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Uncovering the Causes and Economic Burden of Unused Medicines Due to Non-Adherence, Their Storage and Disposal in Households

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ABSTRACT

Unused medication can result in significant financial losses for households and contribute to the overall cost of healthcare. Additionally, improper storage and disposal of these medications can pose public health and environmental risks. This study aimed to identify the financial impact of unused medications in households, as well as factors contributing to their generation, storage, and disposal practices. The study was a community based cross-sectional, offline survey with a structured questionnaire, conducted for a month among 120 participants from rural and urban areas of Dakshina Kannada district in Karnataka state. The study found that all households had unused medications, with 82.5% of participants being non-adherent. Self-discontinuation after condition resolution (23.7%) was one of the major reasons for the generation of unused medication, 35.8% people estimated the financial worth of unused medicines they possess to be between INR 100-250, and 29.2% estimated it to be around INR 250-500. Most households (80.8%) had 1-10 unused medications. Tablets (34.4%) were the most left unused dosage forms in surveyed households. 53.4% of people stored the unused medications in container and 20.9% stored them in shelf. While 55.8% of participants disposed of unused medication in household trash and gave it to waste management system, burning (12.5%) and dumping (47.5%) were also common practices in rural households. The study concluded that a considerable amount of unused medication is generated in households and that optimal dispensing quantities and rational prescription practices could help reduce their generation. To increase consumer understanding and encourage safe disposal practices, healthcare professionals including pharmacists and governmental organizations must offer education and awareness programs.

Key Words: *Unused medicines, Medication adherence, financial burden, storage, disposal practices, awareness*

INTRODUCTION

There has been a steady worldwide increase in drug consumption, resulting from patterns of increased prescribing, dispensing and use of medicines. Taking drugs at home without prescription has become a habit that is often encouraged in the community. Some patients do not comply with the exact duration of prescriptions, this frequently leads to the incomplete consumption of prescribed and dispensed medicines.[1] Unused medications are those that have passed their expiration dates, have been discontinued, have degraded, or are no longer intended for usage. It is a common practice for patients to be in possession of unused medicines at home. According to the World Health Organization report, globally there is only 50 percent adherence to prescriptions in long term condition medicines.[2] Patients may not use all the medications dispensed to them because of many reasons like the symptoms being relieved, forgetfulness, dosage changes, side effect intolerance, medication reaching the expiration date, or some patients die due to life-ending morbidities while on medication.[3] Sometimes high cost of the medicines, lack of disposal method, or the possibility of needing these medicines again in the future may also cause patients to keep medicines.[4] The increased tendency to let medications go unused ultimately results in wastage of medicines and also significant economic loss. Leftover medicines constitute another dominating cause of environmental contamination with drugs. Improper disposal of leftover medication usually contaminates the environment to a great extent. Unused medications are improperly disposed of by people into household trash that is then dumped in landfills and liquid medications that are then flushed down the toilet or sewer system. [5] Concerns about the effects of pharmaceuticals on the environment have prompted the development of a new science called ecopharmacovigilance. It is described as the science and endeavors concerned with identifying, assessing, comprehending, and avoiding the unfavorable effects of pharmaceutical products on the environment.[6] The goal of the study is to assess the quantity of unused medicines in households, factors responsible for their generation and finally their economic burden on the household. The study also goes further to determine how the general public stores, handles, and discards such unused medications.

OBJECTIVES

- To determine the financial impact of unused medicines in households brought on by a variety of factors.
- To determine the factors contributing to the rise in unutilized drugs in households.
- To determine if the unused medications are kept in the recommended storage settings.

- To evaluate the procedures used in households for disposal of unused medications.

METHODOLOGY

A community-based face to face offline survey was conducted using structured questionnaire to collect data from the households on economic burden of unused medicines, factors causing their generation of unused medicines, their storage and disposal practices. Questionnaire comprised of series of questions related to socio demographic characteristics, medication adherence, storage, and disposal of leftover or unused medicines. The importance and purpose of the study was explained and consent was taken prior to start of the interview. Average of 15 minutes were spent for each household. Modified 4 item Morisky medication adherence scale was employed to assess the medication adherence in households.[7]

Study type: The study is a community based, cross sectional, descriptive offline survey conducted through face-to-face interviews using a structured questionnaire.

Study site: This study was conducted in Dakshina kannada district which is in the southern part of state of Karnataka. The areas covered in the study are both urban and rural communities inhabited by people from different cultural, religious, educational, and social backgrounds.

Sample size: The study consisted of 120 participants, with one person from each household, all of whom voluntarily enrolled for the study.

Study Duration: The study was conducted for the duration of one month from 10/3/2024 to 10/4/2024.

Inclusion criteria: Subjects with unused medicines in the households who voluntarily enrolled for the study.

Exclusion criteria: Subjects with unused medicines from non-cooperating households.

Data source: Data was collected through offline surveys using structured questionnaires adapted from previous studies· and modified to suit our purpose. Questionnaire was prepared in English language including all relevant variables based on the objectives of study.

The tools used have six sections designed to address;

1. Socio-demographic characteristics,

2. Medication adherence

3. Quantity and types of unused medications

4. Financial impact of unused medications

5. Storage of unused medications

6. Disposal practices

RESULT

The present study was done with the goal to identify the kinds, quantity and financial cost of unused medicines as well as their household storage and disposal practices. The data set consisted of 120 households spread across various regions of Dakshina kannada. The socio demographic details of the households surveyed included (table:1) 33.3% of families surveyed in this study were from urban area and 66.7% were rural area.(figure:1) 6.7% of the household had 7-8 members in the family, 33.3% had 1-3 family members and 60% had 4-6 family members in their household. 64.2% of the studied population had one or more chronic illnesses like hypertension, diabetes, arthritis, hyperlipidemia, kidney diseases, asthma, Crohn's disease, atherosclerosis, angina, thyroid, hypotension and stroke. 67.7% surveyed households didn't have a medical professional in their family.

TABLE:1- Socio-Demographic details of respondents

Variables and categories	N= 120	%
Place of residence		
Adyarpadav	33	27.5
Bajjodi	27	22.5
Thiruvail	18	15
Ganjimutt	11	9.2
Gurupura	11	9.2
Hampankatta	7	5.8

Variables and categories	N= 120	%
Mijar	7	5.8
Valencia	6	5
Delineation		
Rural	80	66.7
Urban	40	33.3
Number of people in the household		
1-3	40	33.33
4-6	72	60
7-9	8	6.7
10 or above	0	0
chronically ill patients in your household		
Yes	77	64.2
No	43	35.8
condition(s) they are diagnosed/suffering from		
Hypertension	44	32.4
Diabetes	35	25.7
Arthritis	30	22.1
Asthma	14	10.3
Hyperlipidemia	5	3.7
Kidney diseases	2	1.5
Atherosclerosis	1	0.7
Crohn’s disease	1	0.7
Angina	1	0.7
Thyroid	1	0.7
Hypotension	1	0.7
Stroke	1	0.7
Medical professional in the family		
Yes	46	38.3
No	74	61.7

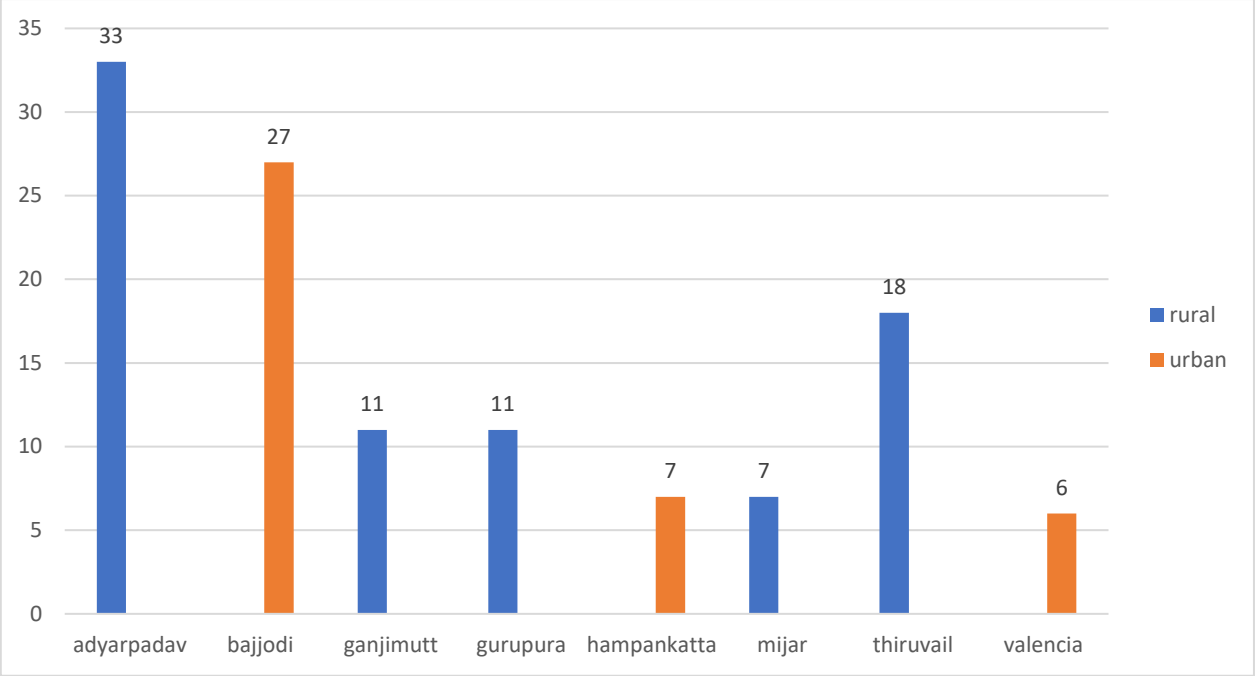


Figure 1: Delineation

Medication adherence of the surveyed population was checked using 4 item modified morisky scale and the points were rewarded depending on the answer (table:2). 71.7% of the people interviewed said they sometimes forgot to take their medications. 70.8% were sometimes not careful in taking their medications. 71.7 % of people said they had the tendency to stop taking their medications if they felt better and finally; 66.7% people said they stopped the treatment if they felt worse. Judging these parameters and scoring them as per the scale it was found that 82.5% were non adherent and 17.5% of the population was adherent. Adherence in rural areas was 7.5% in contrast to urban areas that was 10% (table 3). Difference in medication adherence between rural and urban communities has been shown in (figure 2)

Table 2: Medication adherence evaluation of respondents using

Variables and categories	N= 120	%
Do you ever forget to take your Medication(s)?		
Yes	86	71.7
No	34	28.3
Do you sometimes, not being careful in taking your medication (s)?		
Yes	85	70.8
No	35	29.2
When you feel better, do you sometimes stop taking your medication(s)?		
Yes	86	71.7
No	44	28.3
Sometimes if you feel worse when you take your medication(s), do you stop taking them?		
Yes	80	66.7
No	40	33.3

Table 3: Medication adherence of respondents and the comparison in terms of delineation

Variables and categories	N=120	%
Medication Adherence		
Non adherent	99	82.5
adherent	21	17.5
Delineation		
Non adherent - urban	28	70.00
Adherent - urban	12	30.00
Non adherent - rural	71	88.75
Adherent - rural	9	11.25

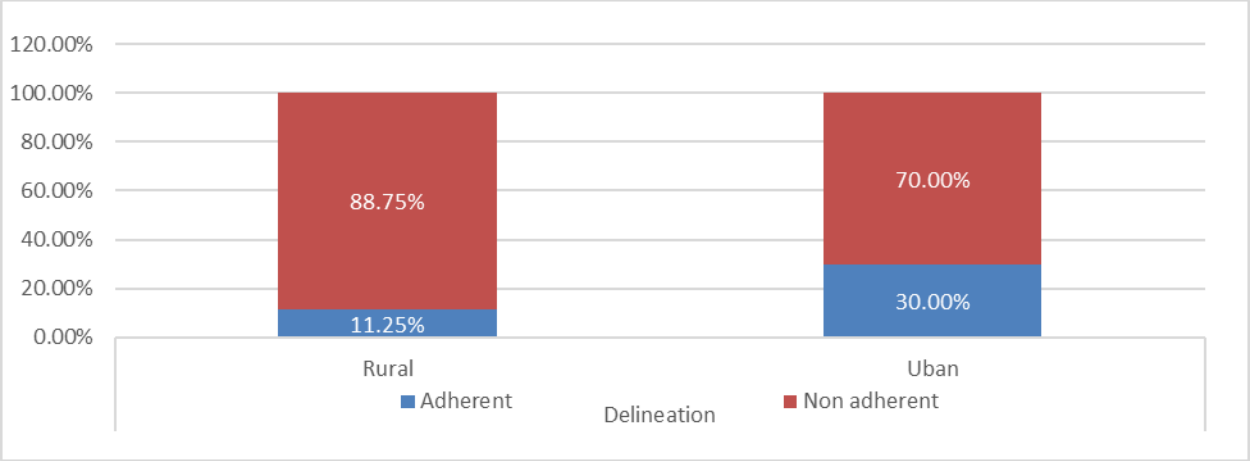


Figure 2: Medication adherence

80.8% of people said they had 1-10 unused medications in their household (table 4). 18.3% had 11-20 unused medications and only 0.8% had more than 20 medications. Surveyed households had multiple classes of unused medications in their household. 20.9% had topical medicines like eye drops, creams and ointments, 20.7% had vitamins and syrups, 20.0% had antipyretics, 17.2% had analgesics, 12.6% antihistamines and 5.6% had antibiotics as unused medications in their household (figure 3). Common forms of dosage forms in surveyed households have been shown in (figure 4).

Table 4: Number of unused medications in the households

Variables and categories	N=120	%
Number of unused medications in the household		
0	0	0
1-10	97	80.8
11-20	22	18.3
More than 20	1	0.8

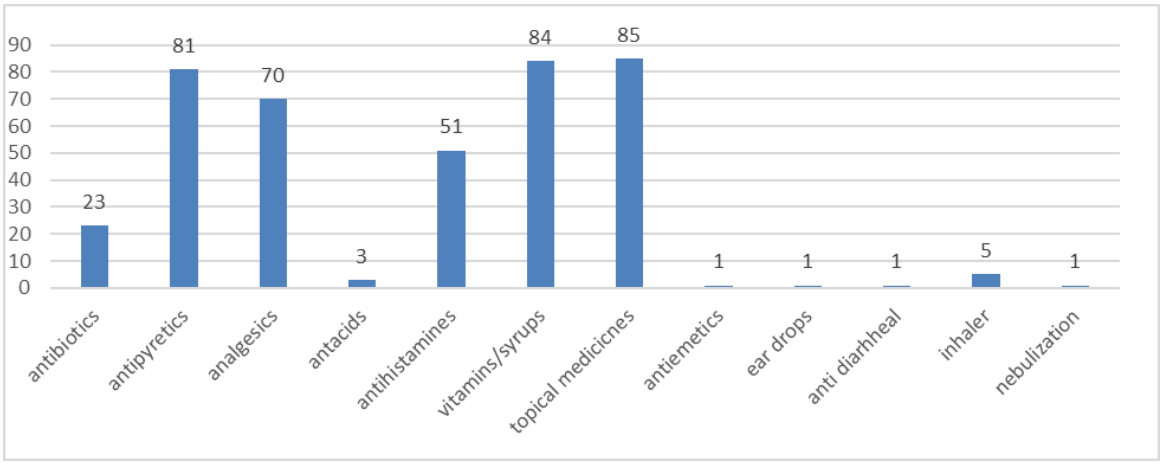


Figure 3: Classes of unused medications in the household (multiple responses)

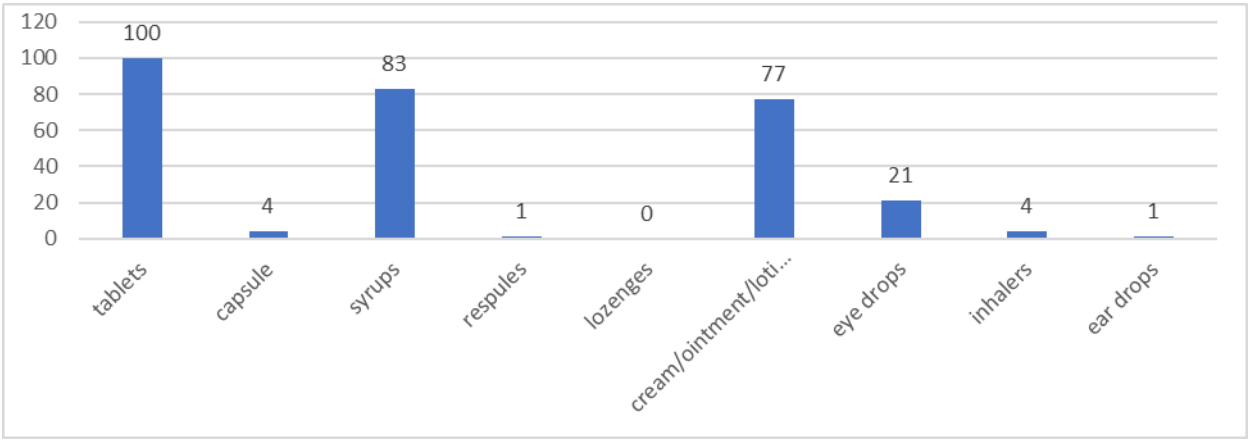


Figure 4: Commonly unused medications dosage forms in the household (multiple responses)

Reasons for possession of unused medications

When asked about reasons for possession of unused medicines, there were multiple reasons given by the interviewed subjects. 23.7% of people said self-discontinuation after the condition was resolved was one of the reasons for having unused medication at the household. Other reasons included, 19.6% possibility of needing these medicines in the future, 15% doctor changed the treatment, 14.4% passed expiry date, 13.4% prescribed more than required, 9% had left over medicines from previous OTC purchase and 4.9% said adverse effects/side effects from the medicine was the reason for the medicines to remain unused. (table: 5)

Table 5: Reasons for possession of unused medicines

Variables and categories	N= 120 (multiple responses)	%
Reasons for possession of unused medicines		
Self-discontinuation after the condition was resolved	87	23.7
Possibility of needing these medicines in the future	72	19.6
Doctor changed the treatment	55	15.00
Passed expiry date	53	14.4
Prescribed more than required	49	13.4
Left over medicines from previous OTC purchase	33	9.00
Adverse effects or side effects to the medications prescribed	18	4.9
death due to life ending morbidities while on medications	0	0

Storage of unused medications

Although people stored unused medications in various places in the house, 53.4% of people stored the unused medications in container and 20.9% stored them in shelf. Other places of storage included 13.5% storing in plastic bag, 7.4% keeping the medicines on the window side, 4.1% agreed that they stored medications on the fridge top and 0.7% kept the medications open on the table top. (figure: 5)

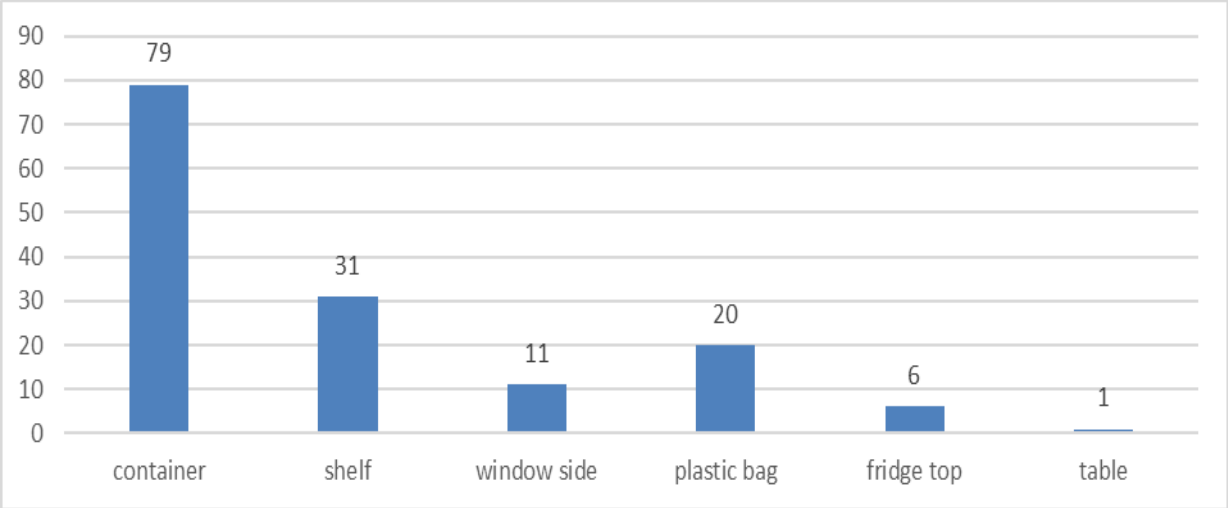


Figure 5: Storage of unused medicines

Economic burden of unused medicines

65% of the people interviewed said that they never considered the financial value of the unused or leftover medications in their household while 35% said they have considered it. When asked whether they could estimate the value of unused medication in their household; about 35.8% people estimated it to be between INR 100-250, 29.2% estimated it to be around INR 250-500 , 19.2% estimated INR 500-1500, 5% said it was less that INR 50 and 2.5% estimated it to be above INR 1500. Among the urban people that were interviewed 12.5% estimated value of unused medicines to be INR 100-250 in contrast to 23.33% of rural people who estimated it to be INR 100- 250. (figure: 6)

Disposal practices of unused medications

72.5% of the respondents agreed that they checked expiry of the medications every month, 11.7% said they checked the expiry every 2 months, 6.7%of the participants said that they never check the expiry of the medications, on the other hand 5.8% checked every 6 months, 2.5% of the participants said they checked the expiry at least once a year and merely 0.8% response was that they checked it every 4 months. When asked about how often they dispose the unused medicines at their household, 54.2% said they checked and disposed unused medications every month. 20.8% agreed they disposed every 2 months, 13.3% said they disposed off medications once in every 6 months, whereas 8.3% people said they disposed off medications once in a year. (table: 6)

Table 6: frequency of checking expiry and disposal of unused medications

Variables and categories	**N=120**	**%**
Frequency of checking expiry of unused medications		
Every month	87	72.5
Every 2 months	14	11.7
Every 4 months	1	0.8
Every 6 months	7	5.8
yearly	3	2.5
Never	8	6.7
Frequency of disposal of unused medicines		
Every month	65	54.2
Every 2 months	25	20.8
Every 4 months	2	1.7
Every 6 months	16	13.3

Variables and categories	**N=120**	**%**
yearly	10	8.3
Never	2	1.7

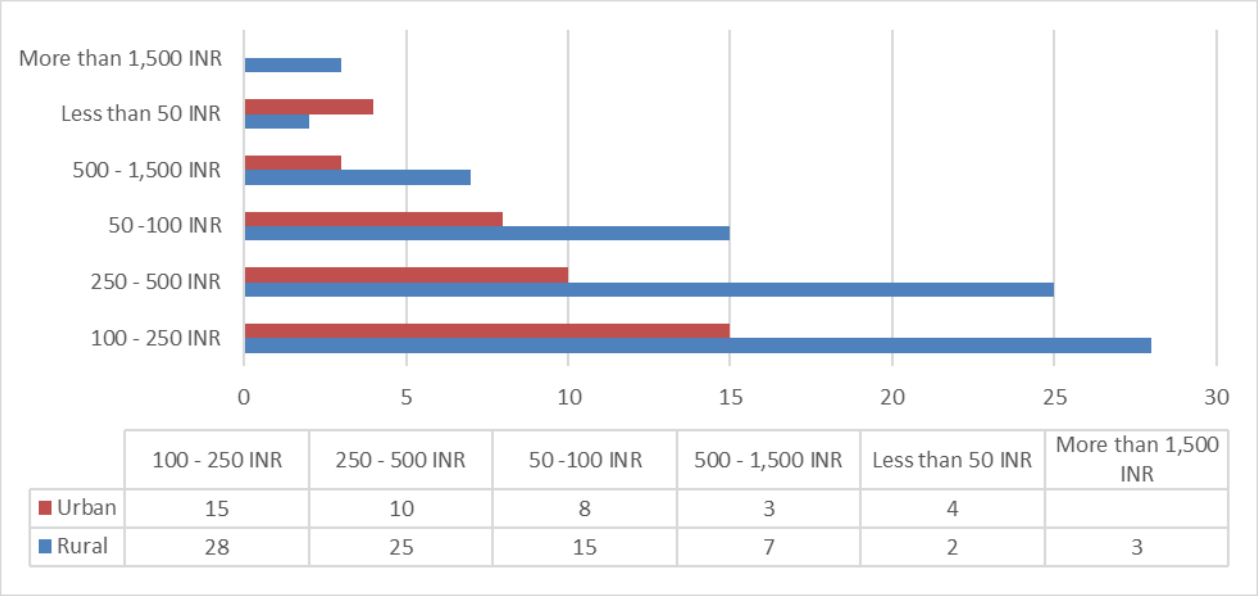
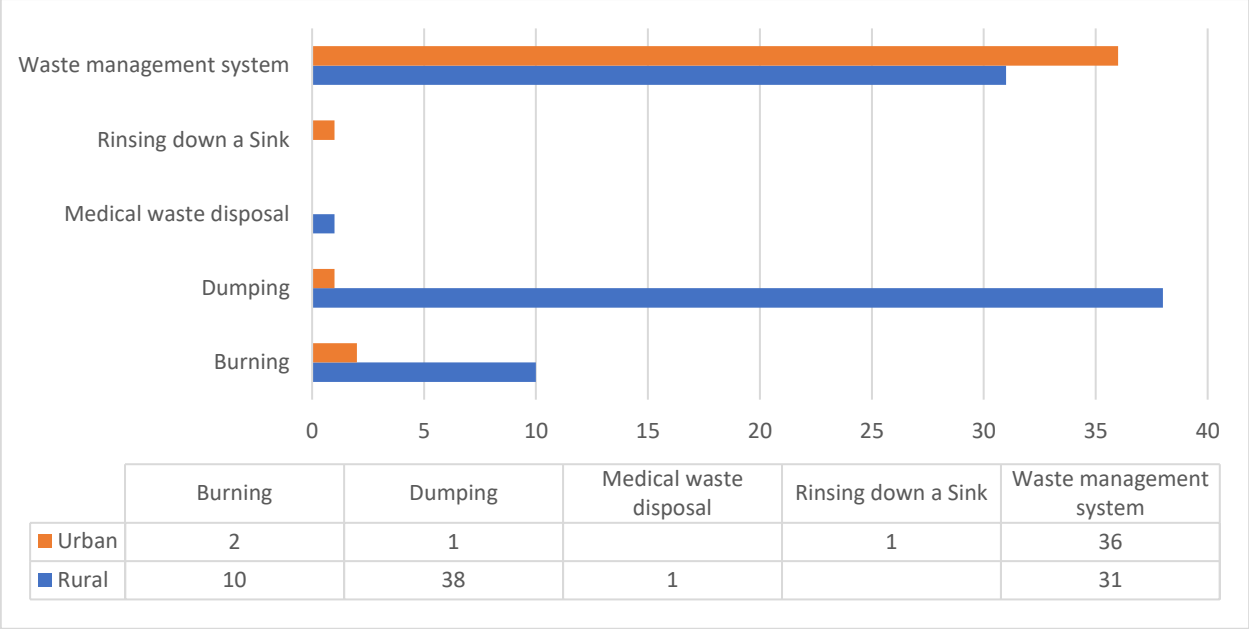


Figure 6: Estimated financial worth of unused medicines in the household

When asked about household disposal practices of unused medications 55.8% (90% [urban] and 38.75% [rural]) agreed that disposed it as household trash/garbage in dry waste bag and gave it to waste management system, 32.5% said that they dumped the medications, whereas 10% disposed by burning the medications. Burning of expired medications in the back yard of the home was a common practice for medication disposal in rural households (12.5%) (table:7) (figure:7).When asked whether they had received information about how to dispose unused medications by, 99.2% of people said they have never received such information by any means.

Table 7: percentage disposal practices between rural and urban households

.	*Delineation*		
Disposal practices	Rural	Urban	Grand Total
Burning	12.50%	5.00%	10.00%
Dumping	47.50%	2.50%	32.50%
Medical waste disposal	1.25%		0.83%
Rinsing down a Sink		2.50%	0.83%
Waste management system	38.75%	90.00%	55.83%
Grand Total	**100.00%**	**100.00%**	**100.00%**



	Burning	Dumping	Medical waste disposal	Rinsing down a Sink	Waste management system
Urban	2	1		1	36
Rural	10	38	1		31

Figure 3: Methods of disposal of unused medications in households

When asked about what did they think were the acceptable methods of disposal of unused medications, they had multiple responses for the question. The results are summarized in the table below (table 8). 6.66% responded by saying they were willing to donate if the medicines were not expired and were kept in good store conditions.

Table 8: Acceptable disposal methods for unused medications according the respondents

Variables and categories	N=120 (multiple responses)	%
Acceptable disposal methods for unused medications according the respondents		
Rinsing down a sink	3	2.22
Flushing down a toilet	0	0
Burning	12	8.88
Dumping	38	28.15
Returning to pharmacist	5	3.70
Donate	9	6.66
Municipality/collect on at home (waste management)	66	48.88
Giving away to friends	1	0.74
Medical waste disposal	1	0.74

Awareness

92.5% people agreed that consumers should be more aware of the hazards of unsafe disposal and methods of safe disposal of medications. 85% of people felt there is a need for a program to collect unused medications from houses and dispose them safely and were supportive of it.

When given options about the methods they would suggest to improve awareness of consumers regarding safe disposal of medicines they had chosen multiple methods. (table 9) 27.5% of people said patient awareness by pharmacist, doctors and nurses were the best methods to improve awareness about safe disposal. 19.9% chose that awareness program by government can also help the cause, 19.4% of people chose written instructions on medications to be useful too. 17.7% said awareness by village healthcare workers would also help and finally 15.2% of people chose provisions for information on newspaper, television or posters as a good method to improve awareness (figure 8).

Table 9: Measures to improve awareness of consumers regarding safe disposal of medicines

Variables and categories	N=120 (multiple responses)	%
Measures to improve awareness of consumers regarding safe disposal of medicines		
Patient education by pharmacists, doctors, and nurses	112	27.5%
Awareness programs by the government	80	19.9%
Written instructions on medicine	78	19.4%
Awareness by village healthcare workers	71	17.7%
Provisions for information in newspaper, television, or poster	61	15.2%

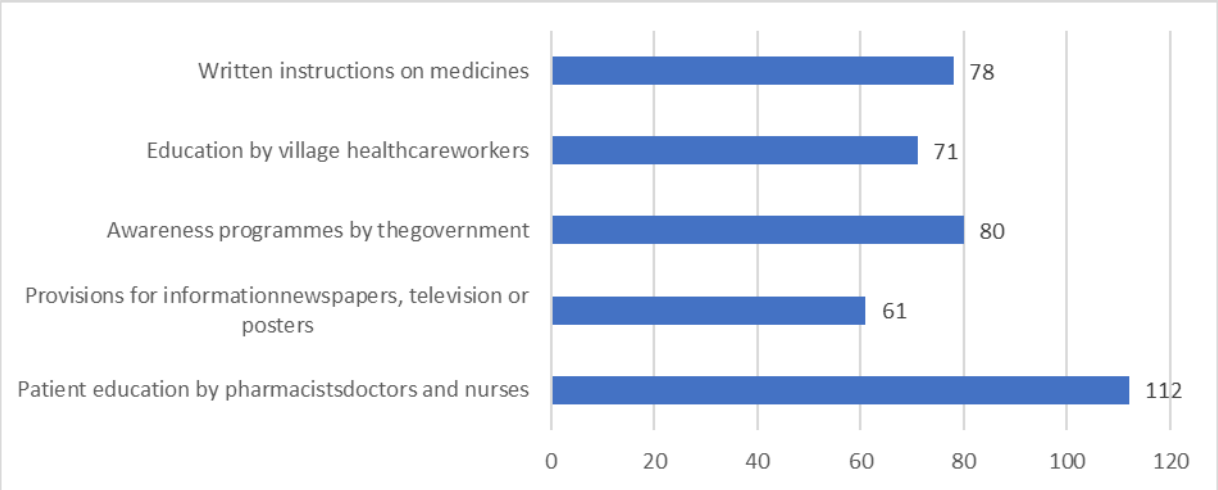


Figure 8: Measures to improve awareness of consumers regarding safe disposal of medicines

DISCUSSION:

A significant gap has emerged in the healthcare systems of several developing nations, including India, as a result of the unjustified use of drugs and weak regulatory frameworks for handling pharmaceuticals. The lack of a waste disposal system intended specifically for pharmaceuticals has a significant role on how the general public views medications. Irrational medication use has grown to be a major global concern. The production of unused medications is one of the negative effects of this practice. Medication hoarding by patients frequently causes them to lose their effectiveness and wastage of resources. Environmental pollution is further exacerbated by a lack of knowledge about proper disposal techniques.

This study was done intending to determine the types, quantities, and costs of unused medications as well as how they are stored and disposed of at households. Based on the findings of the current study all the households (100%) had unused medications with them. which can be compared to studies done in Indonesia (64.3%) by W.N Insani et al.[8] Similarly, studies conducted in Saudi Arabia (89.3%) by Wajid S et al and Tanzania (70.19%) by K.J Marwa et.al [13], reported that they had unused medications at home.[9,10] This is not a surprising result because the people in Dakshina kannada have unhindered access to healthcare as the district has is widely considered as hospital hub.

The study revealed that 80.8% of households had 1-10 unused medications in their household. 18.3% had 11-20 unused medications. Most consumer-stored medications were those needed for common illnesses like pain, fever, and cough. Even though this practice may not be entirely irrational, it is crucial that consumers understand how to safely use, discard, and store unused medications. Tablets (34.4%) were the most left unused dosage forms in surveyed households maybe be because of the acceptability in the community and ease of administration. Similar results were found in studies done in Northern Uganda.[11]

Even though participants gave multiple reasons for having unused medications in their household. The current study found that self-discontinuation (23.7%) after the condition was resolved was one of the major reasons for having unused medication at the household. Self-discontinuation of medicines after relief from condition has also been reported by Lagishetty *et al.* in south India and Braund *et al.* in New Zealand. [12,13] This might be because once the condition is resolved and knowing the efficacy the medicines, those are kept for re-use incase similar illness occurs again. This suggests that patients need to be educated on the importance of completing their medication regimen, possible side effects and antibiotic resistance.

Maintaining of unused and expired medications may be due to lack of a suitable method of disposal or simply not seeing unused medications as dangerous. This is an issue of importance not only from the environmental point of view, but is also the unnecessary financial burden both for the individual and the

healthcare system. 35.8% participants of the current study estimated financial value of unused medicines to be between INR 100-250, 29.2% estimated it to be around INR 250-500 , 19.2% estimated INR 500-1500, 5% said it was less that INR 50 and 2.5% estimated it to be above INR 1500.

Large proportion of people in the survey stored medications in the container (53.4%) or shelf (20.9%) both of which are considered ideal places for storage of medicines. These results can be compared to study conducted in Qatar where 48.2% of medicines were kept in proper storage conditions.[14] the reason for many people storing medicines in ideal conditions could be because of percentage of chronically ill patients in the study. By keeping the medications in designated place it becomes easier for then not miss any dose. plastic bag, window side, fridge top and on table top. Storing medicines in places other than shelves and containers is not ideal because it can compromise their quality and efficacy. Exposure to light, moisture, heat, or other environmental factors can degrade the active ingredients in the medication, rendering it less effective or even harmful.

When asked about household disposal practices of unused medications 55.8% (90% [urban] which is slightly higher than what was reported by by Kusturica MP *et al*. in Serbia.[15] 38.75% [rural] people) agreed that disposed it as household trash/garbage in dry waste bag similar to results found in USA and Ethiopia which was 54% and gave it to waste management system.[16,17] nowadays waste management vehicles also are providing the services in rural areas therefore by encouragement by panchayaths, people of rural areas too are making use of waste management services. 32.5% said that they dumped the medications, burning of expired medications in the back yard of the home was a common practice for medication disposal in rural households (8.3%). This method is used more frequently in Lithuanian rural households (50 %).[18]

92.5% people agreed that consumers should be more aware of the hazards of unsafe disposal and methods of safe disposal of medications similar to what was reported by Alshehri D *et al*. in Saudi Arabia.[19] 85% of people felt there is a need for a program to collect unused medications from houses and dispose them safely and were supportive of it.

In the current study 27.5% of people said patient education by pharmacist, doctors and nurses were the best methods to improve awareness about safe disposal. 19.9% chose that awareness program by government can also help the cause which are similar to the results obtained by Raja S et al.[20]This might be because people like doctors, nurses and pharmacist who work at the forefront of the healthcare system should be the primary mode for spreading the awareness.

FUTURE PROSPECTIVES

The finding of this study emphasizes on the financial impact of unused medications in the households of both urban and rural communities, factors causing the generation of such unused medicines, how the public stores the unused medicines and finally the disposal practices. High proportion of participants did not adhere to the treatment and self-discontinued the medications once the condition was resolved which later led to the leading cause of generation of unused medications in the households. But further research is necessary in this area to understand the people's attitude towards the unused medication and how that differs among the people of urban and rural communities, as well as And the measures and planning to appropriately implement these awareness and disposal programs in different areas.

CONCLUSION

In conclusion, the study highlights the high prevalence of unused medicines in the households and major cause of it being self-discontinuation of medications after relieved of condition. The study also stresses on the necessity of setting up a thorough and efficient pharmaceutical waste management system in developing nations to guarantee the secure disposal of unused medications. Optimal dispensing quantity and rational prescription practices could help reduce unused medication. High proportion of participants did not adhere to the treatment and self-discontinued the medications once the condition was resolved which later led to the leading cause of generation of unused medications in the households. Pharmacists, particularly those with good communication and counseling skills, can directly and positively affect patient adherence to medications, therefore reducing medication wastage. Customers can benefit greatly from the professional messages that pharmacists can deliver. As the study found that large percentage of participants felt the need for a program to collect the unused medications from homes. Drug take back systems should be effectively implicated and public should be encouraged to support such program. The results would be helpful in developing strategies to reduce the number of unused medications and promote proper disposal practices. The study suggests that consumers may not be aware of the risks associated with disposing of and storing unused medications. Therefore, in order to increase consumer understanding and encouraging safe disposal practices, healthcare professionals and governmental organizations must offer education and awareness programs. Village Health Care Workers in rural areas should actively contribute in educating the population about hazards of unsafe disposal like dumping of medications and promote the ways of safe disposal of drugs.

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