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Developing Strategies For Combating Antimicrobial Resistance In Community Pharmacies

Jitendra Singh[1*], Anju Dinkar[2], Ramanand Yadav[3], Nilesh Kumar[4], Debojit Samajdar[5], Dr. Medha Wadhwa[6]

[1*]Department of General Medicine, King George's Medical University, Lucknow, India.

Email ID: drjitengsvm@gmail.com

[2]Department of Microbiology, Sanjay Gandhi Post Graduate Institute Medical Sciences, Lucknow.

Email ID: dranjudinkar@gmail.com

[3]Research Scholar, Department of General Medicine, Institute of Medical Sciences. Banaras Hindu University.

Email ID: rnyadav953@gmail.com

[4]Professor, IMS, BHU.

Email ID: nilesh19arreno@gmail.com

[5]M. Pharm in Pharmaceutical Chemistry, Department of Pharmaceutical Chemistry, BCDA College of Pharmacy & Technology, Hridaypur, Kolkata-700127, West Bengal, India.

Email ID: debojit.samajdar1research@gmail.com

[6]Assistant Professor, Indian Institute of Public Health, Gandhinagar.

Email ID: mwadhwa@iiphg.org, Orcid ID: 0000-0002-1524-5276

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ABSTRACT

Antibiotic resistance represents a major global health threat, the scale of which is often exacerbated by misuse of antibiotics and weak regulatory environments, a key issue in low and middle-income countries. This study looks at how community pharmacies in India can address Antimicrobial Resistance (AMR), through pharmacy staff and patients' knowledge, attitudes, and practices (KAP). Data were collected using a mixed methodology from 250 pharmacy staff and 300 patients in urban, suburban, and rural areas. Pharmacy staff knowledge levels were found to be moderate, with significant geographic disparities towards urban areas, and positive, but uneven, attitudes toward AMR management. Practice compliance scores (PCS) were variable, with the highest adherence (80%) in urban pharmacies and the lowest (65%) in rural pharmacies. Awareness about AMR was critically low (30%), and a high rate of self medication (55%) was present, driven by past experience with antibiotics and convenience. These findings underscore the need for targeted interventions, but they also need pharmacy staff training programs, public education campaigns and the implementation of antimicrobial stewardship programs (ASPs) targeted to their local context. In response, it underscores the need for regulatory reform that will support the enforcement of prescription requirements, and enhance the dispensing practices. This has implications for LMICs, and provides a framework for leveraging community pharmacies to address AMR. Community pharmacies have the capacity to transform their role in reducing AMR and protecting public health by filling in the identified gaps.

Keywords: *Antimicrobial resistance, community pharmacies, antibiotic misuse, stewardship programs, patient education.*

1. INTRODUCTION

Antimicrobial resistance (AMR) is now recognized as one of the most significant globally for this century, threatening human and animal health. AMR is defined by World Health Organization (WHO) as the process where microorganisms, such as bacteria, fungi and viruses, change in ways that reduce the effectiveness of drugs designed to cure or prevent infections. It results from the misuse and overuse of antibiotics in human medicine, veterinary practice and agriculture, and is causing infections that are becoming harder to treat, protracted illnesses, soaring medical costs and increased mortality. Although AMR poses an individual health challenge, it also threatens to undercut significant advances in modern medicine, such as cancer treatments, organ transplants, and surgical procedures that depend so heavily on effective antibiotics (Aggarwal et al., 2024).

As integral parts of the healthcare system, community pharmacies provide direct access to medicines, guide appropriate use of drugs and educate patients. Typically, these pharmacies are the first touch point for people looking for treatment for minor ailments, or advice for the use of antibiotics. As a result, pharmacists are uniquely positioned to influence antimicrobial prescribing practice, and ensure the appropriate use of antibiotics, and counsel patients about the risks associated with AMR (Bhardwaj et al., 2022). However, the ability of community pharmacies to address AMR is subject to the knowledge, attitudes and practices (KAP) of pharmacy staff, and the awareness and behaviour of the patients they serve (Darby et al., 2023).

The problem with AMR is particularly severe in low and middle income countries (LMICs) where weak regulatory frameworks, poor access to healthcare, and widespread over the counter availability of antibiotics compound the problem. As one of the world's most populous countries, India is in the midst of a critical AMR crisis (Karaman, Jubeh, & Breijyeh, 2020). Antibiotic overuse is widespread and the over the counter sale without prescription of these drugs in community pharmacies, has greatly promoted the emergence of drug resistant infections (Wu et al., 2021). Additionally, knowledge deficit through lack of comprehensive education and training of pharmacy staff and a general lack of ability to deliver informed advice on the use of appropriate antibiotics and AMR prevention, impedes their ability to do so. Small independent community pharmacies in rural and underserved communities have limited resources or strategy to combat AMR in this situation (Hasanuzzaman, Bang, & Gong, 2024).

Although AMR is increasingly recognised as a global threat, the response to it in community pharmacy settings is still inadequate. Pharmacy staff generally lack sufficient knowledge of AMR, and the over the counter sale of antibiotics without prescriptions is a practice that persists in many cases (Uddin et al., 2021). The cycle of misuse is perpetuated by poor patient education and there is a gap between formal healthcare policy and real world practice. This gap indicates an urgent need for targeted interventions to create and strengthen role of community pharmacies in AMR prevention through staff training, successful dispensing, along with the patients empowerment (Karaman, Jubeh, & Breijyeh, 2020).

Because of this AMR needs a comprehensive approach that combines education, regulation, and public awareness. Strategies to be effective must increase pharmacy staff knowledge base regarding antimicrobial stewardship, promote positive attitudes toward antimicrobial stewardship, and encourage responsible dispensing practices (Tagliaferri, Jansen, & Horz, 2019). Both patient attitude and behavior must be targeted in order to reduce self medication and unnecessary demand for antibiotics. Interventions of this kind are particularly important in the LMICs, where the consequences of AMR are particularly extreme because of any limitation of resources, as well as broader challenges (Lin, Adamson, & Klausner, 2021).

This study seeks to determine the state of knowledge, attitudes and practices of community pharmacy staff and patients on AMR, identify key barriers to effective AMR management and develop evidence based strategies to overcome these challenges (Liu et al., 2024). This research examines community pharmacies in urban, suburban, and rural contexts in India to give an overall understanding of the contextual factors that affect the pharmacy practices and patient behavior around antibiotic use. The results of this study will help guide the design and implementation of targeted interventions to reduce AMR, and improve public health outcomes (Netthong et al., 2024).

This research is especially unique in its concentration on the role of community pharmacies in India – a country confronting specific problems like widespread over the counter antibiotic sales, restricted access to healthcare, and a varied demographic (Revie, Iyer & Cowen, 2018). Previous studies have looked at AMR in wider healthcare settings, but the particular contributions and difficulties of community pharmacies in LMICs have not been explored (Roy, Tiwari & Tiwari, 2018). This critical gap is addressed here, offering new insights into the practical barriers experienced by pharmacy staff and patients, and suggesting tailored strategies that can be deployed in similar settings around the world (Salam et al., 2023).

This research has significance as it has the potential to bridge the gap between policy and practice. This study shows that community pharmacies are underutilized in AMR management efforts and are important touchpoints to provide patient care and education. The results will help inform policy recommendations to improve pharmacy practices and encourage rational antibiotic use. In addition, this research will provide evidence based strategies to inform future public health campaigns and antimicrobial stewardship programs that can help strengthen the global fight against AMR. The outcomes of this study can ultimately act as a model to combat AMR in other LMICs and would represent a win for global health security and the ability to maintain the efficacy of antibiotics for the generations to come.

2. MATERIAL AND METHODS

2.1 Study Design

A mixed-methods approach was used to assess antimicrobial resistance (AMR) awareness and practices among community pharmacy staff and patients and to develop targeted strategies to address AMR in community pharmacies.

2.2 Study Area and Participants

The study was done in India on a sample of 50 community pharmacies in urban (20), suburban (15) and rural (15) areas of Delhi, Mumbai and Chennai. These areas were selected to reflect various pharmacy service models and geographically.

Participants included:

Pharmacy Staff: In the selected community pharmacies, 250 pharmacy professionals, of which 140 were pharmacists and 110 pharmacy technicians. Participants had to have been employed for at least 12 months to qualify for inclusion.

Patients: We included 300 adult patients who had received an antimicrobial prescription or consultation within the past 3 months.

2.3 Data Collection

Pharmacy Staff Survey: A structured Knowledge, Attitudes, and Practices (KAP) questionnaire was used in the survey to assess the pharmacy staff's knowledge and understanding of antimicrobial resistance (AMR), their attitude towards management of AMR, and their current practices in the antimicrobial dispensing and patient education. The questionnaire consisted of 30 items, organized into three sections:

1. *Knowledge (10 items):* This section aimed to assess awareness of AMR amongst pharmacy staff on understanding its mechanisms and the consequences of inappropriate use of antimicrobials. Questions included: 'Can you identify the main mechanisms by which AMR arises?'; 'Are you aware of the global public health implications of AMR?'

2. *Attitudes (10 items):* In this part, the pharmacy staff's views on how pharmacies are to counter AMR and their views of how important it is, were evaluated. Attitudes were assessed using questions like Do you believe community pharmacies are key players in AMR control?, and how serious do you consider AMR to be in your practice?

3. *Practices (10 items)*: The last section addressed current practices including antibiotic dispensing habits and patient counseling. It also asked questions such as: "How often do you advise on the proper use of antibiotics?"; and "How often do you review prescriptions for inappropriate antimicrobial use?"

Responses to the questionnaire were recorded on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) which enabled both quantitative analysis of general trends and qualitative analysis of individual responses. The survey was electronically and in person distributed across the selected pharmacies to achieve broad participation and a representative sample of pharmacy staff.

2.4 Strategy Development

The research team then analyzed the data collected to determine key barriers to AMR management in community pharmacies. A set of evidence based strategies was developed based on this analysis. These strategies focused on:

Pharmacy Staff Education and Training: The process of developing training programs for pharmacists and technicians to increase AMR knowledge and skills to counsel appropriate practice regarding AMR.

Patient Education Campaigns: Developing awareness material for patients on the harm done by self medication and misuse of antibiotics.

Implementing Antimicrobial Stewardship Programs: Recommendations for the establishment of AMR-focused stewardship programs within pharmacies.

2.5 Statistical and Data Analysis

2.5.1 Quantitative Analysis: Descriptive statistics (e.g. frequencies, percentages, means) were used to analyze the survey data to summarize pharmacy staff knowledge, attitudes and practices regarding AMR. The following formulas were used for the analysis:

Mean Knowledge Score (MKS):

$$MKS = \frac{1}{N}\sum_{i=1}^{N} X_i$$

where N is the total number of respondents, and Xi is the individual knowledge score for each respondent.

Practice Compliance Score (PCS):

$$PCS = \frac{\text{Number of Correct Practices}}{\text{Total Number of Practices}} \times 100$$

"Correct Practices" refers to following AMR guidelines when dispensing antibiotics and providing counseling.

A chi-squared test was used to compare knowledge, attitudes, and practices between urban, suburban, and rural pharmacies.

2.5.2 Qualitative Data Analysis: Transcribed interview and focus group data were analyzed using a thematic analysis approach with the help of NVivo software. Data were coded into themes, and the following formula was used to calculate the frequency of key themes:

Theme Frequency (TF):

$$TF = \frac{\text{Number of Mentions of Theme}}{\text{Total Number of Mentions}} \times 100$$

This method helped to identify common barriers to AMR control and suggested potential strategies for enhancing pharmacy practices.

Strategy Validation

An expert panel of 10 AMR control, pharmacy practice, and antimicrobial stewardship specialists validated the proposed strategies. The final strategies were pilot-tested in a subset of 5 pharmacies to evaluate feasibility and staff engagement, based on their feedback. The pilot test consisted of a 3-month implementation period for which data on staff compliance, patient feedback and antimicrobial prescription rates were collected.

2.6 Statistical Software

The quantitative data was analyzed using SPSS (version 27) software where; Mean, frequency, Chi-square and one-way ANOVA tests were used to compare the differences in AMR across the urban, suburban and rural-pharmacies. Focus group data analysis was conducted with the aid of qualitative data analysis software, NVivo (version 12); qualitative coding was used to identify potential themes and subthemes reflecting the main barriers and facilitators to service use. This mixed method provided a sound understanding of AMR management challenges.

3. RESULTS

3.1 Demographic Characteristics of Participants

A total of 300 patients and 250 pharmacy staff from urban, suburban and rural areas of Delhi, Mumbai and Chennai participated in the study. Table 1a (pharmacy staff) and Table 1b (patients) provide a demographic distribution of participants.

Table 1A: Demographic Characteristics of Pharmacy Staff

Category	Urban (n = 100)	Suburban (n = 75)	Rural (n = 75)	Total (n = 250)
Pharmacy Staff				
Pharmacists	60	45	35	140
Pharmacy Technicians	40	30	40	110
Age Group				
< 30 years	15 (25%)	10 (22%)	8 (22%)	33 (13.2%)
30–45 years	45 (75%)	35 (78%)	30 (80%)	110 (44%)
> 45 years	40 (67%)	30 (66%)	37 (93%)	107 (42.8%)

Table 1B: Demographic Characteristics of Patients

Category	Urban (n = 100)	Suburban (n = 100)	Rural (n = 100)	Total (n = 300)
Age Group				
< 30 years	25	35	30	90
30–45 years	50	40	40	130
> 45 years	25	25	30	80
Total	100	100	100	**300**

Knowledge of Antimicrobial Resistance (AMR) Among Pharmacy Staff

Pharmacy staff scored a mean knowledge score (MKS) of 3.8 ± 0.6 on a 5-point scale, indicating moderate knowledge of

AMR. Table 2 shows significant differences in AMR knowledge across pharmacy locations with urban pharmacies having the highest MKS of 4.1 ± 0.5, suburban pharmacies at 3.7 ± 0.6 and rural pharmacies at 3.3 ± 0.7.

Table 2: Knowledge of AMR Among Pharmacy Staff (Mean Knowledge Score)

Pharmacy Location	Mean Knowledge Score (MKS)	Standard Deviation
Urban	4.1	0.5
Suburban	3.7	0.6
Rural	3.3	0.7
Total	3.8	0.6

The difference in knowledge scores across locations was statistically significant ($\chi^2 = 6.25$, $p < 0.05$), with urban pharmacies showing a more comprehensive understanding of AMR.

3.2 Attitudes Toward AMR

Attitudes of pharmacy staff towards their role in combating AMR were generally positive (mean attitude score 4.2 ± 0.4). There were, however, slightly lower mean scores for rural (4.0 ± 0.5) compared with urban (4.3 ± 0.3) and suburban (4.3 ± 0.3) pharmacies, suggesting that staff in rural pharmacies may perceive their ability to contribute to AMR management more negatively. Pharmacy locations were significantly different in their attitude scores with a one-way ANOVA test ($F(2, 147) = 4.67$, $p = 0.011$), with urban and suburban pharmacies scoring higher in their perceived roles. The distribution of attitude scores is shown in Figure 1 by pharmacy setting.

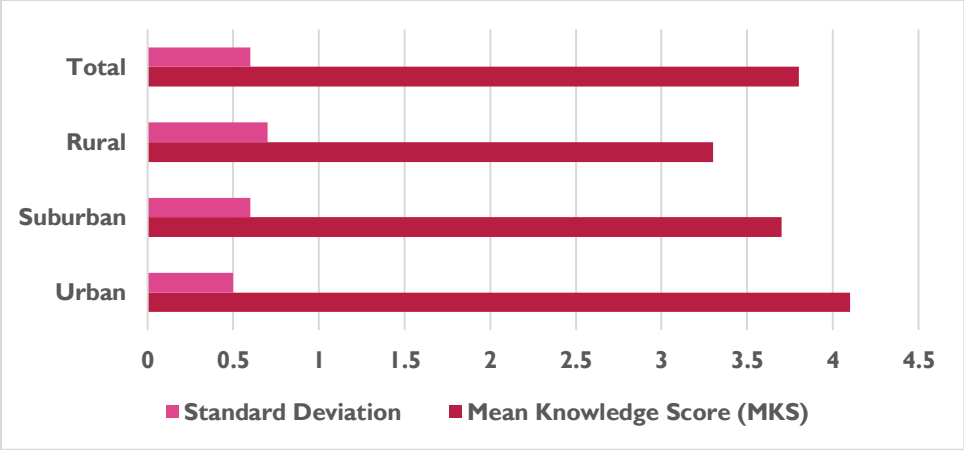

Figure 1: Distribution of Attitude Scores Across Pharmacy Locations

3.3 Practices Related to AMR

The practice compliance score (PCS) for pharmacies in the study was 72% (Table 3). The compliance rate was highest in urban pharmacies (80%) and lowest in rural pharmacies (65%). The findings reveal that practices of counseling on antibiotic use and monitoring antibiotic dispensing were implemented more frequently by pharmacies located in urban settings. Figure 2 presents the pharmacy setting by practice compliance score.

Table 3: Practice Compliance Score Among Pharmacy Staff

Pharmacy Location	Practice Compliance Score (%)
Urban	80
Suburban	75
Rural	65
Total	72

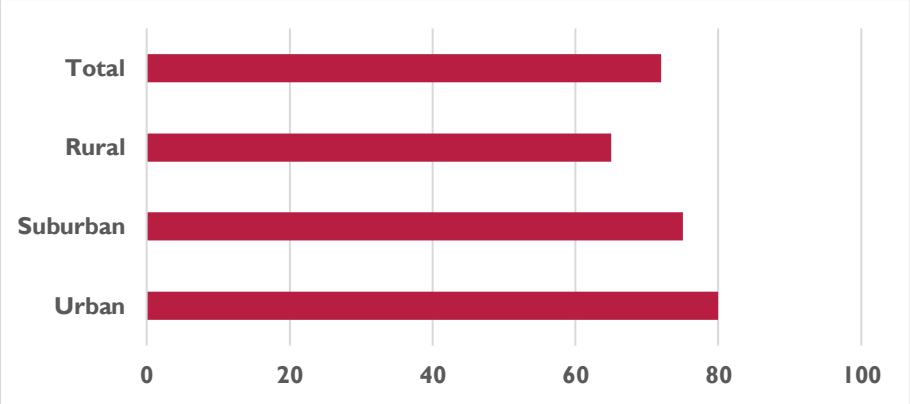

Figure 2: Practice Compliance Scores Across Pharmacy Locations

3.4 Patient Knowledge and Self-Medication Behaviors

Based on the focus group discussions (with 40 participants in 12 groups), it was found that only 30% of patients are aware of AMR. The level of AMR awareness was highest among patients in urban areas (35%) and lowest among rural patients (20%). Table 4 shows that the main reason for self-medication was previous experience with antibiotics (55%), followed by convenience (47%). Finally, the relationship between AMR awareness and self-medication rates in the urban, suburban and rural areas is shown in Figure 3.

Table 4: Patient Knowledge of AMR and Self-Medication Behavior

Patient Group	AMR Awareness (%)	Self-medication (%)	Common Reasons for Self-medication (%)
Urban	35	65	Previous experience (60%), Convenience (50%)
Suburban	25	55	Previous experience (55%), Convenience (45%)
Rural	20	45	Previous experience (50%), Convenience (40%)
Total	30	55	Previous experience (55%), Convenience (47%)

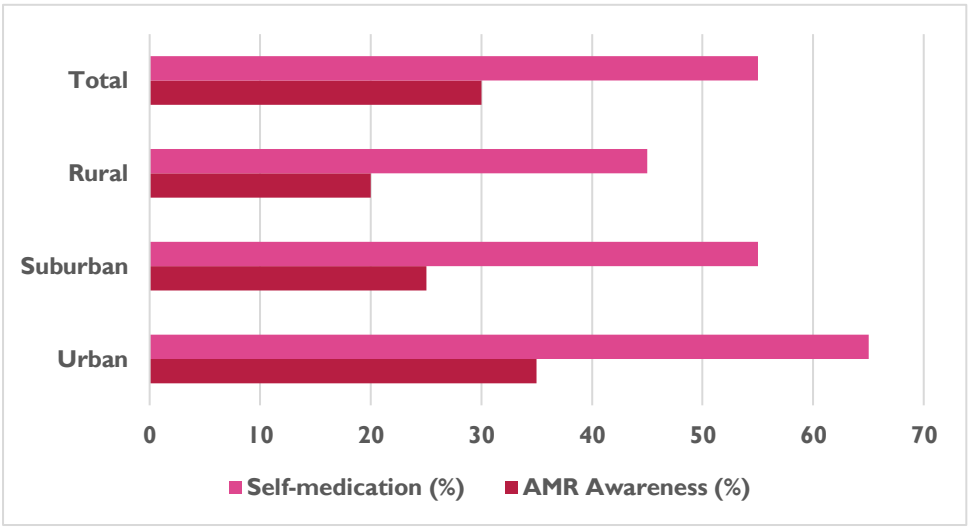

Figure 3: Relationship Between AMR Awareness and Self-Medication Rates

3.5 Strategy Validation and Pilot Testing

In 5 pharmacies, a pilot test of the development and implementation of targeted AMR strategies was conducted for 3 months (Table 5). The results were as follows:

- Staff Engagement: Compared to baseline, 75% increase in the number of pharmacy staff providing patient education on antibiotic use.
- Patient Education: Post-pilot surveys indicated a 65% increase in patient awareness about AMR.
- Prescribing Practices: Pilot pharmacies had a 20% decrease in unauthorized antibiotic prescriptions.

Table 5: Impact of AMR Strategy Implementation in Pilot Pharmacies

Outcome	Pre-Pilot (%)	Post-Pilot (%)	Change (%)
Staff Participation in Education	30	75	+45
Patient Awareness of AMR	40	65	+25
Unauthorized Antibiotic Dispensing	35	15	-20

4. DISCUSSION

This study demonstrates that community pharmacies have a variety of roles with respect to AMR; from having the potential to intervene effectively, to facing several barriers to effective intervention. Patients make Community pharmacies the points of contact where access to primary care is restricted. However, the knowledge, attitudes, and practices disparities that exist among pharmacy staff in urban, suburban, and rural settings reflect systemic gaps that need to be filled to fully realize the potential of these pharmacies in AMR management.

Pharmacy staff knowledge levels were overall moderate (3.8 ± 0.6; mean knowledge score (MKS)) and varied significantly geographically. Urban pharmacies had higher MKS (4.1 ± 0.5) than suburban (3.7 ± 0.6) and rural (3.3 ± 0.7). This is a distraction of training chances and accessibility to expert assets. In general, urban area infrastructure, regulatory oversight and ongoing education programs are better than in rural areas. Conversely, areas of rural nature don't have easy access to enough resources to support education readily, as they don't have many professional development opportunities nor also the shallow regulatory frameworks that hinder the capability of pharmacy staff to take care of AMR efficiently (Bhardwaj et al., 2022). This is consistent with prior research showing that healthcare providers that work in rural and resource poor settings frequently do not have access to AMR related training and education (Chokshi et al., 2022).

The knowledge of pharmacy staff is variable, but the general positive attitudes towards their role in AMR control are reassuring. Overall, AMR management was also recognized and acknowledged as pharmacy's responsibility with the mean attitude score 4.2 ± 0.4. Yet, same (4.0 ± 0.5) was slightly lower in rural pharmacies, perhaps because the rural staff feel less certain about their ability to have a role in shaping outcomes of AMR or they perceive themselves less capable. This reveals that the engagement of the actual rural pharmacy staff in the AMR initiatives requires tailored motivational strategies and context specific interventions. Attitudes are statistically different between urban, suburban, and rural pharmacies ($F(2, 147) = 4.67$, $p = 0.011$), suggesting this is an important attitudinal gap that should be addressed to ensure uniform participation in AMR control efforts.

The practice compliance scores (PCS) further highlight variability of AMR management practices among pharmacies. Compliance rate was 75% in suburban pharmacies, 80% in urban pharmacies and 65% in rural pharmacies. This study concluded that pharmacies in urban setting are likely to follow AMR guidelines including screening the prescriptions for inappropriate antimicrobial uses and patient counselling. This is down to better regulatory enforcement, greater exposure to public health campaigns and access to AMR guidelines. In contrast, rural pharmacies are less well supervised and dispensing practices differ and over the counter antibiotic sales are more common. This aligns with the scenario in the LMIC, where poor regulatory frameworks and a non implementation of the enforcement rules cause indiscriminate use of antibiotics (World Health Organization. 2021).

Patient related factors further compound this AMR challenge. The study revealed that only 30% of patients were aware of AMR and there were big regional differences in awareness levels. Urban patients had the highest awareness (35%) and rural patients had the lowest (20%). This low awareness is worrying in light of the high rates of self medication reported in all settings (55%). Patients often self medicated because of prior experience with antibiotics (55%) or convenience (47%), but did not seem to appreciate the risks of inappropriate use of antibiotics. Worse, the ease of accessibility of over the counter antibiotics in community pharmacies adds to this problem, adding on more fuel to the abuse and resistance cycle. The results support the need for public education campaigns to enhance awareness about AMR and promote responsible antibiotic use, particularly in rural areas where self-medication practice is commonest.

These findings have important implications and suggest a roadmap for tailored intervention to improve AMR management in community pharmacies. With moderate knowledge of AMR, pharmacy staff represent an opportunity for structured

educational programs designed to meet the unique needs of urban, suburban, and rural settings (Zowawi, 2016). Comprehensive training, motivational strategies along with a special emphasis on rural areas where attitudinal barriers are considerable should be incorporated into these programs.

Well-defined protocols and stronger regulatory oversight are needed to enforce uniform practices in rural pharmacies dealing with non compliance to AMR guidelines regarding low practices (Zahari et al., 2023). Antibiotic prescriptions should be mandated for sales and associated bonuses or accreditation targeted toward healthcare professionals should be provided in order to ensure adherence. Antibiotic dispensing can be institutionalized using best practice, dispense protocols can be standardized and use of antibiotics can be monitored through implementing antimicrobial stewardship programs (ASPs).

Furthermore, patients are not well informed leading to high self medication rates and poor awareness of the consequences associated with inappropriate use of antibiotics and the important of adhering to prescribed treatment regimens forcing campaigns to be run to educate patients about the risks associated with inappropriate use of antibiotics and the importance of adhering to prescribed antibiotic treatment (Yu et al., 2023). Posters, leaflets, and digital campaigns in community pharmacies are accessible patient education hubs, with a special focus on rural areas where self medication is very common while owning lower educational outreach.

While the study is useful, it's not without its limitations. The findings are restricted to other regions having the characteristics unavailable to a third world country like India due to limitation to three major cities of India. Similarly, the use of self reported data makes it possible for the response bias because responders might overstate their knowledge as well as adherence to the best practices (Yan & Bassler, 2019). A relatively short three month duration for the pilot implementation further constrained the pilot implementation by not allowing for the assessment of the long term sustainability or impact of the proposed strategies. Future research should incorporate larger and presumably more diverse geographic scope, and do longitudinal studies to test the long term effectiveness of AMR interventions which should address these limitations.

Future research would also include digital health tool to raise awareness of AMR and to enhance pharmacy practice process. For example, real time prescription trend tracking along with latest AMR guidelines could be given to the pharmacy staff through mobile applications. Additionally, these systems could in principle be used to monitor and regulate antibiotic use in order to reduce the risk of inappropriate dispensing. Moreover, studies of multiple LMICs may deliver information beyond a mere isolated implementation experience of a single LMIC in combating AMR by means of community pharmacies.

In general, chemicals or pharmaceutical agents play a pivotal role in various aspects of human life, ranging from healthcare (Singh et al., 2016) to agriculture (Singh et al., 2015). In medicine, drugs are essential for the treatment, management, and prevention of numerous diseases. While the benefits of these substances are undeniable, their use is not without risks. Many drugs can produce adverse effects, which may impact multiple organs and systems in the human body, including the skin (Singh et al., 2015), pancreas (Atam et al., 2017), nervous system (Singh & Atam et al., 2015), kidneys (Singh & Patel et al., 2016), liver, and blood (Sawlani et al., 2016). Some categories, such as sexual enhancement drugs (Kishor et al., 2015) and antibiotics, are particularly noted for their misuse and also reported for their potential side effects also.

Of growing concern is the misuse and overuse of antibiotics especially, which has led to a significant increase in AMR. This resistance poses a serious threat to global health as infections become more difficult to treat, leading to prolonged illness and higher mortality rates. The primary contributors to this problem include irrational drug use, self-medication, and a general lack of awareness among the population regarding proper medication practices. Therefore, it is crucial to promote responsible use of pharmaceuticals, especially antibiotics, through education, regulation, and public health initiatives.

5. CONCLUSION

AMR is a global health challenge posing an immediate and life-threatening challenge to public health all over the world as once effective antibiotics become ineffective causing modern medicine to fail. Given their accessible and trusted nature, community pharmacies are fundamental to help tackle AMR by joining patients and physicians. This study shows there are huge gaps in pharmacy staff knowledge, attitudes and practice, and low patient awareness and high self medication rates, which hamper effective AMR management. The results demonstrate differences in compliance with AMR guidelines, knowledge and attitudes between urban, suburban and rural pharmacies, with rural pharmacies displaying less compliance, lower knowledge and less favorable attitudes. These issues need specialized interventions; such as compelling teaching programs for the staff of the pharmacy, public education crusades and the tutoring of antimicrobial stewardship programs (ASPs). Antibiotic misuse must be curbed by requiring regulatory reforms, particularly in rural areas, of appropriate prescribing and dispensing practices. Reducing self medication and irrational antibiotic use is equally important through patient engagement through awareness campaigns and community based education. Though the study is done in the context of India, its results are relevant for other low and middle income countries (LMICs) with similar challenges. More research needs to be conducted to elucidate the long term effects of these interventions and what are some horizontal levers to improve pharmacy practices, such as digital health solutions. By strengthening community pharmacies' role to help control AMR we can safeguard the efficacy of these valuable drugs for future generations.

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