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ASSESSMENT OF PUBLIC AWARNESS REHARDING SAFE DISPOSALOF UNUSED AND EXPIRED MEDICATIONS

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ABSTRACT

Background: The accumulation of unused and expired medications in households is a common occurrence resulting from changes in prescribed therapy, incomplete treatment courses, improvement in health conditions, or medication non-adherence. Improper disposal of these medications may pose significant risks to public health and the environment, including accidental poisoning, drug misuse, and environmental contamination. Despite the potential consequences, awareness of appropriate medication disposal practices remains limited among the general population.

Objective: To assess the awareness, storage practices, and disposal behaviours related to unused and expired medications among visitors to community pharmacies.

Methods: A cross-sectional observational study was conducted among 150 participants recruited from selected community pharmacies. Data were collected using a structured questionnaire comprising demographic characteristics, medication storage practices, awareness of safe medication disposal, and disposal behaviours. Descriptive statistical methods were employed for data analysis, and the relationship between demographic variables and awareness levels was examined where applicable.

Results: The study demonstrated that a considerable proportion of participants stored unused or expired medications in their households. Most respondents lacked adequate knowledge regarding recommended disposal methods and reported disposing of medications through household waste. Awareness of the environmental and health hazards associated with

improper medication disposal was found to be limited. In addition, only a small proportion of participants were aware of medication take-back programs. However, the majority expressed a willingness to receive education on proper disposal practices and to participate in safe medication disposal initiatives.

Conclusion: The findings indicate inadequate public awareness regarding the safe disposal of unused and expired medications. Strengthening pharmacist-led educational interventions and establishing medication take-back programs may enhance public knowledge, encourage appropriate disposal practices, and reduce potential risks to both public health and the environment.

KEYWORDS: Unused medications, expired medications, medication disposal, public awareness, community pharmacy, pharmaceutical waste.

1. INTRODUCTION

Pharmaceutical products are indispensable in contemporary healthcare, contributing significantly to the prevention, diagnosis, management, and treatment of numerous diseases. Their widespread use has led to remarkable improvements in patient outcomes and overall quality of life. However, the increasing availability and utilization of medications have also resulted in the accumulation of unused and expired medicines in households, posing a growing challenge to both public health and environmental safety. Medications may remain unused for a variety of reasons, such as modifications in treatment regimens, adverse drug reactions, clinical recovery, non-compliance with prescribed therapy, or the purchase of medications in larger quantities than required. Likewise, medicines may reach their expiration date when stored for long periods without being consumed.[1 3]

The presence of unused and expired medications in households can pose several potential health risks. Improperly stored medicines may be accidentally ingested by children, elderly individuals, or household pets, leading to poisoning and other harmful consequences. Additionally, leftover medications may be shared among family members, self-administered without medical supervision, or intentionally misused, thereby increasing the risk of adverse drug events, medication errors, and substance abuse.

Improper disposal of medications is another issue of considerable concern. Common disposal practices, including discarding medicines in household trash, flushing them down toilets, or pouring them into sinks, can result in the release of pharmaceutical substances into the environment. These contaminants may enter soil, groundwater, surface water, and aquatic

ecosystems, potentially affecting environmental and human health. Studies have reported the occurrence of pharmaceutical residues in various environmental settings, highlighting their possible adverse effects on aquatic organisms, wildlife, and ecosystems. Furthermore, inappropriate disposal of antibiotics may contribute to the emergence and spread of antimicrobial resistance, which remains a significant global public health concern.[5,10,17]

Recognizing these risks, several national and international health authorities, including the World Health Organization (WHO), have recommended appropriate strategies for the safe disposal of medications. Such strategies include returning unused medicines to authorized collection facilities, participating in medication take-back programs, and adhering to established disposal recommendations. Although these initiatives have been implemented in many countries to minimize pharmaceutical waste and environmental contamination, awareness and participation among the public remain limited.

Community pharmacists play a pivotal role in promoting the responsible use, storage, and disposal of medications. As easily accessible healthcare professionals, pharmacists are well positioned to educate patients about proper disposal practices, raise awareness regarding the consequences of inappropriate medication disposal, and encourage involvement in medication take-back programs. Through patient counselling and educational initiatives, pharmacists can help reduce medication-related risks and contribute to the protection of public health and the environment.

Despite the increasing emphasis on pharmaceutical waste management, evidence from previous studies suggests that awareness of proper medication disposal practices among the general population remains inadequate. Many individuals continue to dispose of unused and expired medications using inappropriate methods due to insufficient knowledge and limited access to disposal services. Therefore, assessing public awareness and understanding existing storage and disposal practices are essential for the development of targeted educational interventions and effective public health policies.

In response to these concerns, the present study was conducted to evaluate the awareness, storage practices, and disposal behaviours associated with unused and expired medications among visitors to community pharmacies. The findings of this study may assist in identifying knowledge deficits, supporting pharmacist-led educational programs, and encouraging the adoption of safe medication disposal practices to enhance public health and environmental protection.[3,9,11,12]

2. MATERIALS AND METHODS

2.1 Study Design

The present study employed a cross-sectional observational design to evaluate public awareness, storage practices, and disposal behaviours related to unused and expired medications among visitors to selected community pharmacies. A structured questionnaire was used as the primary tool for data collection to assess participants' knowledge, attitudes, and practices regarding medication disposal.

2.2 Study Site

The study was conducted in selected community pharmacies situated in Hyderabad, Telangana India. Community pharmacies were selected because they serve as an important point of contact between healthcare professionals and the public, providing an appropriate setting for assessing awareness and practices related to medication use, storage, and disposal.

2.3 Study Duration

The study was carried out over a six-month period fromDecember 2025 to may 2026 The study duration included various stages such as protocol preparation, obtaining ethical approval, development of the questionnaire, recruitment of participants, collection of data, statistical analysis, and preparation of the research report.

2.4 Study Population

The study population comprised adult individuals who visited the selected community pharmacies during the study period. Participants representing different age groups, educational levels, and occupational categories were included to obtain a comprehensive understanding of public awareness and medication disposal practices.

2.5 Sample Size

A total of 150 participants were enrolled in the study. The sample size was considered adequate to assess awareness and disposal behaviours among the target population and to generate meaningful descriptive results. Participant recruitment continued until the desired sample size was achieved.

2.6 Sampling Technique

A convenience sampling technique was adopted for participant selection. Individuals visiting the selected community pharmacies who fulfilled the eligibility criteria were invited to participate in the study. This sampling approach was selected because of its practicality and suitability for community-based observational studies.

2.7 Inclusion Criteria

Participants were included in the study if they met the following criteria:

- Individuals aged 18 years or older.
- Visitors to the selected community pharmacies during the study period.
- Individuals capable of understanding the questionnaire and study objectives.
- Individuals willing to provide informed consent and participate voluntarily.

2.8 Exclusion Criteria

Participants meeting any of the following criteria were excluded from the study:

- Healthcare professionals, including physicians, pharmacists, nurses, and other allied healthcare workers.
- Pharmacy students and students from other healthcare-related fields.
- Individuals unwilling to participate in the study.
- Participants who submitted incomplete or improperly completed questionnaires.

2.9 Study Instrument

Data were collected using a structured and pre-validated questionnaire developed following an extensive review of relevant literature related to medication storage and disposal practices. The questionnaire was initially prepared in English and translated into the local language whenever necessary to ensure better understanding among participants.

The questionnaire consisted of four sections:

Section A: Demographic Characteristics

This section collected demographic information from participants, including:

- Age
- Gender
- Educational qualification
- Occupation
- Area of residence

Section B: Medication Storage Practices

This section evaluated participants' medication storage behaviours within their households and included questions regarding:

- Presence of unused medications at home
- Presence of expired medications at home
- Commonly stored categories of medications

- Frequency of checking medication expiry dates
- Reasons for retaining unused medications

Section C: Awareness Regarding Safe Medication Disposal

This section assessed participants' knowledge and awareness regarding proper medication disposal methods and included questions related to:

- Awareness of recommended medication disposal practices
- Knowledge of environmental consequences of improper disposal
- Awareness of health risks associated with inappropriate disposal
- Familiarity with medication take-back programs
- Sources of information regarding medication disposal

Section D: Disposal Practices and Attitudes

This section examined participants' disposal behaviours and attitudes toward safe medication disposal and included questions regarding:

- Methods used for disposing of unused medications
- Methods used for disposing of expired medications
- Previous counselling received regarding medication disposal
- Willingness to return unused medications to pharmacies
- Interest in participating in medication take-back initiatives

2.10 Questionnaire Validation

The questionnaire was evaluated by experts in community pharmacy and pharmacy practice to ensure its clarity, relevance, and content validity. Necessary modifications were incorporated based on expert feedback before the questionnaire was finalized and administered to participants.

2.11 Data Collection Procedure

Permission to conduct the study was obtained from the selected community pharmacies before the commencement of data collection. Eligible participants were approached and provided with information regarding the purpose, objectives, and significance of the study. Written informed consent was obtained from all participants before their enrollment.

Participants were requested to complete the questionnaire independently. Clarifications were provided whenever necessary without influencing participant responses. All completed questionnaires were reviewed for completeness and accuracy before being included in the final analysis.

2.12 Outcome Measures

Primary Outcome

The primary outcome of the study was to assess the level of public awareness regarding safe disposal practices for unused and expired medications.

Secondary Outcomes

The secondary outcomes included:

- Assessment of medication storage practices within households.
- Identification of commonly practiced methods of medication disposal.
- Evaluation of awareness regarding environmental impacts associated with improper disposal.
- Assessment of awareness concerning medication take-back programs.
- Evaluation of participants' willingness to participate in safe medication disposal initiatives.

2.13 Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) software version [Version Number].

Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize participant demographics and study findings. Associations between demographic variables and awareness levels were examined using the Chi-square test wherever appropriate. A p-value of less than 0.05 was considered statistically significant.

2.14 Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee before the initiation of the study. Participation was voluntary, and written informed consent was obtained from all participants prior to data collection.

The confidentiality and anonymity of participants were maintained throughout the research process. No personal identifiers were recorded, and all collected information was used solely for research purposes. Participants were informed of their right to withdraw from the study at any stage without any penalty or negative consequences.[4,17,18,21]

3. RESULTS

3.1 Demographic Characteristics of Participants

A total of 150 participants were included in the study. The demographic characteristics of the participants are presented in Table 1. Among the participants, 82 (54.7%) were female and 68 (45.3%) were male. The majority belonged to the age group of 18–30 years (40.0%),

followed by 31–45 years (32.0%). Regarding educational status, most participants had completed undergraduate education (42.0%).

Table 1. Demographic Characteristics of Participants. (n = 150)

Variable	Frequency (n)	Percentage (%)
Age Group		
18–30 years	60	40.0
31–45 years	48	32.0
46–60 years	27	18.0
>60 years	15	10.0
Gender		
Male	68	45.3
Female	82	54.7
Educational Status		
Primary Education	15	10.0
Secondary Education	42	28.0
Undergraduate	63	42.0
Postgraduate	30	20.0

3.2 Medication Storage Practices

The medication storage practices of the participants are shown in Table 2. Among the respondents, 108 (72.0%) reported having unused medications at home, while 67 (44.7%) reported the presence of expired medications. Only 38.7% of participants regularly checked the expiry dates of their medications, whereas a considerable proportion checked them only occasionally or not at all.

Table 2. Medication Storage Practices Among Participants. (n = 150)

Parameter	Frequency (n)	Percentage (%)
Unused medications present at home	108	72.0
Expired medications present at home	67	44.7
Regularly check expiry dates	58	38.7
Occasionally check expiry dates	62	41.3
Rarely/Never check expiry dates	30	20.0

3.3 Awareness Regarding Safe Medication Disposal

Participants' awareness regarding safe disposal of unused and expired medications is summarized in Table 3. Only 48 (32.0%) participants were aware of recommended

medication disposal methods, while 102 (68.0%) lacked such awareness. Awareness regarding environmental consequences and health risks associated with improper medication disposal was also found to be limited. Furthermore, only 12.0% of participants were aware of medication take-back programs.

Table 3. Awareness Regarding Safe Medication Disposal. (n = 150)

Awareness Parameter	Frequency (n)	Percentage (%)
Aware of recommended disposal methods	48	32.0
Unaware of recommended disposal methods	102	68.0
Aware of environmental consequences	55	36.7
Unaware of environmental consequences	95	63.3
Aware of health risks	61	40.7
Unaware of health risks	89	59.3
Aware of medication take-back programs	18	12.0
Unaware of medication take-back programs	132	88.0

3.4 Disposal Practices of Unused and Expired Medications

The disposal methods adopted by participants are presented in Table 4. Disposal of medications through household garbage was the most commonly reported practice (64.0%). Other methods included flushing medications into toilets (10.0%), disposal through sinks (8.0%), and returning medications to pharmacies (6.0%). These findings indicate that recommended disposal practices are not commonly followed.

Table 4. Disposal Practices of Unused and Expired Medications. (n = 150)

Disposal Method	Frequency (n)	Percentage (%)
Household garbage	96	64.0
Flushing in toilet	15	10.0
Disposal through sink	12	8.0
Returned to pharmacy	9	6.0
Other methods	18	12.0

3.5 Awareness and Willingness to Participate in Medication Take-Back Programs

Table 5 presents participants' awareness and willingness regarding medication take-back programs. Although only 12.0% of participants were aware of such programs, a large majority (84.0%) expressed willingness to participate if such facilities were made available. Additionally, 88.0% of respondents showed interest in receiving education regarding safe medication disposal practices.

Table 5. Awareness and Willingness to Participate in Medication Take-Back Programs. (n = 150)

Parameter	Frequency (n)	Percentage (%)
Aware of take-back programs	18	12.0
Previously participated	6	4.0
Willing to participate in future	126	84.0
Interested in receiving education	132	88.0

3.6 Association Between Educational Status and Awareness Levels

The relationship between educational status and awareness regarding safe medication disposal is shown in Table 6. A statistically significant association was observed between educational level and awareness ($p = 0.032$). Participants with higher educational qualifications demonstrated greater awareness regarding appropriate medication disposal practices compared to those with lower educational levels.

Table 6. Association Between Educational Status and Awareness of Safe Medication Disposal.

Educational Status	Aware n (%)	Unaware n (%)	p-value
Primary Education	2 (13.3)	13 (86.7)	
Secondary Education	10 (23.8)	32 (76.2)	
Undergraduate	24 (38.1)	39 (61.9)	
Postgraduate	12 (40.0)	18 (60.0)	
Total	**48 (32.0)**	**102 (68.0)**	**0.032**

Summary of Findings

Among 150 participants, 72% reported storing unused medications at home, while 44.7% had expired medications in their households. Only 32% were aware of recommended medication disposal methods, and awareness of medication take-back programs was particularly low (12%). Household garbage was the most common disposal method (64%). Despite limited awareness, 84% of participants expressed willingness to participate in medication take-back programs, and 88% were interested in receiving education regarding safe medication disposal.

4. DISCUSSION

The present study was undertaken to assess the level of public awareness, storage habits, and disposal practices related to unused and expired medications among individuals visiting

community pharmacies. The findings demonstrated that a substantial proportion of participants kept unused medications in their households and possessed limited knowledge regarding appropriate medication disposal methods.

In the current study, 72.0% of participants reported the presence of unused medications in their homes. This may be attributed to various factors, including changes in prescribed treatment, recovery from disease, adverse drug reactions, non-compliance with medication regimens, and the purchase of medicines in quantities greater than required. Similar findings have been reported in previous studies, indicating that the accumulation of unused medications in households is a common phenomenon across different populations.[18,21,22]

Furthermore, 44.7% of participants reported storing expired medications at home. The continued retention of expired medicines may increase the risk of accidental consumption, inappropriate self-medication, drug misuse, and other medication-related issues. These findings emphasize the need to educate the public about regularly monitoring medication expiry dates and ensuring the safe disposal of expired products.[5,10,26,28]

The results also indicated that awareness regarding safe medication disposal practices was inadequate. Only 32.0% of participants were aware of the recommended methods for medication disposal, whereas the majority lacked sufficient knowledge regarding proper disposal procedures. This finding is consistent with previous studies that have reported poor public awareness concerning the safe disposal of unused and expired medications.

Disposal of medications through household garbage was identified as the most commonly practiced method, accounting for 64.0% of responses. In comparison, fewer participants reported disposing of medications through toilets or sinks. Such disposal practices may contribute to environmental contamination by introducing pharmaceutical compounds into soil and water resources. Therefore, these findings highlight the importance of increasing public awareness regarding environmentally safe medication disposal practices.[3,11,12,18

Awareness regarding medication take-back programs was found to be notably low, with only 12.0% of participants reporting familiarity with such initiatives. Despite this limited awareness, a majority of respondents expressed willingness to participate in medication take-back programs if these services were available. This observation suggests that enhanced awareness and improved access to disposal facilities may encourage greater public participation in safe medication disposal activities.

A statistically significant association was observed between educational status and awareness regarding safe medication disposal. Participants with higher educational qualifications exhibited greater awareness compared with those possessing lower levels of education. This

finding indicates that educational interventions may play an essential role in improving public understanding and promoting appropriate medication disposal behaviours.[21,22 28,23]

Community pharmacists have a significant role in encouraging the safe use, storage, and disposal of medications. Through patient counselling, health education programs, and public awareness campaigns, pharmacists can enhance public knowledge regarding proper medication disposal methods. Pharmacist-led educational initiatives and medication take-back programs may contribute substantially to reducing the accumulation of unused medications, minimizing environmental pollution, and improving public safety.

Overall, the findings of the present study indicate that public awareness regarding the safe disposal of unused and expired medications remains inadequate. The introduction of effective educational programs and organized medication take-back initiatives may help improve disposal practices and contribute to the protection of both public health and the environment.[31,17,16,15,23,24]

5. CONCLUSION

The present study evaluated public awareness, medication storage habits, and disposal practices related to unused and expired medications among visitors to community pharmacies. The findings revealed that a substantial proportion of participants retained unused and expired medications in their homes and possessed limited knowledge regarding appropriate medication disposal methods. Disposal of medications through household waste was found to be the most commonly adopted practice, whereas awareness of medication take-back programs was relatively low.

Improper storage and disposal of medications can lead to various public health and environmental concerns, including accidental poisoning, medication misuse, environmental pollution, and the emergence of antimicrobial resistance. Despite the low level of awareness regarding safe disposal practices, the majority of participants expressed a positive attitude toward participating in medication take-back programs and showed interest in receiving information about proper medication disposal.

The results of this study emphasize the need for enhanced public awareness and educational initiatives to improve knowledge and encourage appropriate medication disposal behaviors. Community pharmacists have an important role in educating patients and promoting the safe storage and disposal of medications. Additionally, the implementation and expansion of medication take-back programs may help reduce pharmaceutical waste and lessen its negative impact on public health and the environment. Therefore, improving public awareness and

establishing well-organized disposal mechanisms are essential for ensuring the safe and effective management of unused and expired medications.

6. LIMITATIONS OF THE STUDY

The present study possesses certain limitations that should be considered while interpreting the findings. Firstly, the study was conducted among individuals visiting selected community pharmacies in a specific geographical area, which may limit the extent to which the results can be generalized to the wider population. Secondly, the adoption of a convenience sampling technique for participant selection may have introduced selection bias and may not accurately reflect the characteristics of the entire target population.

The study data were obtained through self-reported responses collected using a structured questionnaire. Therefore, the results may have been influenced by recall bias or social desirability bias, which could have resulted in either underreporting or overreporting of actual medication storage and disposal behaviours. Moreover, the cross-sectional study design allowed the assessment of awareness and practices at a single point in time and did not facilitate the establishment of causal associations between the variables examined.

In addition, the study was restricted to evaluating public awareness, storage practices, and disposal behaviours concerning unused and expired medications and did not investigate the effectiveness of educational programs or medication take-back services. Despite these limitations, the study offers valuable insights into public awareness and medication disposal practices and highlights the need for future research and targeted public health strategies to address existing gaps in knowledge and practice.

7. RECOMMENDATIONS

Based on the findings of the present study, several recommendations can be suggested to improve public awareness and promote the safe disposal of unused and expired medications.

1. Awareness and educational programs should be conducted regularly to enhance public knowledge regarding the health and environmental consequences of improper medication storage and disposal.
2. Community pharmacists should actively engage in patient education by providing counselling and appropriate guidance on safe medication storage and disposal practices during routine interactions.[1,21,22]

3. Information on recommended medication disposal methods should be made readily accessible through educational brochures, posters, pharmacies, healthcare institutions, and digital media channels.
4. Medication take-back programs should be introduced and extensively promoted to offer safe, convenient, and environmentally sound options for the disposal of unused and expired medications.[29,35,33]
5. Healthcare institutions, regulatory authorities, and government organizations should collaborate to develop and implement policies that support effective pharmaceutical waste management.
6. Educational and awareness initiatives should particularly focus on individuals with limited knowledge to improve understanding and encourage appropriate medication disposal practices.
7. Future studies should be conducted with larger sample sizes and across different geographical regions to obtain more comprehensive and generalizable findings.
8. Further research is needed to evaluate the effectiveness of pharmacist-led educational programs and medication take-back initiatives in improving public awareness and medication disposal behaviours.[13,26,28,30]

Implementation of these recommendations may contribute to improved medication disposal practices, reduced pharmaceutical waste, enhanced public health and safety, and better environmental protection.

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9. Conflict of Interest

The authors affirm that there are no conflicts of interest related to this research study. The investigation was conducted independently, and no financial, personal, academic, or

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