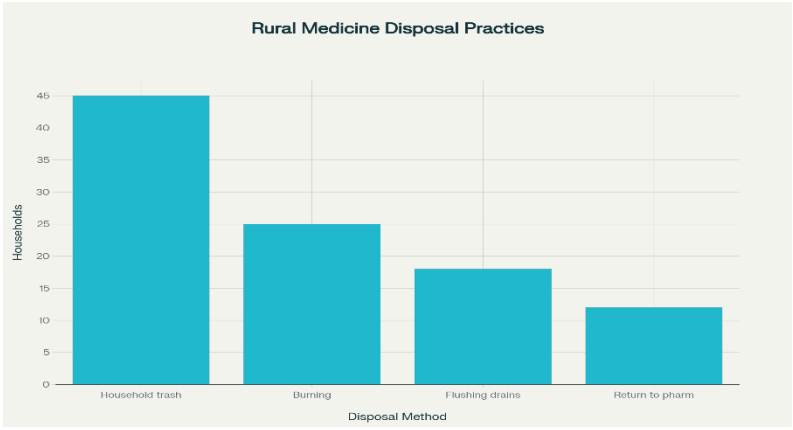

Figure 1. Number of households using different medicine disposal practices

3.3. Awareness Levels

Only 28% of respondents were aware that improper disposal could harm the environment or contribute to antimicrobial resistance. Less than 10% had heard of the concept of "pharmaceutical waste management."

3.4. Factors Influencing Awareness

The analysis demonstrated a significant relationship between participants' educational background and their exposure to health awareness initiatives, both of which had a notable effect on their understanding of medicine waste management ($p < 0.05$). Individuals with higher levels of formal education displayed a stronger sense of responsibility and were more inclined to support the introduction of community-based medicine return or collection systems. Overall, the findings highlight limited awareness and unsafe disposal behaviours among rural households. These results are consistent with observations made in previous studies from India and other Southeast Asian regions, suggesting that deficiencies in community-level pharmaceutical waste management are a common and persistent issue.[18] The lack of systematic collection mechanisms, weak enforcement of disposal regulations, and the absence of consistent public education campaigns emerged as major contributing factors to the problem. Survey analysis further revealed that only 38% of respondents correctly recognized that improper disposal of medicines can lead to environmental pollution, particularly contamination of soil and water. In contrast, about 32% of participants assumed that unused or expired drugs no longer posed any danger once discarded, while nearly 30% admitted uncertainty regarding the possible risks.[19] These figures reflect a substantial knowledge gap within rural populations concerning the long-term ecological effects of pharmaceutical residues. The data also indicated that respondents with at least a secondary school education or prior interaction with community health workers (CHWs) exhibited comparatively higher levels of awareness. Key informants, including pharmacists and local health facilitators, corroborated this finding, noting that most villagers rarely distinguish between expired medicines and ordinary household waste. As one elderly participant remarked, *"When a medicine expires, it's like leftover food—something to be thrown away.* "This prevailing perception underscores the urgent need for targeted educational interventions that simplify the concept of pharmaceutical pollution. Framing awareness messages in relatable, culturally appropriate terms could help communities better understand the environmental and health risks linked to unsafe medicine disposal.[20]

3.5. Barriers to Safe Disposal

Thematic analysis highlighted four main barriers:

- Lack of accessible collection points
- Limited transport options to distant disposal sites
- Absence of clear guidelines at the village level
- Cultural norms treating pharmaceuticals as inert objects

Community health workers expressed willingness to champion disposal education but cited resource constraints and competing priorities.

4. Summary and Conclusion

The findings of this study reveal that a large proportion of rural households dispose of expired or unused medicines through unsafe practices, including open burning, dumping, or flushing into water sources. These behaviours are largely driven by a lack of awareness, limited access to proper disposal infrastructure, and cultural or economic factors. While a minority of participants indicated a willingness to return unused medicines to Primary Health Centres (PHCs) or pharmacies, such collection mechanisms were rarely in place, limiting practical options for safe disposal. To reduce the environmental and public health risks associated with pharmaceutical waste, several strategies are critical:

- Implement ongoing educational and awareness programs in rural communities to inform residents about the hazards of improper medicine disposal.
- Establish medicine return or collection points at PHCs, local pharmacies, and other accessible locations.
- Integrate eco-friendly pharmaceutical waste management policies into routine rural health services and programs.

The study underscores significant gaps in both knowledge and practice concerning medicine waste management. Many households continue to retain unused medications and dispose of them via environmentally harmful channels due to factors such as cost considerations, entrenched cultural norms, lack of guidance from healthcare professionals, and insufficient infrastructure. Furthermore, pharmacies and informal medicine vendors generally do not follow standardized protocols for disposing of expired products. Addressing these challenges requires a comprehensive, multi-faceted approach. Key interventions include community education led by trusted local health workers, practical pharmacy-based take-back systems, incorporation of disposal guidance into routine primary care interactions, and modest support from local authorities for policy and logistics. Pilot initiatives should be designed to be culturally appropriate, cost-effective, and embedded within existing outreach programs, thereby enhancing feasibility and scalability. Protecting both rural populations and the surrounding environment from the adverse effects of pharmaceutical waste is achievable when interventions align with community priorities, leverage existing infrastructure such as PHCs and community health workers, and are supported by pragmatic policy frameworks. Immediate actionable steps include developing a community education toolkit, piloting a pharmacy take-back program in selected villages, and establishing simple monitoring indicators to track progress. Future research should assess the environmental impact of these interventions, measure changes in disposal behaviours over time, and evaluate the effectiveness of sustainable waste management models integrated into rural healthcare systems. Embedding these strategies

within routine health services can help safeguard both ecosystem integrity and public health in vulnerable rural populations.

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Institutional Review Board Statement

All procedures performed in this study complied with institutional and international ethical standards

Informed Consent Statement

Prior to data collection, all participants were informed about the objectives of the study, the voluntary nature of their participation, and the confidentiality of their responses. Oral consent was obtained from each participant before inclusion in the survey. Participants were assured that no personal identifiers would be recorded or disclosed.

Data Availability Statement

To protect participant confidentiality, raw data have been anonymized and stored securely in accordance with institutional data management policies.

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Conflicts of Interest

Nil

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