

Assessment of Awareness and Appropriate Behavioural Measures of Community Pharmacists Towards Antimicrobial Stewardship: A Cross-Sectional Questionnaire-Based Survey.

Dr P. Ansuman Abhisek^{1*}, Dr. Shweta Supriya Pradhan¹, Dr. Sachin Tripathy², Dr. Pratyush Mishra³,
Dr. Trupti Rekha Swain⁴, Dr. Deepak Choudhury⁵, Dr. Senthilkumar S²

¹ Assistant Professor, Department of Pharmacology, SCB Medical College and Hospital, Cuttack, Odisha, India.

² Senior Resident, Department of Pharmacology, SCB Medical College and Hospital, Cuttack, Odisha, India.

³ Assistant Professor, Department of Pharmacology, MKCG Medical College and Hospital, Berhampur, Odisha, India.

⁴ Professor and Head, Department of Pharmacology, PMPM Medical College and Hospital, Talcher, Odisha, India.

⁵ Assistant Professor, Department of Ophthalmology, MKCG Medical College and Hospital, Cuttack, Odisha, India.

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Abstract

Introduction: The increasing problem of antimicrobial resistance (AMR) is one of the major challenges to public health and is largely due to the misuse of antimicrobials. Community Pharmacists (CPs) are vital in antimicrobial dispensing and AMS practice. This study sought to explore AMR awareness, practices, barriers, and associated determinants among CPs in Odisha, India. **Methodology:** A cross-sectional study was conducted among registered community pharmacists in Cuttack district. Out of 135 questionnaires distributed, 108 usable questionnaires were analyzed using a 38-item questionnaire including awareness/perceptions (12 items), dispensing practices (18 items), and barriers (8 items). I-CVI, scale-level CVI, Lawshe's CVR, and Cronbach's alpha were used for content validity and reliability, respectively. Logistic regression analysis was carried out to identify determinants of AMS practice adoption. **Results:** The majority of the participants were male (81.5%; n = 88) and had obtained a D.Pharm degree (61.1%; n = 66). Uninformed, inactive adopters, and those with high perceived barriers were 52.8% (n = 57), 55.6% (n = 60), and 61.1% (n = 66), respectively. About half (47.2%; n = 51) of the study population dispensed >60 antimicrobials per month without prescriptions. The I-CVI for all constructs was found to be 1.00. The alpha values of the awareness/perception and dispensing practice scales were 0.731 and 0.793, respectively. Increased years of experience among pharmacists were significantly associated with increased odds of being inactive AMS adopters (adjusted OR = 1.237; 95% CI: 1.016–1.505; p = 0.034). Nevertheless, the whole regression model was not significant ($\chi^2 = 11.585$; df = 11; p = 0.396). **Conclusion:** There exist notable deficits in AMS awareness and practices, high perceived barriers and non-prescription dispensing which warrant interventions on the part of pharmacists. **Generalizability:** Findings mainly represent community pharmacists from one district but are indicative of similar contexts in Odisha and India at large.

Keywords: Antimicrobial Resistance; Antimicrobial Stewardship; Community Pharmacy Services; Drug Resistance, Bacterial; Drug Dispensing; Health Knowledge, Attitudes, Practice.

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Corresponding author: Dr P. Ansuman Abhisek

Email: ansumanabhisek123@gmail.com

Assistant Professor, Department of Pharmacology, SCB Medical College and Hospital, Cuttack, Odisha, India

Introduction

Antimicrobial resistance (AMR) is a serious threat to global public health that reduces infection prevention and cure efficiency. AMR is associated with a higher risk of persistent infection, inappropriate treatment, complications, morbidity, and mortality. Global analyses suggest that AMR was the direct cause of 1.27 million deaths and 4.95 million deaths in 2019 worldwide. [1] In the United States of America, the Centers for Disease Control and Prevention

(CDC) reports over 2.8 million antimicrobial-resistant infections and more than 35,000 deaths that occurred in 2019. [2] A study conducted across the European Union and the European Economic Area and published in 2015 estimated 33,000 deaths per year due to infection with bacteria resistant to antibiotics. [3] While differences in population and methodology exist between the studies, an overall health hazard AMR poses to the population is evident. Moreover, infections caused by resistant microbes

often require longer or more complex treatment, involving different drugs, regimens, doses, and dosing schedules. This can increase the burden on patients and strain healthcare systems. [1, 3]

Inappropriate antimicrobial use, including not of standard quality (NSQ) or falsified/spurious drugs, promotes AMR emergence and dissemination. [1,4] In this context, antimicrobial stewardship (AMS) is an evidence-based approach that optimizes antimicrobial use to attain the best individual patient outcome while reducing adverse effects. [4, 5] The World Health Organization's (WHO) Global Action Plan to combat AMR highlights the importance of optimizing the use of antimicrobials. [4] However, while hospitals have been the epicenter of AMS at a national level, community antimicrobial use needs interventions to optimize prescribing, dispensing, and consumption. [5, 6] This is especially true for community pharmacists who dispense the prescribed medicines and provide patients with advice on the correct use of antimicrobials, i.e., finishing the course, preventing complications, recognizing adverse effects, and avoiding taking antibiotics unless necessary. A narrative overview by Bishop et al. gives examples of interventions that community pharmacies can employ to improve AMS through training pharmacists or interventions that would affect community members' attitudes toward antibiotic use. [6] Consequently, pharmacists are key stakeholders in promoting rational antimicrobial use and appropriate treatment. However, community pharmacy stewardship interventions' impact is difficult to estimate due to the large variation between pharmacies and pharmacists, i.e., educational background, legal status, patients' expectations, availability of diagnostic tests, and experience. Community pharmacists may either work against antimicrobial stewardship through improper prescription of drugs or work towards its success by assisting the patient in understanding the treatment prescribed. The improper use of antimicrobials poses more problems in India than anywhere else, and that is the reason why the present article focuses on the same in India. As per the Indian Council of Medical Research policy paper on antimicrobial stewardship practices, the role of prescribers, patients, and pharmacists in appropriate use of antimicrobials has been highlighted. Improper prescriptions, self-medication, over-the-counter antibiotics, and lack of awareness pose the problem. [7] The Indian Drugs and Cosmetics Rules, however, allow restricting the sale of antibiotics under certain schedules. Unless the prescriptions are written in accordance with the mentioned acts or rules of a particular region, selling the

drugs would be illegal. [8] Chemists, however, could still decide to dispense inappropriate antimicrobials for various reasons, including patient-related information guiding the choice of the drugs, indication severity, symptoms, patient expectations, pharmacist attitude towards antibiotics, and financial factors. It is therefore essential to further examine the influence of these factors on pharmacy practices in India. Findings in the study conducted by Sahoo KC et al. in Odisha offer local contextual relevance. However, the interpretations should consider the details of the various healthcare personnel studied. Sahoo et al. conducted a qualitative study among healthcare professionals in Odisha on their perspectives on antibiotic use, resistance development, and environmental factors. [9] In another study, the same authors analyzed community perception regarding infectious diseases, antibiotic use, and antibiotic resistance in Odisha. [10] This research offers insight into the local context of antibiotic use and resistance; however, it does not directly address the current level of awareness or inappropriate dispensing practices of community pharmacists in the state of Odisha. Direct evaluation of community pharmacists is essential for this purpose to address knowledge gaps and barriers to implementation of stewardship programs.

Hence, the current study was designed to assess the awareness, dispensing practices, and barriers related to antimicrobial stewardship among community pharmacists in Odisha, India, as well as the factors associated with the adoption of stewardship program practices.

Methodology

Study Design and participants

A cross-sectional study employing questionnaires was conducted among the registered community pharmacists in the Cuttack district, Odisha, India. An open-ended, structured questionnaire incorporating the five-point Likert scale was used to analyze the knowledge and practices, barriers, and determinants of antimicrobial stewardship (AMS) among community pharmacists.

Study Setting

The study was carried out in the Cuttack district, Odisha – an important district in the state. Cuttack city functions as the commercial, educational, and healthcare hub in the state of Odisha. There are many retail and corporate pharmacies as well as hospital OPD pharmacies in the city. This is an ideal location to conduct the study to know about the

practice of dispensing antimicrobials among the community pharmacists.

Participant Selection

Community pharmacists were selected based on a convenience sampling technique. Community pharmacists working in independent retail pharmacies, corporate pharmacy chains, and hospital outpatient pharmacies of Cuttack district were approached and requested to take part in the study. Community pharmacists who were registered with the Odisha Pharmacy Council, possessed a recognized pharmacy degree like D.Pharm, B.Pharm, or M.Pharm, were practicing their profession in a community pharmacy in Cuttack district, and had consented to take part in the study were selected for the survey. Pharmacy staff who did not have a license, pharmacy technicians, unregistered salespersons or dispensers, and retail pharmacies that lacked a license of a registered pharmacist were excluded from the study.

Ethical Issues

Approval for ethical conduct of the research was sought and granted by the Institutional Ethics Committee of Srirama Chandra Bhanja Medical College and Hospital, Cuttack, before conducting the research, with IEC application and approval Number 2021/ dated 12.12.24. The research followed the guidelines of the Declaration of Helsinki. Participation in the study was voluntary and anonymous.

Informed Consent

Prior to the completion of the questionnaire, all subjects were given detailed information about the objective of the study, voluntary participation, duration of time, and confidentiality of their answers. Informed consent was obtained from all participants prior to giving access to the questionnaire using the Google Forms system. Only those participants who gave consent were allowed to answer the questionnaire.

Bias

To avoid any possibility of bias, the questionnaire was developed by all the authors through an extensive review of the literature, textbooks, and questionnaires on antimicrobial stewardship. Further revisions were made taking into account the knowledge and expertise of senior pharmacists and the academic scientific committee of the same institution, which is familiar with the field. This

method facilitated the drafting of a survey instrument for community pharmacists that was highly relevant and user-friendly. The questionnaire was then pretested by ten subject experts and piloted among 20 community pharmacists. The language was Unimpeded and concise to remove ambiguity. This played a role in attenuating social desirability bias by safeguarding anonymity and non-coercive enrollment.

Development of Questionnaire: Content validity of the questionnaire was established through 10 experts, while pretesting was done using 20 people to check its understandability, feasibility, and reliability. After this step, the finalized questionnaire was used in the main study to check knowledge, antimicrobial dispensing practices, barriers, and factors influencing AMS practices among community pharmacists. The methodology of the study is given in Figure 1.

Study Instrument and its Validation

The structured closed-ended questionnaire was developed into four different domains:

1. Demographic Profile: Included age, gender, qualification, practice setting (Rural, Semi-urban, Urban), experience in years, total dispensing volume per month in non-prescription medicines, and dispensing volume per month in non-prescription antimicrobials.

2. Awareness and Perception (12 questions): Includes knowledge regarding Antimicrobial Resistance, Misuse of broad-spectrum antimicrobial agents, National Action Plans, and pharmacists' stewardship role.

3. Attitudes and Practices (18 Questions): Includes daily dispensing practices, prescription verification, educating patients about antimicrobial adherence, antimicrobial resistance, and denial of non-prescription antibiotic demands.

4. Perceived Barriers (8 Questions): Includes patient pressure, economic competition, unclear diagnosis, gaps in Continuing Professional Development, and no regulation.

The participants were classified into three groups – Awareness, Barriers, and Practice based on the cutoff scores as specified in the study. The Awareness group was further subdivided into Informed individuals, who had awareness domain scores equal to or greater than the cutoff score and thus relatively high awareness levels regarding AMS, and Uninformed individuals, who had awareness domain scores less than the cutoff score and thus relatively low awareness levels regarding AMS [11,12]. The Barriers group consisted of participants with Low Barriers, who had barriers domain scores less than the cutoff score, indicating that there were

few perceived barriers to AMS implementation, and High Barriers, who had barriers domain scores equal to or greater than the cutoff score, indicating that there were many perceived barriers to AMS implementation [12,13]. The Practice group consisted of Proactive Adopters, who had practice domain scores equal to or greater than the cutoff score and thus relatively high AMS practice, and Inactive Adopters, who had practice domain scores less than the cutoff score and thus relatively low AMS practice [11,12]. Validity of the finalized questionnaires was assessed using face and content validity, which was done through an expert panel and computation of Lawshe's formula and critical table value for the value of Content Validity Ratio (CVR), Average Congruency Percentage (ACP) method, which gives the threshold percentage value of >90%, and Content Validity Index, which uses I-CVI > 0.78 and S-CVI levels. After validity, 20 questionnaires were used in a pilot test to determine the measurement reliability, which was done using the calculation of Cronbach's alpha for scores above the >0.70 threshold value of good internal consistency before conducting the actual survey.

Instrument Validation and Psychometric Reliability Assessment

Face and content validity of the 38-item structured Antimicrobial Stewardship (AMS) questionnaire were evaluated by a multidisciplinary panel of 10 subject-matter experts. Quantitative content validation was performed using Lawshe's Content Validity Ratio (CVR), the Content Validity Index (CVI), and the Average Congruency Percentage (ACP).

Content Validity Ratio

The item necessity was evaluated using Lawshe's CVR, which is expressed as $CVR = (n_c - N/2) / (N/2)$, whereby n_c indicates the number of experts who considered the item necessary, and N is the total number of experts involved. Since there were 10 experts, CVR values ranged from -1 to +1, where high values indicated a high degree of agreement among the experts regarding item necessity. Content validity of each questionnaire item was measured using Lawshe's content validity ratio (CVR). An acceptable CVR value is dependent on the number of experts as well as the critical value table used. When there are nine experts, an item is considered acceptable when its CVR value is 0.78 or more, showing that the item is considered necessary by at least eight experts out of nine. In the case of ten experts, an acceptable CVR value is 0.62 or more according to

Lawshe's critical value table, showing that the item was considered necessary by at least eight of the ten experts. On the other hand, according to Ayre and Scally's exact binomial method, the acceptable CVR value is 0.80 or more for a ten-member panel of experts. [14,15] For the current study, inclusion of the items was conditional on their CVR meeting or exceeding the critical value corresponding to the number of experts and statistical criterion chosen. The average CVR was calculated for all 38 items. Every expert evaluated each item of the questionnaire separately as being very important (score – 3 points), important but not vital (score – 2 points), and not important at all (score – 1 point). Then, the CVR was calculated for each item in accordance with the number of experts who considered the item as being very important, divided by and corrected according to the total number of experts.

Content Validity Index and Congruency

Relevance of each question was measured based on a four-point scale provided by 10 experts, in which 1 meant "not relevant," 2 meant "somewhat relevant," 3 meant "quite relevant," and 4 meant "highly relevant." A score of 3 or 4 meant that the item was relevant, and the scores of 1 and 2 were irrelevant. Content Validity Index at the item level (I-CVI) was defined as the number of experts who gave a score of 3 or 4 for each item. The level of content validity at the scale level was estimated by the average method (S-CVI/Ave), which involved calculation of the mean value of I-CVIs of all questions and the universal-agreement method (S-CVI/UA) that implied calculation of the proportion of the number of questions rated 3 or 4 by all 10 experts. [16] The Average Congruency Percentage (ACP) was calculated as well to show the level of congruency between experts, with the threshold value of 90%.

Following expert assessment, a pilot study was conducted among 20 practising community pharmacists to evaluate the internal consistency and preliminary measurement characteristics of the questionnaire. The overall 38-item questionnaire, whereas complete data were available for Domain 1, Domain 2 and Domain 3, each with 20 participants.

Internal consistency reliability

Cronbach's alpha was calculated for the two domains conceptualized as reflective constructs: Awareness and Perception and Current Dispensing Practices.[17] The overall 38-item alpha was also calculated as a descriptive measure of the internal consistency of the composite

instrument. Exact 95% confidence intervals (CIs) for alpha were derived using Feldt's central F-distribution method (Feldt, 1965).[18] An alpha coefficient above 0.70 was used as a conventional benchmark for acceptable internal consistency, while the confidence intervals were considered when interpreting the precision of the estimates.

Domain 3, Implementation Barriers, was designed as a formative, multi-attribute inventory because of the independence of the commercial, institutional, human resource, educational, and clinical barriers it comprises. Thus, Cronbach's alpha was not used as the key criterion for assessing this particular domain. All eight items were formulated in terms of barriers; thus, reverse scoring was not seen as theoretically appropriate just to increase reliability.

Exploratory structural diagnostics

Item-correlation patterns were considered, and hierarchical clustering with Ward's algorithm with a dissimilarity measure of $(d=1-r)$ was employed to look into the relationships between items that represented the barriers. In addition, principal component analysis (PCA) with varimax rotation was employed to consider whether there were any possible patterns in the covariance matrix of items. These tests could be viewed only as exploratory diagnostic procedures as the pilot sample included just 20 respondents for eight items, and not as definitive evidence of latent dimensions. The barrier scale could be interpreted based on responses and content validity of individual items.

Sample Size and Data Collection

The sample size for this research was calculated based on the finite population formula by Cochran, at a 95%

confidence level, 10% margin of error, 12,159 registered pharmacists in the population, and an expected proportion of 50%. [18] Based on the formula $N_0 = Z^2 pq / e^2$, where $Z=1.96$, $p=0.50$, $q=0.50$ and $e=0.10$, the sample size was $N_0 = (1.96)^2 \times 0.50 \times 0.50 / (0.10)^2 = 96.04$. Given that the source population was finite, the sample size was corrected using the finite population correction formula $N_{\text{final}} = N_0 / [1 + (N_0 - 1) / N]$, where $N=12,159$. Therefore $n = 96.04 / [1 + (96.04 - 1) / 12,159] = 95.3$, and rounding up to get 96. Thus, at least 96 community pharmacists were needed in this study. For this online survey, the web form was created and published using Google Forms, and the invitation was sent to the target respondents via regional professional pharmacist networks, academic alumni groups, and social networking sites

Statistical Analysis

Data analysis was done by coding; tabulation was done in Microsoft Excel version 2021. Complete statistical analysis was performed using R software (Version 4.6.0). Frequencies and percentages were calculated for descriptive statistics on the demographics and questionnaire. Validity and reliability of the questionnaire were tested. Principal Component Analysis (PCA) with Varimax Rotation was done to analyze the factors. Respondents were grouped based on the standard cutoff scores of informed/uninformed (awareness), proactive/inactive adopters (practice), and high/low barriers. A multivariate binary logistic regression was carried out to find the determinant factors of stewardship practice adoption, where inactive adopters are treated as the reference variable. The odds ratio (OR), confidence interval (CI), and p-value were calculated.

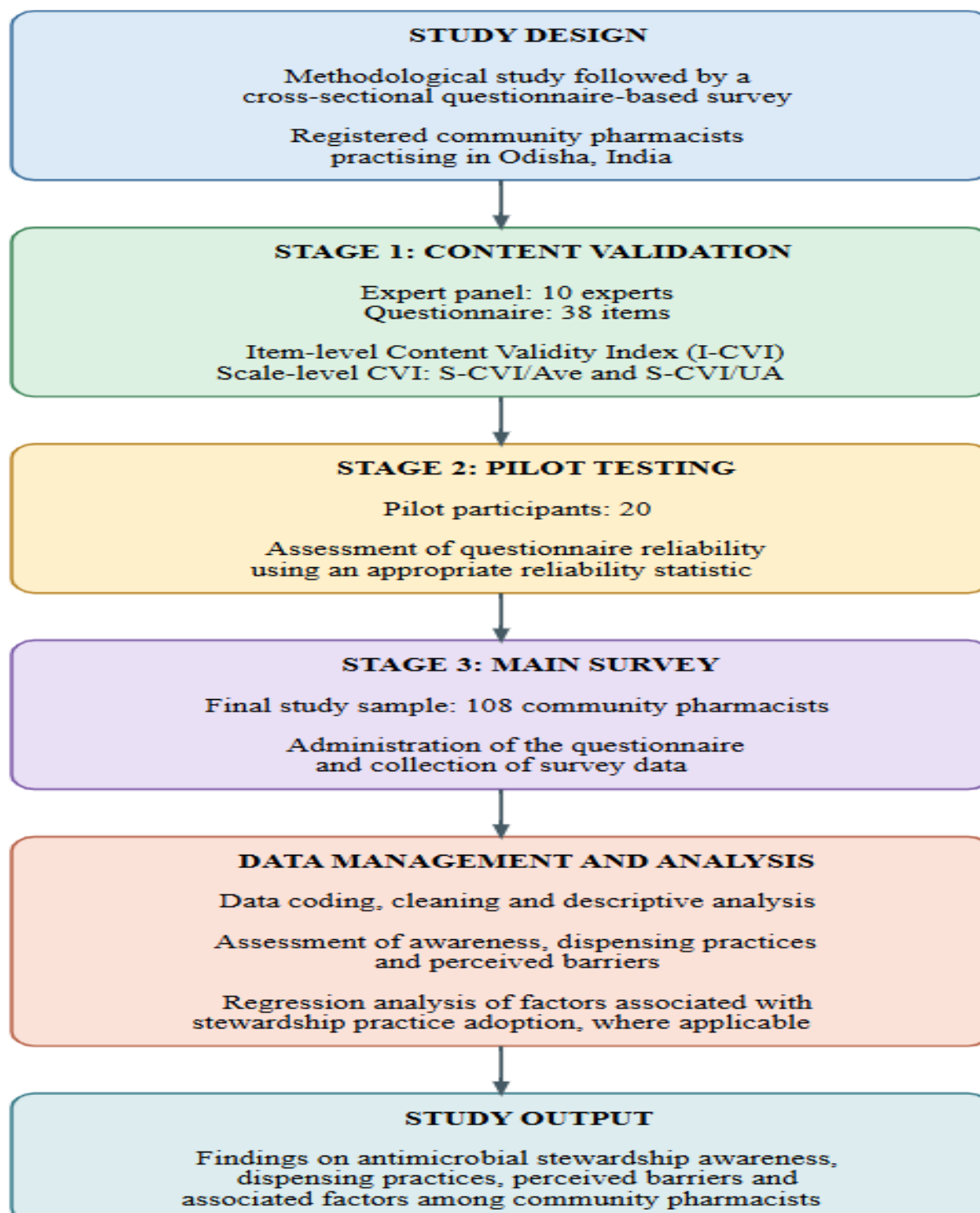


Figure 1. Methodological flowchart illustrating questionnaire content validation by 10 experts, pilot testing for reliability among 20 participants, and the main cross-sectional survey involving 108 registered community pharmacists in Odisha, India, followed by data management and statistical analysis.

Results

Questionnaire Content Validity and Pilot Reliability Diagnostics: Content validity

The content validity of the instrument was assessed using ten experts in an instrument consisting of 38 items. The Content Validity Index at the item level (I-CVI) was determined as the ratio of the experts who provided a rating of 3 and 4 for each of the items. The experts rated the relevance of all 38 items, which gives an I-CVI of 1.00 for all the items. As a result, the Scale-level Content Validity Index using the average method (S-CVI/Ave) is 1.00, and the Scale-level Content Validity Index using the universal agreement method (S-CVI/UA) is also 1.00, as shown in Table 1.

Table 1 *Formulas, Calculations, and Interpretation of Scale-Level Content Validity Indices*

Index	Formula	Calculation (38 items; 10 experts)	Result	Interpretation
I-CVI (Item-level Content Validity Index)	$I-CVI = \text{Number of experts rating an item 3 or 4} / \text{Total number of experts}$	For each item: 10 / 10 experts rated it relevant	1.00 (100%) per item	Every item met the prespecified relevance criterion according to all 10 experts.
S-CVI/Ave (Scale-level Content Validity Index–Average)	$S-CVI/Ave = \text{Sum of all item-level I-CVI values} / \text{Total number of items}$	$(1.00 + 1.00 + \dots + 1.00 \text{ till } 38) / 38 = 38 / 38$	1.00 (100%)	The average item-level content validity was complete across all 38 items.
S-CVI/UA (Scale-level Content Validity Index–Universal Agreement)	$S-CVI/UA = \text{Number of items with universal agreement} / \text{Total number of items}$	38 items with agreement from all 10 experts / 38 items	1.00 (100%)	All 10 experts agreed on the relevance of every item.

Average Congruency Percentage (ACP)	ACP = (Sum of CP _i from 1 to N)/N Where CP _i = (Experts agreeing on congruency × 100)/(Total experts)	CP _i = (10+10+...+10 till 38) × 100 = 100% ACP = (100 × 38)/38 = 100%	Complete expert congruency under the study's scoring method
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An assessment of item necessity based on Lawshe's Content Validity Ratio (CVR) resulted in an average of 0.895 for the 38 items. The number of items considered essential by all 10 experts (CVR = 1.00) was 19 (50.0%), by nine experts (CVR = 0.80) was 18 (47.4%), and by eight experts (CVR = 0.60) was one (2.6%), as shown in Table 2. With the use of the

predetermined critical CVR value of 0.62, 37 items (97.4%) satisfied the necessary criterion, whereas only one item (Q18; CVR = 0.60) did not meet that criterion. Still, all 38 items were included in pilot testing according to the retention criterion of the study and because of the I-CVI of 1.00 and ACP of 100% for each item.

Table 2 Lawshe's Content Validity Ratio (CVR)

CVR category	No. of experts rating item essential (n _e)	CVR=(n _e -N/2)/(N/2) [N=10]	Items	n (%)
Unanimous essentiality	10	1	Q1, Q3, Q6, Q8, Q11, Q14, Q16, Q20, Q21, Q23, Q27, Q29, Q30, Q32, Q34, Q35, Q36, Q37, Q38	19 (50.0%)
Nine experts	9	0.8	Q2, Q4, Q5, Q7, Q9, Q10, Q12, Q13, Q15, Q17, Q19, Q22, Q24, Q25, Q26, Q28, Q31, Q33	18 (47.4%)
Eight experts	8	0.6	Q18	1 (2.6%)
Total / mean	—	0.895 (mean)	38 items	38 (100%)

Pilot reliability of the reflective domains

Complete case analysis provided good point estimates of the internal consistency of the two reflective domains, as shown in Table 3. For Domain 1 (Awareness and Perception, 12 items, n = 20), there was a Cronbach's alpha of 0.731 (Feldt 95% CI: 0.518 – 0.876). For Domain 2 (Current Dispensing Practices, 18 items, n = 20), the alpha value was 0.793 (Feldt

95% CI: 0.629 – 0.907). The overall 38-item composite questionnaire had an alpha of 0.719 (n = 20; Feldt 95% CI: 0.502–0.872). All three-point estimates were more than 0.70, but the relatively large confidence intervals showed the level of uncertainty about the estimates, considering the small pilot sample size. Overall alpha should be considered with caution since the questionnaire has several domains and not one homogeneous construct.

Table 3 *Pilot internal consistency of reflective domains and overall questionnaire*

Scale/domain	Items (k)	n	Cronbach's α	Feldt 95% CI	Interpretation
Domain 1: Awareness and Perception	12	20	0.731	0.518–0.876	Point estimate > 0.70; CI indicates uncertainty.
Domain 2: Current Dispensing Practices	18	19	0.793	0.629–0.907	Point estimate > 0.70; acceptable preliminary consistency.
Overall, 38-item composite	38	19	0.719	0.502–0.872	Descriptive only; questionnaire contains multiple domains.

Implementation Barriers: formative inventory and exploratory diagnostics

In relation to Domain 3, Implementation Barriers (8 items; $n = 20$), the preliminary Cronbach's alpha value is -0.628 (Feldt 95% confidence interval: -1.984 to 0.259). In view of this, a poor inter-item covariance structure was obtained, thus making the scale unsuitable for interpretation as a typical reflective construct. The fact that all items measured different operational barriers and were framed as barriers in wording precluded theoretical justification for reverse scoring. This domain was hence retained for interpretation as a barrier inventory on a formative basis, based on item response patterns and content validity ($I-CVI = 1.00$).

Hierarchical clustering analysis with an exploratory approach revealed two clusters among the observed patterns of dissimilarities between the items as presented in Table 4. The first included retail/commercial barriers, which involved the following: time pressure (Q31), disconnection

from physicians (Q34), and profitability (Q36). The second cluster included the following structural and educational barriers: access to guidelines (Q32), staff shortage (Q33), literacy of patients (Q35), lack of training (Q37), and institutional support (Q38). Exploratory factor analysis using varimax rotation indicated that these items showed different covariance structures, where Q36 had a negative loading (-0.720) on the first rotated component while Q33 and Q37 had positive loadings ($+0.733$ and $+0.726$, respectively). With a small pilot sample size, these results were viewed as preliminary and could not be taken as evidence of confirmatory latent factors. Expert assessment of the content validity revealed the content relevance of all 38 items. Pilot data showed preliminary evidence of internal consistency of the two reflective constructs, whereas Domain 3 was retained as a formative inventory because the items reflected different operational barriers. Further assessment will be needed to examine the reliability and the reproducibility of the exploratory factors.

Table 4 *Implementation Barriers domain: formative inventory diagnostics*

Diagnostic	Result	Interpretation
Domain specification	8 items; $n = 20$	Formative multi-attribute inventory; items represent distinct barriers.
Unadjusted Cronbach's α	-0.628	Not interpreted as conventional reflective reliability.
Feldt 95% CI for α	-1.984 to 0.259	Uncertainty around the alpha estimate; reinforces cautious interpretation.

Content validity	I-CVI = 1.00 for all items	All items judged relevant by all experts under the prespecified rule.
Hierarchical clustering	Ward's method; $d = 1 - r$	Exploratory diagnostic only; cluster patterns require cautious interpretation.
Exploratory PCA	Varimax rotation; Q36 loading on RC1 = -0.720; Q33 = +0.733 and Q37 = +0.726	Preliminary covariance patterns only; not definitive latent-factor evidence.
Scoring decision	No reverse scoring	All items were phrased as barriers; reverse scoring solely to increase alpha was not justified.
Primary reporting approach	Item-level response frequencies and content validity	Appropriate emphasis for a formative barrier inventory.

The sample consisted of a total of 108 registered community pharmacists. The majority of the subjects were male (81.5%, $n = 88$) and held a D.Pharm qualification (61.1%, $n = 66$). Majority practiced in urban areas (60.2%, $n = 65$), and 61.1% ($n = 66$) had an experience of less than four years in their profession. Regarding dispensing patterns, 52.8% ($n = 57$) dispensed 100 or more non-prescription medications per month, whereas 47.2% ($n = 51$) dispensed 60 or more

antimicrobials per month without a prescription. In relation to the composite outcome domains, 52.8% ($n = 57$) of the participants were uninformed about the AMS practices, 55.6% ($n = 57$) were inactive adopters of the stewardship practices, and 61.1% ($n = 66$) had high perceived barriers to implementing stewardship protocols in their practice, as evident from Table 5.

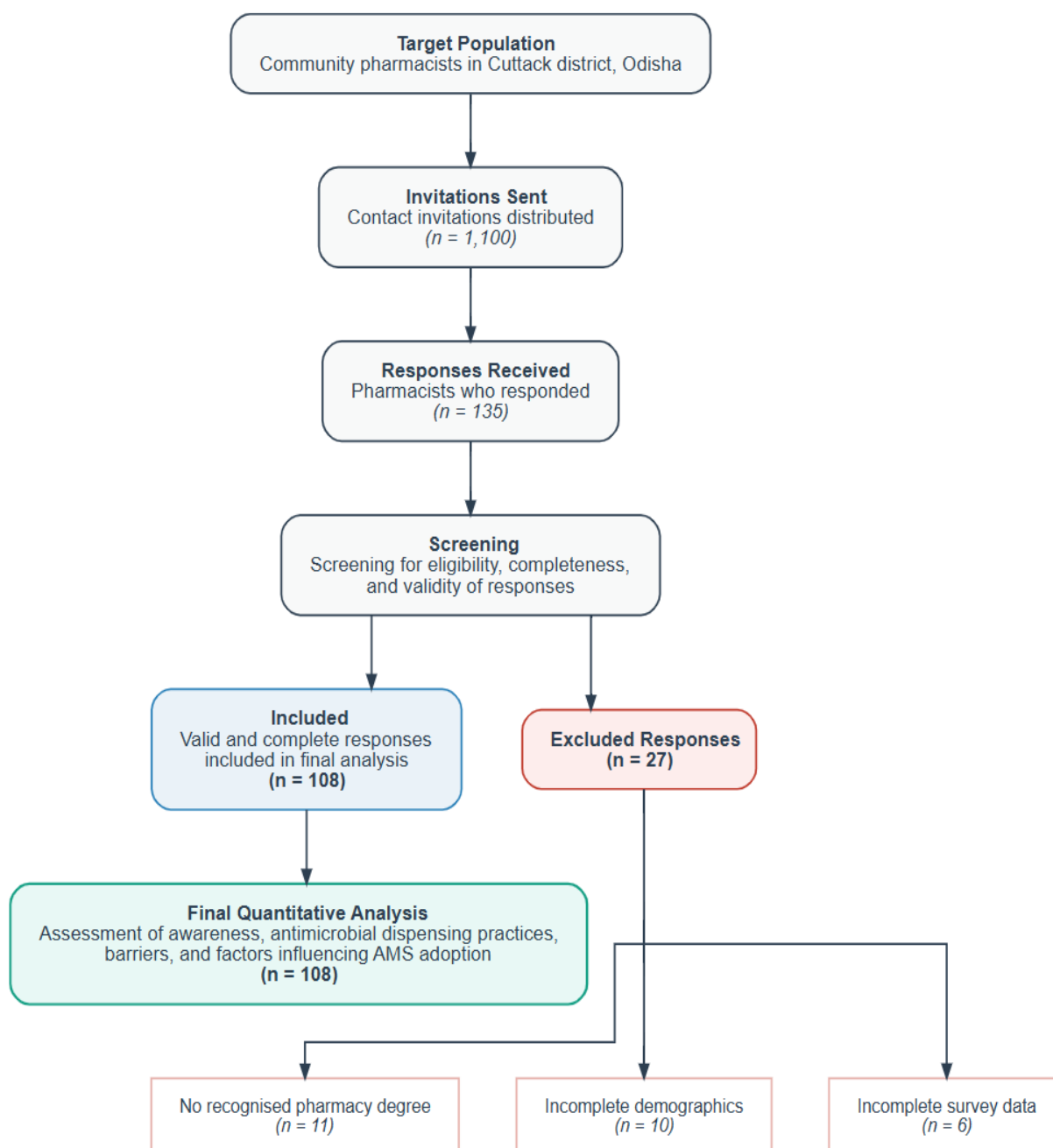


Figure 2: Flowchart of participant recruitment and inclusion in the study.

A total of 1,100 community pharmacists in Cuttack district, Odisha, were contacted through invitations to participate in the study. Out of this total, 135 pharmacists responded to the survey. All the responses were then assessed in terms of their eligibility, completeness, and validity. Out of these, 27 responses were found unsuitable for analysis purposes. Out

of these 27 responses, 11 were disqualified since the respondents had no recognized qualifications in pharmacy, 10 were disqualified due to incomplete demographic details, and 6 were disqualified due to incomplete survey responses. In the end, 108 responses remained for analysis, as shown in Figure 2.

Table 5 *Demographic and Operational Characteristics of Community Pharmacists (N = 108)*

Characteristic/variable	Category	n	%
Age (years)	21–30	65	60.2
	31–40	23	21.3
	41–50	11	10.2
	51–60	06	5.6
	>60	03	2.8
Age group (dichotomized)	<27 years	51	47.2
	≥27 years	57	52.8
Gender	Male	88	81.5
	Female	20	18.5
Highest educational qualification	D.Pharm	66	61.1
	B.Pharm	24	22.2
	M.Pharm	18	16.7
Practice setting	Urban	65	60.2
	Rural	32	29.6
	Semi-urban	11	10.2
Total practice experience (years)	<1	15	13.9
	1–4	51	47.2
	5–9	21	19.4
	≥10	21	19.4
Practice experience (dichotomized)	≤4 years	66	61.1
	≥5 years	42	38.9
Monthly dispensing without prescription	<100 encounters	51	47.2
	≥100 encounters	57	52.8
Monthly OTC antibiotic sales	<60 units	57	52.8
	≥60 units	51	47.2
Monthly pharmacy footfall	Low (<5,000 customers)	36	33.3
	Medium (5,000–9,999 customers)	45	41.7
	High (≥10,000 customers)	27	25

Awareness Group	Informed	51	47.2
	Uninformed	57	52.8
Barriers Group	Low barriers	42	38.9
	High barriers	66	61.1
Practice Group	Inactive Adopters	60	55.6
	Proactive adopters	48	44.4

A comparison of two methods for categorizing the participants in terms of their levels of awareness, practice, and perceived barrier domains is presented in Table 6. The median split criterion categorizes the participants into two groups based on whether their domain score is equal to or above the median level of the sample or below the sample median level. The Modified Bloom's two-tier classification categorizes participants whose scores are equal to or higher than 80% as having good scores, while those with scores below 80% as having scores below the good threshold. The Modified Bloom's three-tier classification further

categorizes participants whose scores are 60%-79% as having moderate scores and those below 60% as poor. Different categorization results were observed. The median splits resulted in relatively balanced groupings. [19,20] However, the Modified Bloom's criteria categorized very few participants as having good awareness or practice levels. Participants were not categorized as having poor practices and barriers by the three-tier criteria.

Table 6 Comparison of Median-Split and Modified Bloom's Classification of Questionnaire Domains (N = 108)

Domain	Classification method	Category	Cutoff/score range	Frequency, n (%)
Domain 1: Awareness	Median split	Informed	At or above median	51 (47.2%)
		Uninformed	Below median	57 (52.8%)
	Modified Bloom (2-tier)	Good	≥ 48 ($\geq 80\%$)	51 (47.2%)
		Below good threshold	< 48 ($< 80\%$)	57 (52.8%)
	Modified Bloom (3-tier)	Good	≥ 48 ($\geq 80\%$)	51 (47.2%)
		Moderate	36–47 (60–79%)	54 (50.0%)
		Poor	< 36 ($< 60\%$)	3 (2.8%)
Domain 2: Practice	Median split	Proactive	At or above median	48 (44.4%)
		Inactive	Below median	60 (55.6%)
	Modified Bloom (2-tier)	Good	≥ 72 ($\geq 80\%$)	9 (8.3%)

Domain Barriers	3:	Modified Bloom (3-tier)	Below good threshold	< 72 (< 80%)	99 (91.7%)
			Good	$\geq 72 (\geq 80\%)$	9 (8.3%)
			Moderate	54–71 (60–79%)	99 (91.7%)
			Poor	< 54 (< 60%)	0 (0.0%)
		Median split	High barriers	At or above median	66 (61.1%)
			Low barriers	Below median	42 (38.9%)
			High barriers	$\geq 32 (\geq 80\%)$	9 (8.3%)
		Modified Bloom (2-tier)	Below high-barrier threshold	< 32 (< 80%)	99 (91.7%)
			High	$\geq 32 (\geq 80\%)$	9 (8.3%)
			Moderate	24–31 (60–79%)	99 (91.7%)
		Modified Bloom (3-tier)	Low	< 24 (< 60%)	0 (0.0%)

Note. Percentages are based on (N=108). The median-split classifications and Modified Bloom classifications represent different approaches and should not be treated as interchangeable.

A comparison of two methods for categorizing the participants in terms of their levels of awareness, practice, and perceived barrier domains is presented in Table 6. The median split criterion categorizes the participants into two groups based on whether their domain score is equal to or above the median level of the sample or below the sample median level. The Modified Bloom's two-tier classification categorizes participants whose scores are equal to or higher than 80% as having good scores, while those with scores below 80% as having scores below the good threshold. The Modified Bloom's three-tier classification further categorizes participants whose scores are 60%-79% as having moderate scores and those below 60% as poor. Different categorization results were observed. The median splits resulted in relatively balanced groupings. [19,20] However, the Modified Bloom's criteria categorized very few participants as having good awareness or practice levels. Participants were not categorized as having poor practices and barriers by the three-tier criteria.

The multivariable logistic regression analysis indicated that years of pharmacy practice experience were the only independent predictor of the practice of adoption at the 5% level of significance. For every extra year of experience, there was a 23.7% increase in the adjusted odds of being an Inactive Adopter (AOR = 1.237, 95% CI: 1.016–1.505; $p=0.034$), when controlled for age, gender, qualification, posting location, monthly footfall, antimicrobials dispensation without prescriptions, awareness, and barriers perception. The variable age exhibited tendencies of decreased odds of being an Inactive Adopter as age increased (AOR = 0.894, 95% CI: 0.791–1.010; $p=0.072$); but this relationship was not statistically significant. Also, pharmacists who were categorized as uninformed had 2.11 times higher odds of being inactive adopters than informed pharmacists, but it was not statistically significant (95% CI: 0.898–4.950; $p=0.087$).

No statistically significant relationships were found between gender, professional qualification, posting location, footfall at the pharmacy per month, prescription-free dispense of

antimicrobials per month, and barriers. Confidence intervals of some categorical variables were large enough, meaning that there is uncertainty about the strength of their relationships with the variable of interest. More importantly,

the global likelihood-ratio test was not statistically significant ($X^2=11.585$, $df = 11$; $p=0.396$). Therefore, the significant association for experience should be interpreted cautiously, as the overall model test was nonsignificant.

Table 7 *Multivariable binary logistic regression analysis of factors associated with adoption practice among community pharmacists*

Predictor	β (Beta)	SE	Z-value	P-value	AOR	95% CI Lower	95% CI Upper
Age	-0.1120	0.0622	-1.7995	0.0719	0.8941	0.7914	1.01
Gender: Male	-0.3187	0.6129	-0.5201	0.603	0.7271	0.2187	2.4168
Qualification: D.Pharma	0.2288	0.6552	0.3492	0.7269	1.2571	0.3481	4.5404
Qualification: M.Pharma	-0.7101	1.2222	-0.5810	0.5612	0.4916	0.0448	5.3947
Place of posting/practice: Semiurban	-0.8111	0.9457	-0.8577	0.3911	0.4443	0.0696	2.8363
Place of posting/practice: Urban	-0.3317	0.4805	-0.6905	0.4899	0.7177	0.2799	1.8404
Experience (years)	0.2124	0.1002	2.1209	0.0339	1.2367	1.0162	1.5049
Monthly pharmacy footfall	-0.0001	0.0001	-0.7368	0.4613	0.9999	0.9997	1.0001
Antimicrobials dispensed monthly without prescription	0.0004	0.001	0.3517	0.7251	1.0004	0.9984	1.0023
Awareness group: Uninformed	0.7461	0.4353	1.7139	0.0865	2.1088	0.8984	4.9497
Barriers group: Low barriers	-0.2007	0.4538	-0.4422	0.6583	0.8182	0.3362	1.9911

Note: Values are rounded to four decimal places. Reference categories: Outcome—Proactive Adopters; Gender—Female; Qualification—B.Pharma; Setting—Rural; Awareness group—Informed; Barriers group—High Barriers. Statistical significance was set at $p < 0.05$. Experience was the only statistically significant predictor in the presented model.

Discussion

This current study investigated antimicrobial stewardship (AMS) awareness, dispensing behavior, barriers, and factors that influence the adoption of stewardship practices by registered community pharmacists in Odisha, India. Out of the 108 subjects, 60 (55.6%) were found to be inactive adopters, whereas 48 (44.4%) were categorized as proactive adopters. Overall, the multivariate logistic regression analysis in this study was not significant (likelihood ratio $\chi^2 = 11.585$, $df = 11$, $p = 0.396$; McFadden pseudo- $R^2 = 0.078$). Therefore, the observed associations should be interpreted as exploratory rather than as evidence of confirmed independent predictors.

Community pharmacies warrant easy availability of medications, devices, and health advice. In addition, they can help in the promotion of the right use of antibiotics through counselling, detection of improper demand, and referral for medical consultation. The possible community pharmacy-based interventions for antimicrobial stewardship were presented by Bishop et al., whereas the research conducted by Sahoo et al. among healthcare professionals in Odisha investigated the use and resistance to antibiotics. [6,9] However, none of the above sources proves the level of integration of community pharmacies with the formal stewardship programs in Odisha. Therefore, it is safe to say that inadequate integration might be a contextual challenge. The issue of dispensing non-prescription antibiotics persists in India. Earlier studies have reported issues of medicine consumption as well as factors associated with inappropriate dispensing. [21,22] While the above discussion provides background to interpret the findings of the current study in terms of dispensing, these studies do not provide the rate of inappropriate dispensing in the state of Odisha. Any conclusion regarding the non-compliance with the regulations should rely on the findings of the current study. Patient demand, access to prescribers, and business factors can affect dispensing. Studies in the city of New Delhi have examined issues of irrational use of antibiotics and the role of the pharmacist. Studies in the rural parts of Andhra Pradesh and Orissa also show the significance of studying the patients' initial contact with healthcare services. [23,24] These studies together justify taking into account patient demand and healthcare accessibility in the interpretation of community pharmacy practices. However, this should not be done if the current study's results do not support these factors.

Inappropriate use of antimicrobials is one of the most important factors in the development of resistance and a

public health concern. International guidelines stress the importance of optimizing antimicrobial prescribing and usage. [4] Previous work by pharmacies on deviations from appropriate dispensing behavior has been conducted. [21] Nevertheless, answers in a questionnaire cannot prove that some kind of behavior was responsible for resistance development in individual cases. Present results indicate the presence of potential practice-related problems, rather than actual proof of resistance development. A strong awareness campaign may play an important role in antimicrobial stewardship. However, mere awareness cannot ensure appropriate practice when pharmacists have limited time, more customer requests, lack of guidelines, training based on updated guidelines, or business interests to consider. Interventions at the community pharmacy level might be an effective tool in promoting appropriate antibiotic prescribing through education and practice-based approaches. [6] Nevertheless, awareness was not significantly associated with the implementation of stewardship practice in this study. That doesn't mean that awareness isn't important, but there was no significant association.

These barrier types are to be understood as possibly different individual, professional, business, and health system barriers. Training requirements, time constraints, lack of guideline availability, business reasons, and limitations in working with prescribers align with the barriers that have been identified in the community pharmacy and Indian stewardship literature. [2,7,21-23] India's AMS policy highlights coordinated implementation. [7] The alignment demonstrates contextual similarity. However, it does not mean the same barriers as those studied previously. As these barrier items reflect various barriers, they might be considered a formative inventory rather than one internally consistent scale. The low pilot Cronbach's alpha needs to be explained and critically assessed with respect to item coding and scoring; it does not prove good internal consistency.

Any apparent connection between professional experience and the stewardship adoption must also be interpreted with caution. Professional experience can lead to greater familiarity with medicine and counseling, and well-established work processes may be maintained throughout the period. This is a probable explanation, not a demonstrated mechanism through this study. The overall nonsignificant regression model provides no basis to make a definite judgment about the effect of professional experience on stewardship adoption. These results suggest that practical continuing professional development on issues

such as antibiotic requisition, patient counseling, referral, prescription practices, and clinical guidance is warranted. Such education will probably be more effective if done along with well-defined dispensing practice, prescriber cooperation, availability of clinical guidelines, and regulation.[6,7] But their efficacy needs to be tested in multiple districts of Odisha.

Strengths: This research has a number of strengths. First, community pharmacists who were registered with the Odisha Pharmacy Council and working in Cuttack district, one of the most active districts of Odisha, were involved in this study, thus providing practical information on community pharmacy practice. Second, the questionnaire was created based on a structured and staged procedure with the participation of 10 subject experts and pilot testing of 20 respondents, thus enhancing the content validity and feasibility of the instrument. Third, the total sample of 108 pharmacists was larger than the minimum necessary sample size of 96.

Limitations: Several limitations need to be considered about the current study. This study does not provide an opportunity to determine a causal link between the variables being studied and antimicrobial stewardship behavior, as the research was designed in a cross-sectional manner. There is a chance of social desirability and recall bias, as the drug dispensing process was based on self-reporting. Even though the sample size was sufficient for conducting the initial analysis, it was not adequate to verify the factor structure using confirmatory factor analysis (CFA) to enhance the accuracy of the regression coefficients. Though the low McFadden pseudo- R^2 value indicates low explanatory power, this does not rule out the presence of statistically significant associations.

Generalizability: The outcome of this research will have relevance only for community pharmacists working in the Cuttack district of Orissa. The outcomes of this research cannot be taken as universal because different pharmacies in other parts of India may have varying practices, policies, training opportunities, and types of patients served. To test the validity of these results, further research with pharmacists from different regions is needed.

Conclusion

This study gives local information regarding the awareness of AMS, dispensing practices, and perceived barriers among community pharmacists in Odisha, India. Lack of awareness, lack of stewardship practices, high barriers, and non-prescription dispensing of antibiotics are areas where

improvements may be considered. Nevertheless, due to the lack of significance of the whole regression model, observed relationships must be interpreted only exploratively. Targeted education, accessible guidelines, collaboration with prescribers, and appropriate regulatory implementation may strengthen community-pharmacy stewardship.

List of Abbreviations

AMS: Antimicrobial Stewardship, AMR: Antimicrobial Resistance, CPs: Community Pharmacists, D.Pharm: Diploma in Pharmacy, B.Pharm: Bachelor of Pharmacy, M Pharm: Master of Pharmacy, PCA: Principal Component Analysis, I-CVI: Item-Level Content Validity Index, CVI: Content Validity Index, CVR: Content Validity Ratio, ACP: Average Congruency Percentage, UA: Universal Agreement, df: degrees of freedom, OTC: Over the Counter, SE: Standard Error, aOR: Adjusted Odds Ratio, CI: Confidence Interval

Conflict of interest

The authors declare no conflict of interest.

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Author biography

Dr. P. Ansuman Abhisek (MBBS, MD Pharmacology) is an Assistant Professor of Pharmacology at SCB Medical College and Hospital, Cuttack. He possesses over 10 years of extensive teaching experience, instructing MBBS, BDS, Nursing, D.Pharm, DMLT, and Physiotherapy students in medical pharmacology and therapeutics. He also holds credentials in Diabetology, Geriatric Medicine (PGDGM), and Palliative Care. His research domain encompasses therapeutic drug monitoring, pharmacogenetics, pharmacometrics, pharmacoeconomics, and questionnaire development. An accomplished academician, Dr. Abhisek has authored 20+ peer-reviewed papers in indexed journals and regularly serves as a peer reviewer for reputed national and international Q1/Q2 indexed journals. Recognized with multiple prizes for speaker, oral, and poster presentations across major conferences, he remains committed to advancing rational pharmacotherapy, patient safety in pharmacovigilance & materiovigilance, AI and ML drug discovery, medical research, and medical education. ORCID ID: 0000-0001-7082-2665

Dr. Shweta Supriya Pradhan (MBBS, MD Pharmacology) is an Assistant Professor of Pharmacology at SCB Medical College and Hospital, Cuttack. A dedicated medical educator and researcher, she brings extensive experience in medical education and has actively served for over 4 years as an Institutional Ethics Committee member. Her core academic and research interests include antimicrobial stewardship, pharmacovigilance, rational drug use, and public health. She specializes in evaluating healthcare professionals' knowledge, attitudes, and prescribing behaviors through robust questionnaire development and statistical analysis. With over 10 peer-reviewed publications in indexed journals, Dr. Pradhan is deeply committed to evidence-based research, mitigating antimicrobial resistance, and fostering patient safety through interdisciplinary collaboration and scientific inquiry. ORCID ID: 0000-0001-6212-6635

Dr. Sachin Tripathy (MBBS, MD Pharmacology) is a Senior Resident at SCB Medical College and Hospital, Cuttack. With over four years of clinical experience as a Government Medical Officer in Odisha across PHCs and CHCs, he specializes in rural healthcare, emergency care, and prescription audits. His interests center on public health management, hospital administration, and rational drug use to improve healthcare quality. ORCID ID: 0009-0005-1774-6882

Dr. Pratyush Mishra (MBBS, MD Pharmacology) is an Assistant Professor of Pharmacology, medical educator, and interdisciplinary researcher. His work bridges clinical and social pharmacology, pharmacovigilance, and in silico drug discovery with ethnopharmacology, functional medicine, and lineage-based healing traditions. Focusing on medical ethnography, research philosophy, cognitive psychology, and ancient Indian ethno-cultural healing systems, Dr. Mishra explores integrated healing paradigms and behavioral heuristics. He is dedicated to advancing evidence-based healthcare, patient safety, and transformative health and wellness solutions through deep scientific inquiry and philosophical hermeneutics. ORCID ID: 0009-0007-4557-7865

Dr. Trupti Rekha Swain (MBBS, MD Pharmacology) is Professor and Head of the Department of Pharmacology at PMP Medical College and Hospital, Talcher, with former academic leadership at SCB Medical College, Cuttack. An Advanced Course in Medical Education graduate, she brings decades of research excellence with 89 publications, 37,000+ reads, and 500+ citations. Her expertise spans clinical pharmacology, diabetology,

pharmacoepidemiology, pediatric essential medicine pricing, antimicrobial stewardship, and rational drug use. Honors include a WHO Fellowship in Thailand (2009), UNICEF consultancy in Copenhagen (2010), editing a WHO-funded book on rational therapeutics in Odia, and the IPS Best Paper Prize (1994). She remains dedicated to mentoring, advancing drug safety, and strengthening evidence-based patient care.

ORCID ID: 0000-0002-7596-2031

Dr. Deepak Choudhury (MBBS, MS Ophthalmology, FICO) is an Assistant Professor of Ophthalmology at SCB Medical College and Hospital, Cuttack. He completed his MS at VSS Medical College (2016), senior residency at RIO Cuttack (2018), and a fellowship in Phacoemulsification from JPM Rotary Eye Institute. With 10 years of teaching experience, his clinical focus spans Cataract, Oculoplasty, and Medical Retina. An active researcher and former YOSI Odisha Treasurer, Dr. Choudhury has authored 28 peer-reviewed publications and won 1st prize in the OSOS 2025 Quiz. His interests include ophthalmic antimicrobial stewardship, biostatistics, AI software development, and drug discovery. ORCID ID: 0000-0002-0378-0992

Dr. Senthilkumar S (MBBS, MD Pharmacology) is a Senior Resident at SCB Medical College and Hospital, Cuttack. Technologically adept, his expertise includes computer-aided in silico drug discovery, pharmacovigilance, and clinical PK/PD modeling. He brings broad clinical experience across tertiary intensive care, nephrology, and rural health settings. Fluent in English and Tamil, Dr. Senthilkumar is committed to evidence-based drug prescribing, healthcare innovation, and clinical research. ORCID ID: 0009-0005-9216-0187

Data availability

The datasets generated and analysed during the current study are not publicly available to protect the privacy and confidentiality of the study participants. The data may be considered for sharing only after completion of other planned secondary or post hoc analyses, and subject to consultation with the study team and as per institutional policy.

Author Contributions

Dr P. Ansuman Abhisek: Conceptualisation, study design, questionnaire development, data collection, data analysis, interpretation of results, manuscript writing, and final approval of the manuscript.

Dr Shweta Supriya Pradhan: Literature review, study design, questionnaire development, data collection, manuscript writing, and final approval of the manuscript.

Dr Sachin Tripathy: Preparation of the study questionnaire and Google Form, including the study objectives, informed consent section, and domain-wise questions; data collection; manuscript revision; and final approval of the manuscript.

Dr Pratyush Mishra: Literature review, questionnaire development, manuscript writing, grammar and plagiarism checking, manuscript revision, and final approval of the manuscript.

Dr Trupti Rekha Swain: Study supervision, questionnaire validation process, critical revision of the manuscript, and final approval of the manuscript.

Dr Deepak Choudhury: Data analysis, interpretation of results, questionnaire validation process, manuscript revision, critical review, and final approval of the manuscript.

Dr Senthilkumar S: Preparation and digital distribution of the study questionnaire through Google Forms and public networking platforms; study supervision, data collection with cleaning and coding, critical revision of the manuscript, and final approval of the manuscript.

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