Al-Subol et al., UST J Med Sci 2026;4:4.
https://doi.org/10.59222/ustjms.4.4

UST JOURNAL FOR MEDICAL SCIENCES
Published by
University of Science and Technology, Sana'a, Yemen

ORIGINAL ARTICLE

Supporting OPEN-ACCESS Publishing

Discrepancy between Knowledge and Practice Regarding Antimicrobial Resistance among Retail Pharmacists in Sana'a City, Yemen

Ibrahim H. Al-Subol[1*], Kholoud N. Morad[2], Roa'a A. Shafi[2], Khairya S. Al-Jabri[2], Rawan J. Alwajeh[2], Farah A. Al-Mashreqi[2], Amani A. Al-Bakali[2], Manar T. Nassar[2], Amina H. Al-Moliky[2], Doaa A. Alezzi[2]

[1]Department of Basic Medical Sciences, Faculty of Medicine and Health Sciences, University of Science and Technology (USTY), Sana'a, Yemen

[2]Department of Medical Laboratory Sciences, Faculty of Medicine and Health Sciences, University of Science and Technology (USTY), Sana'a, Yemen

*** Corresponding author:** Email: alsabalibrahim@gmail.com

ABSTRACT

Background: Antimicrobial resistance (AMR) is a growing global health threat. While improving knowledge is a key part of antimicrobial stewardship (AMS), a significant gap often exists between what healthcare providers know and what they actually practice. assess retail pharmacists' knowledge, awareness, and dispensing practices regarding AMR and its contributing factors in Sana'a City, Yemen.

Methods: A cross-sectional survey was conducted among 300 conveniently sampled retail pharmacists from nine districts in Sana'a City, Yemen, between October 2023 and January 2024. Data were collected using a structured, self-administered questionnaire assessing pharmacists' demographic and professional characteristics, knowledge of AMR, awareness of its factors contributing, and antibiotic-dispensing practices. Knowledge and awareness items were scored on a 3-point Likert scale, while dispensing practices were assessed using a 5-point Likert scale. Scores were converted to percentage values and categorized as good or poor using a 75% cutoff. Associations of pharmacists' characteristics with their knowledge, awareness, and practices were examined using chi-square or Fisher's exact tests, with statistical significance set at P <0.05.

Results: Most pharmacists demonstrated good knowledge of AMR, where 83.7% correctly defined AMR, 88% recognized it as a major global health problem, and 88.7% identified it as a direct threat to human health. Microbial mutations were recognized as a key driver of AMR by 84.3%, while only 51% acknowledged genetic transmission, and fewer recognized healthcare-associated spread (42.3%) or hospital-acquired resistant infections (45.7%). Awareness of contributing factors was high, including inappropriate antibiotic use (85.7%), treatment interruption (93.3%), suboptimal dosing (77.7%), use of broad-spectrum antibiotics (61.3%), antibiotic use in livestock (86.3%), and environmental contamination (83.3%). Despite high levels of good knowledge (86%) and awareness (86.7%), poor antibiotic-dispensing practices were common (86.0%), with 35.7% reporting dispensing antibiotics without prescription. Pharmacists with a bachelor's degree had higher odds of good

Online ISSN: 2959-4146
Print ISSN: 2959-4138

knowledge and awareness than those holding a diploma degree (OR = 2.1, 95% CI: 1.06–4.03; *P* = 0.034 and OR = 2.0, 95% CI: 1.03–4.05; *P* = 0.040, respectively).

Conclusion: Retail pharmacists in Sana'a exhibit a notable level of knowledge and awareness of AMR and its contributing factors, but this level does not translate into good antibiotic-dispensing practices. This discrepancy underscores the pressing necessity for a comprehensive strategy that goes beyond existing AMS by implementing mandatory training, educational workshops, and strict enforcement of dispensing regulations. Further research into the social and professional drivers of these practices is essential to develop more effective, targeted interventions.

Keywords: Antimicrobial resistance ▪ Retail pharmacist ▪ Awareness ▪ Practice ▪ Yemen

1. Introduction

Antimicrobials play a crucial role in saving lives by combating bacterial infections and reducing mortality rates.[1–4] However, the irrational use of these agents has led to the emergence and spread of antimicrobial-resistant microbes, posing a threat to their effectiveness.[3] Antimicrobial resistance (AMR) is a natural phenomenon that develops through several mechanisms, including genetic mutations and horizontal gene transfer.[1,5–7] It has emerged as one of the most challenging public health issues of the 21st century, undermining all achievements and efforts to combat infectious diseases.[8–13] AMR is not limited to a specific geographic region, as reports from the World Health Organization (WHO) have documented the global spread of antibiotic-resistant bacteria.[3, 13–15]

Although AMR is a natural phenomenon, various human behavioral factors have hastened the emergence and spread of antimicrobial-resistant microbes.[1,6] Key factors include the overuse and misuse of antimicrobial agents, inadequate infection control practices, a lack of awareness, misdiagnoses, and the failure of many laboratories to perform antibiotic susceptibility testing.[1,15,16] AMR has serious effects on human health and economies, resulting in higher treatment costs, prolonged hospitalization, elevated mortality rates, increased expenses, and reduced productivity.[9,17–21] In the United States, an estimated 2 million people contract infections caused by antibiotic-resistant bacteria each year, resulting in approximately 23,000 deaths.[16,22] Antibiotic resistance is also increasing in European countries, with an estimated 33,000 deaths annually due to antibiotic-resistant infections.[23] Globally, antibiotic-resistant infections cause around 700,000 deaths annually, a number projected to reach 10 million by 2050 in the absence of effective interventions.[1,8,11,12,22,24,25]

Without effective measures to address the problem, the economic burden could escalate to USD 1 trillion in global output by 2030. [1,8,12,23,24,26] This critical situation has drawn global attention to AMR, leading the WHO to announce a Global Action Plan (GAP) in 2015 and urge countries to adopt appropriate action plans to tackle AMR.[1,2,11,16,26,27] One of the main goals of GAP is to raise global awareness about AMR, its implications for public health, and the importance of appropriate antimicrobial use to mitigate this growing global health threat.[10,11,14,16,26,28]

Insufficient awareness of AMR, along with the lack of comprehensive antimicrobial stewardship (AMS) programs in communities, contributes to the irrational use of antimicrobials in both hospital and community settings. This misuse, in turn, fosters the spread of AMR.[8,13,15,27–30] Retail pharmacists are among the healthcare professionals who deal directly with the sale and dispensing of antibiotics have the most interaction with patients and the public. Accordingly, they can play a pivotal role in combating AMR by educating patients and prescribers about rational antibiotics use.[2,13,16,21,23,29,31–33] However,

Online ISSN: 2959-4146
Print ISSN: 2959-4138

previous studies have shown inadequate knowledge and awareness among healthcare providers regarding antibiotic importance, prescribing guidelines, and the factors that prompt antibiotic resistance.[11,28–30] Therefore, identifying AMR knowledge gaps among retail pharmacists is necessary for developing targeted educational and training programs that empower them to effectively combat AMR.

Yemen, a country experiencing protracted conflict and socioeconomic instability, faces significant AMS challenges. The combination of high antibiotic prescribing rates, prevalent over-the-counter dispensing, widespread self-medication, and indiscriminate antibiotic use has contributed to alarming levels of AMR. This crisis is exacerbated by the country's weak AMS programs.[27,34–36] Despite these pressing concerns, data on retail pharmacists' knowledge, awareness, and practices regarding AMR remain scarce in Yemen. This study aimed to assess retail pharmacists' knowledge, awareness, and dispensing practices regarding AMR and its contributing factors. By identifying critical gaps in understanding and practice, this research sought to guide targeted interventions that would enhance pharmacists' capacity to support AMS initiatives within Yemen's fragile health system.

2. Methods

2.1. Study design, population and setting

A cross-sectional survey was conducted among retail pharmacists in Sana'a City, Yemen, from October 2023 to January 2024.

2.2. Sample size calculation and sampling method

A sample of 278 retail pharmacists was calculated using Raosoft® software (www.raosoft.com), based on a population size of 1000, a power of 80%, a response distribution of 50%, a confidence level of 95%, and a margin of error of 5%. However, the sample size was increased to 300 to improve precision. To collect data, pharmacy areas were selected based on the residential locations of researchers. Pharmacies were then conveniently selected until the required sample of retail pharmacists was attained.

2.3. Survey instrument and data collection

Following a review of the literature,[21,25,26,28,31] a structured, self-administered questionnaire comprising four sections was developed. The first section included data on the demographic and professional characteristics of pharmacists. The second section included nine questions to assess knowledge of AMR. The third section included six questions to assess pharmacists' awareness of the factors contributing to AMR. The fourth section included eight questions to evaluate pharmacists' antibiotic-dispensing practices.

Trained students conducted visits to preselected community pharmacies across nine districts in the city. During these visits, the participants were provided with a detailed explanation of the study objectives. Following informed consent procedures, participants received standardized paper-based questionnaires for independent completion. The self-administered survey was implemented to minimize bias, ensure response anonymity, and maintain data integrity. Research team members collected completed questionnaires immediately following participation, maintaining participants' privacy and data confidentiality.

2.4. Scoring scheme and data analysis

To assess knowledge and awareness, responses were scored on a 3-point Likert scale as '1' for disagreement, '2' for neutrality, and '3' for agreement. When assessing antibiotic-dispensing practices, responses were scored on a 5-point Likert scale from '1' to '5' for always, usually, sometimes, rarely, and never, respectively, except for responses to

Online ISSN: 2959-4146
Print ISSN: 2959-4138

items 1, 7 and 8 that were reverse-scored to reflect adherence to good practices, where higher scores indicate better compliance. The responses for each section were summed up and divided by the possible maximum value to get the percentage score. Each score was divided into good or poor using 75% as a cutoff point (≥75% = good, <75% = poor).[14]

The data were analyzed using IBM SPSS Statistics, version 25 for Windows (IBM Corp., Armonk, NY, USA). The chi-square or Fisher's exact test, as appropriate, was used to assess the association of pharmacists' demographic and professional characteristics with their level of knowledge, awareness, and antibiotic-dispensing practices concerning AMR. A *P*-value <0.05 was considered statistically significant.

3. Results

3.1. Demographic and professional characteristics of participants

Table 1 shows that the majority of retail pharmacists were males (94.7%) and aged under 30 years (70.7%). Most participants held a bachelor's degree (62.7%), followed by those with a diploma (32.3%), while only 5% held a master's degree. In terms of experience, more than half had 1–4 years of experience, followed by those having 5–10 years (25%) and over 10 years (13%), while 9.7% had less than one year of experience.

3.2. Knowledge of AMR

Table 2 shows that 83.7% of participants identified AMR as the ability of microbes to survive and reproduce despite antibiotic exposure. On the other hand, 88% stated that AMR represents a significant global health issue, and 88.7% recognized AMR as a direct threat to human health. A notable percentage of participants (84.3%) identified microbial mutations as a driver of antibiotic resistance, with 51% acknowledging resistance transmission through genetic material exchange between microbes. However, only 42.3% recognized the potential spread of antibiotic-resistant infections from health facilities, and 45.7% knew that hospital-acquired infections are commonly caused by antibiotic-resistant microbes. Most participants recognized the importance of culture and antibiotic susceptibility testing in managing antibiotic-resistant infections (85.7%) and were aware that the rational use of antibiotics is a shared responsibility among physicians, pharmacists, and patients.

Table 1: Demographic and professional characteristics of study participants*

Characteristics	*n* (%)
Gender	
Male	284 (**94.7**)
Female	16 (**5.3**)
Age (years)	
<30	212 (**70.7**)
30–40	73 (**24.3**)
>40	15 (**5.0**)
Qualification	
Diploma	97 (**32.3**)
Bachelor's degree	188 (**62.7**)
Master's degree	15 (**5.0**)
Years of experience	
<1	29 (**9.7**)
1–4	157 (**52.3**)
5–10	75 (**25.0**)
>10	39 (**13.0**)

* The total number of participants was 300. SD, standard deviation.

3.3. Awareness of the factors contributing to AMR

Figure 1 shows a high level of awareness of the factors contributing to AMR. Most participants recognized the role of unnecessary antibiotic use in exacerbating AMR (85.7%), and 93.3% demonstrated an understanding of how discontinuing and restarting antibiotic therapy can contribute to AMR. Most participants were also aware of the consequences of suboptimal antibiotic dosages (77.7%) and the preference for broad-spectrum antibiotics over narrow-

Online ISSN: 2959-4146
Print ISSN: 2959-4138

spectrum options in fostering AMR (61.3%). A majority of participants also recognized the impact of antibiotics in livestock feed (86.3%) and the release of antibiotics into the environment (83.3%) on the development of AMR, respectively.

Table 2: Knowledge of AMR among retail pharmacists in Sana'a City, Yemen (2025)*

Knowledge item	Disagree	Neutral	Agree
	n (%)		
AMR is microbes' ability to survive and reproduce despite exposure to therapeutic antibiotic concentrations.	29 (**9.7**)	20 (**6.7**)	251 (**83.6**)
AMR is a global health challenge.	18 (**6.0**)	18 (**6.0**)	264 (**88.0**)
AMR to antibiotics threatens human health.	11 (**3.7**)	23 (**7.7**)	266 (**88.7**)
Some microbes can mutate and become resistant to antibiotics.	16 (**5.3**)	31 (**10.3**)	253 (**84.3**)
AMR can be transmitted between microbes through the exchange of genetic material.	68 (**22.7**)	79 (**26.3**)	153 (**51.0**)
Antibiotic-resistant microbial diseases can spread from health facilities, including hospitals.	51 (**17.0**)	122 (**40.7**)	127 (**42.3**)
Infectious diseases acquired from health facilities such as hospitals are more resistant to antibiotics.	60 (**20.0**)	103 (**34.3**)	137 (**45.7**)
Resistant infections can be identified by culture and susceptibility testing in the laboratory.	15 (**5.0**)	28 (**9.3**)	257 (**85.7**)
The appropriate use of antibiotics is a mutual responsibility between the doctor, pharmacist and patient.	16 (**5.3**)	15 (**5.0**)	269 (**89.7**)

* The total number of participants was 300. AMR, antimicrobial resistance.

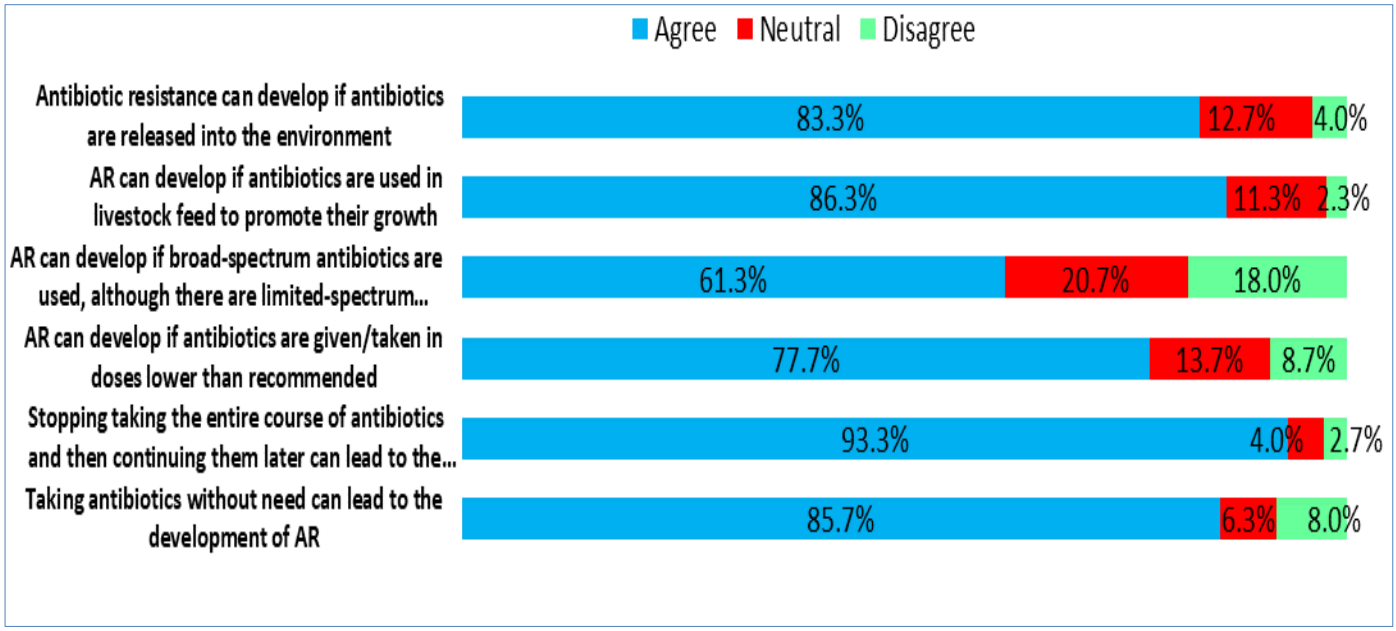

Figure 1: Awareness of the factors contributing to AMR among community pharmacists in Sana'a City, Yemen (*N* = 30)

3.4. Antibiotic-dispensing practices

Table 3 shows that nearly half of the pharmacists (47%) reported that they usually dispense antibiotics only with a prescription. However, 35.7% acknowledged sometimes dispensing antibiotics without a prescription. Participation in the national AMS program was limited, with only 18.3% reporting regular involvement (6% always and 12.3% usually). In addition, more than one-third of pharmacists (36.7%) reported never attending training or educational courses. Nevertheless, 15.3% usually and 12.3% sometimes participated in educational activities related to antibiotic dispensing and AMR

Online ISSN: 2959-4146
Print ISSN: 2959-4138

Table 3: Antibiotic-dispensing practices among community pharmacists in Sana'a City, Yemen (2025)*

Items	Always	Usually	Sometimes	Rarely	Never
			n (%)		
I dispense antibiotics only with a doctor's prescription.	64 (**21.3**)	141 (**47.0**)	75 (**25.0**)	13 (**4.3**)	7 (**2.3**)
I dispense antibiotics without a prescription.	46 (**15.3**)	98 (**32.7**)	107 (**35.7**)	30 (**10.0**)	19 (**6.3**)
I dispense antibiotics as requested by the patient.	25 (**8.3**)	40 (**13.3**)	106 (**35.3**)	61 (**20.3**)	68 (**22.7**)
I only dispense topical antibiotics without a prescription.	38 (**12.7**)	84 (**28.0**)	84 (**28.0**)	46 (**15.3**)	48 (**16.0**)
I only dispense oral antibiotics without a prescription.	36 (**12.0**)	77 (**25.7**)	111 (**37.0**)	34 (**11.3**)	42 (**14.0**)
I dispense intravenous antibiotics without a prescription.	18 (**6.0**)	39 (**13.0**)	44 (**14.7**)	85 (**28.3**)	114 (**38.0**)
I participate in the activities of the National Antibiotic Management Program.	18 (**6.0**)	37 (**12.3**)	38 (**12.7**)	81 (**27.0**)	126 (**42.0**)
I participate in various training and educational courses on methods of dispensing antibiotics and the causes that lead to resistance.	33 (**11.0**)	46 (**15.3**)	37 (**12.3**)	74 (**24.7**)	110 (**36.7**)
I dispense antibiotics only with a doctor's prescription.	64 (**21.3**)	141 (**47.0**)	75 (**25.0**)	13 (**4.3**)	7 (**2.3**)
I participate in the activities of the National Antibiotic Management Program.	46 (**15.3**)	98 (**32.7**)	107 (**35.7**)	30 (**10.0**)	19 (**6.3**)
I participate in training and educational courses on methods of dispensing antibiotics and the causes that lead to resistance.	25 (**8.3**)	40 (**13.3**)	106 (**35.3**)	61 (**20.3**)	68 (**22.7**)

* The total number of participants was 300. AMR, antimicrobial resistance.

3.5. Overall scores of knowledge, awareness, and practices

Table 4 shows that most retail pharmacists demonstrated a high level of knowledge regarding AMR (86%) and a high level of awareness of the factors that contribute to AMR emergence (86.7%). However, a majority of pharmacists (86%) also demonstrated poor antibiotic-dispensing practices.

Table 4: Overall scores of retail pharmacists' knowledge, awareness, and practices in Sana'a City (2025)*

Variable	Good	Poor
	n (%)	
Knowledge of the problem of AMR	258 (**86.0**)	42 (**14.0**)
Awareness of the factors leading to AMR	260 (**86.7**)	40 (**13.3**)
Antibiotic-dispensing practices	42 (**14.0**)	258 (**86.0**)

* The total number of participants was 300. AMR, antimicrobial resistance.

3.6. Factors associated with AMR knowledge and awareness, and antibiotic-dispensing practices

Table 5 shows that retail pharmacists with a bachelor's degree showed notably higher odds of possessing good knowledge and awareness compared to those with a diploma (OR = 2.1, 95% CI: 1.06–4.03; *P* = 0.034 and OR = 2.0, 95% CI: 1.03–4.05; *P* = 0.040, respectively). However, other demographic and professional characteristics did not show any significant association.

Table 5: Factors associated with knowledge and awareness of AMR and antibiotic-dispensing practices among retail pharmacists in Sana'a City, Yemen (2025)

Items	Factors	*N*	*n* (%)	OR (95% CI)	*P*-value
Good knowledge of AMR	**Gender**				
	Male	284	245 (**86.3**)	Reference	
	Female	16	13 (**81.3**)	0.7 (0.19–2.53)	0.576
	Age (years)				
	<30	212	188 (**88.7**)	Reference	
	30–40	73	57 (**78.1**)	0.5 (0.23–0.92)	0.027
	>40	15	13 (**86.7**)	0.8 (0.18-3.90)	0.813
	Qualification				
	Diploma	97	77 (**79.4**)	Reference	
	Bachelor's	188	167 (**88.8**)	2.1 (1.06–4.03)	0.034
	Master's	15	14 (**93.3**)	3.6 (0.45–29.33)	0.225
	Years of experience				
	<1	29	25 (**86.2**)	Reference	
	1–4	157	136 (**86.6**)	1.5 (0.47–4.53)	0.514
	5–10	75	66 (**88.0**)	1.2 (0.53–2.82)	0.638
	>10	39	31 (**79.5**)	0.6 (0.26–1.60)	0.343
Good awareness of factors contributing to AMR	**Gender**				
	Male	284	245 (**86.3**)	Reference	
	Female	16	15 (**93.8**)	2.4 (0.31–18.59)	0.406
	Age (years)				
	<30	212	187 (**88.2**)	Reference	
	30–40	73	60 (**82.2**)	0.6 (0.30–1.28)	0.195
	>40	15	13 (**86.7**)	0.9 (0.19–4.08)	0.859
	Qualification				
	Diploma	97		Reference	
	Bachelor's	188		2.0 (1.03–4.05)	0.040
	Master's	15		3.4 (0.42–27.57)	0.250
	Years of experience				
	<1	29	25 (**86.2**)	Reference	
	1–4	157	137 (**87.3**)	1.0 (0.35–2.90)	0.986
	5–10	75	64 (**85.3**)	0.9 0.39–1.92)	0.720
	>10	39	34 (**87.2**)	1.0 (0.35–2.90)	0.986

AMR, antimicrobial resistance; OR, odds ratio; CI, confidence interval.

Online ISSN: 2959-4146
Print ISSN: 2959-4138

Table 5 continued...

Items	Factors	N	n (%)	OR (95% CI)	P-value
Good antibiotic-dispensing practices	**Gender**				
	Male	284	41 (**14.4**)	Reference	
	Female	16	1 (**6.3**)	0.4 (0.05–3.07)	0.375
	Age (years)				
	<30	212	30 (**14.2**)	Reference	
	30–40	73	11 (**15.1**)	1.1 (0.51–2.28)	0.847
	>40	15	1 (**6.7**)	0.4 (0.06–3.42)	0.427
	Qualification				
	Diploma	97	17 (**17.5**)	Reference	
	Bachelor's	188	24 (**12.8**)	0.7 (0.35–1.35)	0.280
	Master's	15	1 (**6.7**)	0.3 (0.04–2.73)	0.308
	Years of experience				
	<1	29	4 (**13.8**)	Reference	
	1–4	157	22 (**14.0**)	0.8 (0.27–2.12)	0.593
	5–10	75	11 (**14.7**)	0.6 (0.26–1.44)	0.260
	>10	39	5 (**12.8**)	0.8 (0.27–2.12)	0.593

AMR, antimicrobial resistance; OR, odds ratio; CI, confidence interval.

4. Discussion

Awareness of AMR and its contributing factors leads to the judicious use of antibiotics and limits the development of resistance. Retail pharmacists, as key healthcare providers involved in dispensing antibiotics, can play a pivotal role in combating AMR. Their direct contact with patients enables them to inform patients and prescribers on the appropriate use of antibiotics. This study revealed a high level of knowledge and awareness of the key aspects related to AMR and its underlying factors. The majority of participants acknowledged the global health threat of AMR and understood the mechanisms of resistance, including microbial mutation and genetic transfer. They also recognized the shared responsibility among healthcare professionals and patients in ensuring appropriate antibiotic utilization.

Our findings revealed consensus among most participants that discontinuing antibiotic therapy before completing the course, using antibiotics without medical need, using them in livestock feed, and releasing them into the environment are the most prominent factors leading to the development and spread of resistant microbes. Our findings align with many previously published studies,[16,21,23,37] indicating that a substantial proportion of pharmacists possess awareness and understanding of AMR and its contributing factors. The increased awareness among retail pharmacists about AMR and its contributing factors may be attributed to the growing global awareness of this pressing issue. AMR receives significant attention and media coverage across various platforms, including educational curricula, media outlets, and social media channels. This widespread interest has contributed to the dissemination of information and awareness among healthcare workers, resulting in consistent findings across multiple studies. In contrast, the findings of the present study do not agree with other studies,[38–41] which documented a low level of knowledge among community pharmacists regarding AMR and its contributing factors. This disparity underscores the importance of conducting further research to understand differences in levels of knowledge and awareness across different regions and countries.

A concerning finding revealed by this study is the inappropriate antibiotic-dispensing practices by retail pharmacists, which do not reflect their demonstrated good knowledge and awareness regarding AMR and the factors that promote its spread, including the misuse of antibiotics. In this context, most pharmacists reported dispensing antibiotics with a prescription, reflecting non-compliance with antibiotic-dispensing regulations and heralding the exacerbation and development of antibiotic-resistant infections. These findings agree with the findings of previous studies, [1,6,16,31,41,42] which have documented inappropriate antibiotic-dispensing practices by community pharmacists and healthcare providers. This discrepancy between good awareness and poor practices may be attributed to various factors, including poor oversight of antibiotic-dispensing practices, pressure to achieve targeted

Online ISSN: 2959-4146
Print ISSN: 2959-4138

sales, financial incentives linked to drug sales, limited access to updated guidelines, patient demands, and the fragility of the healthcare system in Yemen. This situation emphasizes the need for targeted interventions and ongoing initiatives to enhance knowledge, awareness, and compliance with guidelines among retail pharmacists. These efforts are essential to mitigate the rising threat of AMR and foster rational antibiotic use in healthcare and community settings.

In the present study, holding a bachelor's degree was significantly associated with a high level of knowledge regarding AMR and good awareness of its contributing factors. This finding emphasizes the potential impact of educational qualifications on pharmacists' comprehension and awareness of AMR. However, none of the demographic and professional factors showed a significant association with participants' antibiotic-dispensing practices. These findings are consistent with other studies.[16,28,43,44] Nevertheless, they contradict some previous studies that showed a significant association between holding a bachelor's degree and appropriate antibiotic-dispensing practices by community pharmacists.[1,45]

This study provides insights into the knowledge and awareness of retail pharmacists about AMR and their antibiotic-dispensing practices in Sana'a City. However, a few limitations should be acknowledged. First, the findings may not be generalizable nationally or to all pharmacists as the survey was conducted among a convenience sample of retail pharmacists in Sana'a. In addition, there is a potential for bias in self-administered surveys, as participants may provide inaccurate answers, especially regarding antibiotic-dispensing practices. The study questionnaire did not also include open-ended questions aimed at exploring the factors driving pharmacists' inappropriate dispensing of antibiotics.

5. Conclusion

Retail pharmacists in Sana'a exhibit a notable level of knowledge and awareness of AMR and its contributing factors, but this level does not translate into good antibiotic-dispensing practices. This discrepancy underscores the pressing necessity for a comprehensive strategy that goes beyond existing AMS by implementing mandatory training, educational workshops, and strict enforcement of dispensing regulations. Further research into the social and professional drivers of these practices is essential to develop more effective, targeted interventions.

Acknowledgments

The authors thank the retail pharmacists and survey participants who generously contributed their time and insights to this study.

Ethical considerations

The study was approved by the Research Ethics Committee of the University of Science and Technology (USTY), Sana'a, Yemen (Ethical Clerance No.: 1447/0094/UREC/UST). Verbal consent was obtained from each participant after data collectors provided comprehensive information on research objectives and benefits. Confidentiality measures were in place to protect privacy and maintain response anonymity.

Conflict of interest

The authors declare no conflict of interest associated with this article.

Funding

None.

References

1. Alajmi AM, Alamoudi AA, Halwani AA, Almangour TA, Almozain NH, Al-Jedai A, et al. Antimicrobial resistance awareness, antibiotics prescription errors and dispensing patterns by community pharmacists in Saudi Arabia. J Infect Public Health. 2023;16(1):34–41. DOI • PubMed • Google Scholar
2. Abuhamda GA, Beshir SA, Sam KG, Gillani SW. Antibiotic prescribing and dispensing behavior among doctors and

Online ISSN: 2959-4146
Print ISSN: 2959-4138

pharmacists working in UAE. Pharm Pract (Granada). 2023;21(2):12. DOI ● Google Scholar
3. Tadesse TY, Molla M, Yimer YS, Tarekegn BS, Kefale B. Evaluation of antibiotic prescribing patterns among inpatients using World Health Organization indicators: a cross-sectional study. SAGE Open Med. 2022;10: 20503121221096608. DOI ● PubMed ● Google Scholar
4. Helma RA, Ngwai YB, Nkene IH, Adamu S. Assessment of rational antibiotic prescribing in public hospitals in Nasarawa State, Nigeria. Eur J Biol Biotechnol. 2020;1:4. DOI ● Google Scholar
5. Nisabwe L, Brice H, Umuhire MC, Gwira O, Harelimana JD, Nzeyimana Z, et al. Knowledge and attitudes towards antibiotic use and resistance among undergraduate healthcare students at University of Rwanda. J Pharm Policy Pract. 2020;13:7. DOI ● PubMed ● Google Scholar
6. Orubu ESF, Al-Dheeb N, Ching C, Bu Jawdeh S, Anderson J, Sheikh R, et al. Assessing antimicrobial resistance, utilization, and stewardship in Yemen: an exploratory mixed-methods study. Am J Trop Med Hyg. 2021;105(5):1404–12. DOI ● PubMed ● Google Scholar
7. Kamita M, Mutungi JK, Mungai S, Mureithi D, Kijogi C, Kimani R, et al. A survey on knowledge, attitude, and practice about antibiotic prescribing and resistance among medical practitioners in Kenya. Open Res Afr. 2022;5:3:3. DOI ● Google Scholar
8. Barchitta M, Sabbatucci M, Furiozzi F, Iannazzo S, Maugeri A, Maraglino F, et al. Knowledge, attitudes and behaviors on antibiotic use and resistance among healthcare workers in Italy, 2019: investigation by a clustering method. Antimicrob Resist Infect Control. 2021;10(1):134. DOI ● PubMed ● Google Scholar
9. Mathew P, Sivaraman S, Chandy S. Communication strategies for improving public awareness on appropriate antibiotic use: bridging a vital gap for action on antibiotic resistance. J Family Med Prim Care. 2019;8(6):1867–71. DOI ● PubMed ● Google Scholar
10. Pinto Jimenez C, Pearson M, Hennessey M, Nkereuwem E, Crocker C, Egbujo U, et al. Awareness of antibiotic resistance: a tool for measurement among human and animal health care professionals in LMICs and UMICs. J Antimicrob Chemother. 2023;78(3):620–35. DOI ● PubMed ● Google Scholar
11. Gu Y. Raising awareness of antimicrobial resistance: comment on 'Reducing expectations for antibiotics in primary care: a randomised experiment to test the response to fear based messages about antimicrobial resistance'. BMC Med. 2020;18(1):10. DOI ● PubMed ● Google Scholar
12. Ababneh MA, Nasser SA, Rababa'h AM. A systematic review of Antimicrobial Stewardship Program implementation in Middle Eastern countries. Int J Infect Dis. 2021;105:746–52. DOI ● PubMed ● Google Scholar
13. Gillani SW, Shahwan MKS, Szollosi DE. A questionnaire based survey among pharmacy practitioners to evaluate the level of knowledge and confidence towards antimicrobial stewardship. Pharm Pract (Granada). 2022;20(4):2757. DOI ● PubMed ● Google Scholar
14. Chukwu EE, Oladele DA, Enwuru CA, Gogwan PL, Abuh D, Audu RA, et al. Antimicrobial resistance awareness and antibiotic prescribing behavior among healthcare workers in Nigeria: a national survey. BMC Infect Dis. 2021;21(1):22. DOI ● PubMed ● Google Scholar
15. Simegn W, Moges G. Awareness and knowledge of antimicrobial resistance and factors associated with knowledge among adults in Dessie City, Northeast Ethiopia: community-based cross-sectional study. PLoS One. 2022;17(12):e0279342. DOI ● PubMed ● Google Scholar
16. Bassoum O, Ba-Diallo A, Sougou NM, Lèye MM, Diongue M, Cissé NF, et al. Community pharmacists' knowledge, practices and perceptions on antibiotic use and resistance: a cross-sectional, self-administered questionnaire survey, in Guediawaye and Pikine, Senegal. Open J Epidemiol. 2019;9(4):289–308. Google Scholar
17. Ahmed SK, Hussein S, Qurbani K, Ibrahim RH, Fareeq A, Mahmood KA, et al. Antimicrobial resistance: impacts, challenges, and future prospects. J Med Surg Public Health. 2024;2:100081. DOI ● Google Scholar
18. Limato R, Nelwan EJ, Mudia M, Alamanda M, Manurung ER, Mauleti IY, et al. Perceptions, views and practices regarding antibiotic prescribing and stewardship among hospital physicians in Jakarta, Indonesia: a questionnaire-based survey. BMJ Open. 2022;12(5):e054768. DOI ● PubMed ● Google Scholar
19. Md Rezal RS, Hassali MA, Alrasheedy AA, Saleem F, Md Yusof FA, Godman B. Physicians' knowledge, perceptions and behaviour towards antibiotic prescribing: a systematic review of the literature. Expert Rev Anti Infect Ther. 2015;13(5):665–80. DOI ● PubMed ● Google Scholar
20. Chui CSL, Cowling BJ, Lim WW, Hui CKM, Chan EW, Wong ICK, Wu P. Patterns of inpatient antibiotic use among public hospitals in Hong Kong from 2000 to 2015. Drug Saf. 2020;43(6):595–606. DOI ● PubMed ● Google Scholar
21. Al-Halawa DA, Seir RA, Qasrawi R. Antibiotic resistance knowledge, attitudes, and practices among pharmacists: a cross-sectional study in West Bank, Palestine. J Environ Public Health. 2023;2023:2294048. DOI ● PubMed ● Google Scholar
22. Rehman IU, Asad MM, Bukhsh A, Ali Z, Ata H, Dujaili JA, et al. Knowledge and practice of pharmacists toward antimicrobial stewardship in Pakistan. Pharmacy (Basel). 2018;6(4):116. DOI ● PubMed ● Google Scholar
23. Ashiru-Oredope D, Hopkins S, Vasandani S, Umoh E, Oloyede O, Nilsson A, et al. Healthcare workers' knowledge, attitudes and behaviours with respect to antibiotics, antibiotic use and antibiotic resistance across 30 EU/EEA countries in 2019. Euro Surveill. 2021;26(12):1900633. DOI ● PubMed ● Google Scholar
24. Haque M, Rahman NAA, McKimm J, Sartelli M, Kibria GM, Islam MZ, et al. Antibiotic use: a cross-sectional study evaluating the understanding, usage and perspectives of medical students and pathfinders of a public defence university in Malaysia. Antibiotics (Basel). 2019;8(3):154. DOI ● PubMed ● Google Scholar
25. Alnasser AHA, Al-Tawfiq JA, Ahmed HAA, Alqithami SMH, Alhaddad ZMA, Rabiah ASM, et al. Public knowledge, attitude and practice towards antibiotics use and antimicrobial resistance in Saudi Arabia: a web-based cross-

Online ISSN: 2959-4146
Print ISSN: 2959-4138

sectional survey. J Public Health Res. 2021;10(4):2276. DOI ● PubMed ● Google Scholar
26. Waseem H, Ali J, Sarwar F, Khan A, Rehman HSU, Choudri M, et al. Assessment of knowledge and attitude trends towards antimicrobial resistance (AMR) among the community members, pharmacists/pharmacy owners and physicians in district Sialkot, Pakistan. Antimicrob Resist Infect Control. 2019;8:67. DOI ● PubMed ● Google Scholar
27. Halboup A, Abdi A, Ahmed M, Al-Qadasi F, Othman GQ. Access to antibiotics without prescription in community pharmacies in Yemen during the political conflict. Public Health. 2020;183:30–5. DOI ● PubMed ● Google Scholar
28. Al Sulayyim H, Ismail R, Hamid AA, Ghafar NA. Knowledge, attitude and practice of healthcare workers towards antibiotic resistance during the COVID-19 pandemic. JAC Antimicrob Resist. 2023;5(3):dlad068. DOI ● PubMed ● Google Scholar
29. AlAhmad MM, Rabbani SA, Al-Salman R, Alameri H, Al Namer Y, Jaber AAS. Antimicrobial stewardship practices of community pharmacists in United Arab Emirates. Antibiotics (Basel). 2023;12(8):1238. DOI ● PubMed ● Google Scholar
30. Huttner B, Saam M, Moja L, Mah K, Sprenger M, Harbarth S, et al. How to improve antibiotic awareness campaigns: findings of a WHO global survey. BMJ Glob Health. 2019;4(3):e001239. DOI ● PubMed ● Google Scholar
31. Kumar KS, Saranya S, Rani NV. Community pharmacists' knowledge, attitude, and nonprescription dispensing practices of antibiotics: an explorative study in a selected city of South India. J Res Pharm Pract. 2022;11(2):51–8. DOI ● PubMed ● Google Scholar
32. Durand C, Chappuis A, Douriez E, Poulain F, Ahmad R, Lescure FX, et al. Perceptions, current practices, and interventions of community pharmacists regarding antimicrobial stewardship: a qualitative study. J Am Pharm Assoc. 2022;62(4):1239–48.e1. DOI ● PubMed ● Google Scholar
33. Abdel-Qader DH, Albassam A, Ismael NS, El-Shara' AA, Shehri A, Almutairi FS, et al. Awareness of antibiotic use and resistance in Jordanian community. J Prim Care Community Health. 2020;11:2150132720961255. DOI ● PubMed ● Google Scholar
34. Alkubati SA, Saghir SA, Alhariri A, Al-Areefi M, Al-Sayaghi KM, Alsabri M, et al. Prevalence of antibiotic resident bacteria in intensive care units at Hodeida City, Yemen. J Appl Pharm Sci. 2022;12(9):139–45. DOI ● Google Scholar
35. Alshakka M, Badulla WF, Bahattab A, Al-Abd N, Mahmoud MA, Alahmadi Y, et al. Perception and practices of antimicrobial stewardship by community pharmacists in Aden–Yemen. Biomed Res. 2019;30:819–25. Google Scholar
36. Abdul-Ghani R. A national antimicrobial resistance surveillance network in Yemen: an urgent call for action. UST J Med Sci. 2025;3:1. DOI ● Google Scholar
37. Tang KL, Teoh TF, Ooi TT, Khor WP, Ong SY, Lim PP, et al. Public hospital pharmacists' perceptions and knowledge of antibiotic use and resistance: a multicenter survey. Antibiotics (Basel). 2020;9(6):311. DOI ● PubMed ● Google Scholar
38. Alkadhimi A, Dawood OT, Hassali MA. Dispensing of antibiotics in community pharmacy in Iraq: a qualitative study. Pharm Pract (Granada). 2020;18(4):2095. DOI ● PubMed ● Google Scholar
39. Napolitano F, Della Polla G, De Simone C, Lambiase C, Pelullo CP, Angelillo IF. The knowledge, attitudes, and practices of community pharmacists in their approach to antibiotic use: a nationwide survey in Italy. Antibiotics (Basel). 2019;8(4):177. DOI ● PubMed ● Google Scholar
40. Al Masud A, Walpola RL, Sarker M, Asaduzzaman M, Islam MS, Mostafa AT, et al. Antibiotic dispensing practices in community pharmacies: Implications for antimicrobial stewardship in resource-constrained settings. Explor Res Clin Soc Pharm. 2025;19:100606. DOI ● PubMed ● Google Scholar
41. Tanveer A, Kenchey A, Mohammed Z, Lakshmi PK. Assessment of community pharmacists' knowledge, attitude and practice on antibiotics and antibiotic resistance. Saudi J Med Pharm Sci. 2022;8(2):92–8. DOI ● Google Scholar
42. Al-Shami HA, Abubakar U, Hussein MSE, Hussin HFA, Al-Shami SA. Awareness, practices and perceptions of community pharmacists towards antimicrobial resistance and antimicrobial stewardship in Libya: a cross-sectional study. J Pharm Policy Pract. 2023;16(1):46. DOI ● PubMed ● Google Scholar
43. Khan MU, Hassali MA, Ahmad A, Elkalmi RM, Zaidi ST, Dhingra S. Perceptions and practices of community pharmacists towards antimicrobial stewardship in the State of Selangor, Malaysia. PLoS One. 2016;11(2):e0149623. DOI ● PubMed ● Google Scholar
44. Omar B, Birand N, Aydın MD. Assessment of community pharmacists' awareness of antibiotic resistance and practice of antibiotic use for urinary tract infections in North Cyprus. Cyprus J Med Sci. 2024;9(6):398–402. DOI ● Google Scholar
45. Poyongo BP, Sangeda RZ. Pharmacists' knowledge, attitude and practice regarding the dispensing of antibiotics without prescription in Tanzania: an explorative cross-sectional study. Pharmacy (Basel). 2020;8(4):238. DOI ● PubMed ● Google Scholar

To cite this article...

Al-Subol IH, Morad KN, Shafi RA, Al-Jabri SK, Alwajeh RJ, Al-Mashreqi FA, et al. Discrepancy between knowledge and practice regarding antimicrobial resistance among retail pharmacists in Sana'a City, Yemen. UST J Med Sci. 2026;4:4. https://doi.org/10.59222/ustjms.4.4.

Online ISSN: 2959-4146
Print ISSN: 2959-4138