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Original Article

Knowledge, Awareness, and Attitudes toward Antibiotic Use and Antimicrobial Resistance among Eastern Province Population in Saudi Arabia: Observational Cross-Sectional Study

Esraa Mohammad Haji*

Department of Pharmaceutical Chemistry, College of Pharmacy, University of Hafr Al Batin, Hafr Al Batin, SAUDI ARABIA.

ABSTRACT

Background: Inappropriate use of antibiotics is a public health problem of great concern. Public knowledge is considered a prerequisite for the appropriate use of antibiotics and the limited spread of antibiotic resistance. Hence, the present study is planned to evaluate the level of knowledge, beliefs, attitudes, and behaviors toward antibiotic resistance among the Saudi public in the eastern province of Saudi Arabia. **Materials and Methods:** An observational cross-sectional study was conducted in the eastern province of Saudi Arabia using a self-administered questionnaire in Arabic language and all data were analyzed by SPSS version 28. **Results:** The study's sample comprised 421 participants, with a higher representation of females (65.1%) compared to males (34.9%). The study revealed several significant factors influencing knowledge and attitudes towards antibiotic use and Antimicrobial Resistance (AMR). Married individuals demonstrated better knowledge about antibiotics (OR: 1.1, p=0.01), while those with higher education levels exhibited greater knowledge (OR: 1.1, p=0.01). Conversely, those with a bachelor's degree showed lower knowledge (OR: 0.1, p=0.01). Education level also influenced attitudes, with higher education linked to more positive attitudes towards antibiotic use (OR: 0.9, p=0.02). **Conclusion:** The overall level of knowledge was moderate and attitude towards the use of antibiotics was negative, so this mandates public health awareness intervention programs to be implemented on the use of antibiotics.

Keywords: Knowledge, Attitude, Antibiotics, Saudi Arabia, Antibiotic resistance.

Correspondence:
Dr. Esraa Mohammad Haji
Department of Pharmaceutical Chemistry, College of Pharmacy, University of Hafr Al Batin, Hafr Al Batin-39524, SAUDI ARABIA.
Email: emhaji@uhb.edu.sa.

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INTRODUCTION

Antimicrobial Resistance (AMR) is a critical global health issue, with the World Health Organization (WHO) estimating that bacterial AMR directly caused 1.27 million deaths worldwide in 2019 (Tang *et al*., 2023). Antibiotic resistance is an escalating concern in the global health arena. The issue mostly arises from the improper use of antibiotics, resulting in the resistance of pathogens, including bacteria and fungi, to the medications intended to eliminate them (Salam *et al*., 2023). The mechanism of antibiotic action necessitates meticulous administration and supervision of drug intake to guarantee alignment with the condition being treated (Alara and Alara, 2024). This would guarantee that the antimicrobial user recovers effectively from the illness and does not acquire resistance to the medication, so preserving its efficacy for future treatment (Shibabaw). Antibiotic resistance is lethal since infections become refractory to the medications intended to eradicate them, necessitating other treatment options that are often inaccessible. Consequently, patients who acquire antibiotic resistance jeopardize their chances of obtaining appropriate treatment in the future, as the developed resistance undermines the efficacy of the medications.

Antibiotic resistance represents a significant threat to human health in contemporary society (Bakri *et al*., 2024). According to the most recent Saudi census, Saudi nationals represented approximately 68.9% of the total population, which is 27.1 million, while the expatriate (non-Saudi) population constituted 31.1% of the total population of Saudi Arabia (Khraif *et al*., 2016). The non-Saudi population exhibits unique racial, socioeconomic, and demographic traits; consequently, the healthcare received, therapeutic responses, and clinical outcomes may vary when compared to Saudi nationals (AlFaleh *et al*., 2015).

The non-prescription dispensing of antibiotics constitutes a significant public health issue in Saudi Arabia, raising concerns

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regarding its role in the proliferation of antimicrobial-resistant pathogens and the emergence of antimicrobial resistance (Al-Jedai *et al*., 2022; Kanan *et al*., 2023).

In Saudi Arabia, the prevalence of antibiotic-resistant bacteria is notably high, with resistance rates ranging from 7.6% to 92.3% among various bacterial strains (Thabit *et al*., 2023). This situation is exacerbated by factors such as the overuse and misuse of antibiotics, including nonprescription use, which has been reported at rates of 23.6% to 28.8% in different regions of the country (Bhat *et al*., 2023).

Addressing these challenges in Saudi Arabia's Eastern Province requires comprehensive public education and stringent policy interventions to mitigate the escalating threat of AMR. The availability of antibiotics among the Saudi population is unregulated and not subject to prescription requirements (Al-Mehmadi *et al*., 2023). Antibiotic agents are readily available to the public and purchased without a prescription. The availability of free access to antibiotics alters the framework for antibiotic-related interventions in Saudi Arabia. Research indicates that awareness of antibiotic resistance among patients and the public is limited (Alajel *et al*., 2023), highlighting antimicrobial resistance as a growing and significant issue.

There is a limited number of published studies in Saudi Arabia that assess medication compliance among patients, as well as the public's knowledge and attitude regarding drug use, including the use of antibiotics and resistance. The public significantly contributes to mitigating the misuse and overuse of antibiotics. It is essential to evaluate the public's knowledge and attitudes regarding antibiotic use to determine the educational needs of the population. The objective of this study was to assess the knowledge and attitude of individuals in the Eastern Province of Saudi Arabia regarding antibiotic resistance, as well as to evaluate their attitudes and behaviors related to antibiotic use and antibacterial resistance.

METHODOLOGY

Study Design

This observational cross-sectional study was conducted during a period of six months from May 2024 to October 2024 in the eastern province of Saudi Arabia using a validated questionnaire. The inclusion criteria for this study were Saudi males and females of the age of 18 years and above.

Study instrument and translation

The survey instrument was developed based on previous literature about antibiotic and antibiotic resistance (Al-Mehmadi *et al*., 2024; Alnasser *et al*., 2021).

Three researchers reviewed the questionnaire tool to evaluate the questions' appropriateness, relevancy, clarity, and adequacy. The survey instrument consisted of 25 questions, including socio-demographic characteristics, knowledge about antibiotics, antibiotic resistance (three items), and awareness regarding the use of antibiotics. The original form of the survey was written in the English language. After that, a certified translator translated it into Arabic and put it through a backwards-to-forward translation process. Translators who had sector-specific knowledge and experience in translating surveys where their mother tongues were Arabic, performed the forward translation. A second translator whose native language is English was brought in to translate the questionnaire back into the original language after the authors had received the first translation.

The questionnaire was distributed online to a random sample of people living in different regions of the eastern province of Saudi Arabia. All participants were asked to answer all questions and incomplete questionnaires were omitted from the study.

Data Analysis

All data were analyzed by using SPSS version 28 (IBM, Chicago, IL). The suggestive analysis was used to pick the demographic information in rates and percentages. The association was analyzed by logistic regression. A p-value of <0.05 was considered statistically significant (Sharma, 2021).

RESULTS

Socio-demographic characteristics

The study's sample comprised 421 participants, with a higher representation of females (65.1%) compared to males (34.9%). Age distribution indicated that nearly half of the respondents (47.0%) were over 40 years old, while 27.1% were between 31 and 40, and 25.9% were aged 18 to 30. In terms of marital status, a majority were married (59.1%), followed by single (24.9%), widowed (8.3%), and divorced individuals (7.6%). Educational attainment varied, with 36.8% having higher education, 33.0% holding a diploma, 22.3% possessing a bachelor's degree, and 7.8% completing high school. Employment status revealed that a significant majority were employed (92.9%), leaving a small proportion unemployed (7.1%). The results are explained in Table 1.

Source of Information regarding the use of antibiotics

In Figure 1, respondents showed that around 32% of patients were aware of the use of antibiotics through doctors, 31% through pharmacists, 16% through nurses, 20% through the Internet, and 4% through media.

Knowledge of the participants about antibiotics and antibiotic resistance

The findings highlight substantial knowledge gaps regarding antibiotics and antimicrobial resistance among respondents. While 55.4% correctly identified antibiotics as effective against

bacterial infections, 29.9% were uncertain, and 12.8% believed they worked for both bacterial and viral infections. Over half (51.3%) thought antibiotics should be used whenever feeling sick, while only 36.1% recognized the importance of a prescription. A significant 81.2% mistakenly believed it was safe to stop antibiotics upon feeling better. Most respondents (79.1%) understood that taking antibiotics without a prescription is risky, and 74.8% recognized misuse could cause resistance or side effects. However, confusion about antimicrobial resistance persisted, with 29.0% attributing it to bodily resistance and only 27.1% identifying bacterial resistance as the correct cause. While 66.3% understood antimicrobial resistance complicates treatment, 34.2% were unaware that misuse contributes to resistance. Additionally, 50.1% acknowledged resistance as a global issue affecting Saudi Arabia, yet only 15.7% felt knowledgeable about Antibiotic Stewardship Programs, though 51.5% believed these programs improve antibiotic use. The results are explained in Table 2.

The attitude of respondents towards antibiotics and antibiotic resistance

The results reveal diverse practices and attitudes toward antibiotic use and antimicrobial resistance. Pharmacies with prescriptions were the most common source of antibiotics (49.7%), while 25.4% obtained them without prescriptions, and 21.1% relied on family or friends. A strong majority (82.7%) disagreed with acquiring antibiotics without prescriptions, and 73.9% reported strict adherence to prescribed durations. Antimicrobial resistance was acknowledged as a serious global issue by 78.9%, with 68.2% agreeing that overuse reduces future effectiveness. Personal susceptibility to resistance was recognized by 49.6%, while 77.9% agreed that healthcare workers play a crucial role in combating bacterial resistance. However, misconceptions remain, with 35.9% agreeing that resistance primarily affects frequent antibiotic users. The results are explained in Table 3.

Association between socio-demographic characteristics knowledge and the attitude of respondents towards antibiotics and antibiotic resistance

The analysis reveals significant associations between demographic factors and both knowledge and attitudes toward antibiotic use and antimicrobial resistance. Males exhibited higher odds of possessing knowledge (OR: 1.6; 95% CI: 1.2-1.9; p=0.001) compared to females. Age group 18-30 showed significantly

Table 1: Socio-demographic characteristics of respondents.

Variables	Frequency (n)	Percentage (%)
Gender		
Male	147	34.9
Female	274	65.1
Age		
18-30	109	25.9
31-40	114	27.1
>40	198	47.0
Marital status		
Single	105	24.9
Married	249	59.1
Divorced	32	7.6
Widowed	35	8.3
Education		
High Education	155	36.8
Bachelors	94	22.3
Diploma	139	33.0
High School	33	7.8
Occupation		
Employed	391	92.9
Unemployed	30	7.1

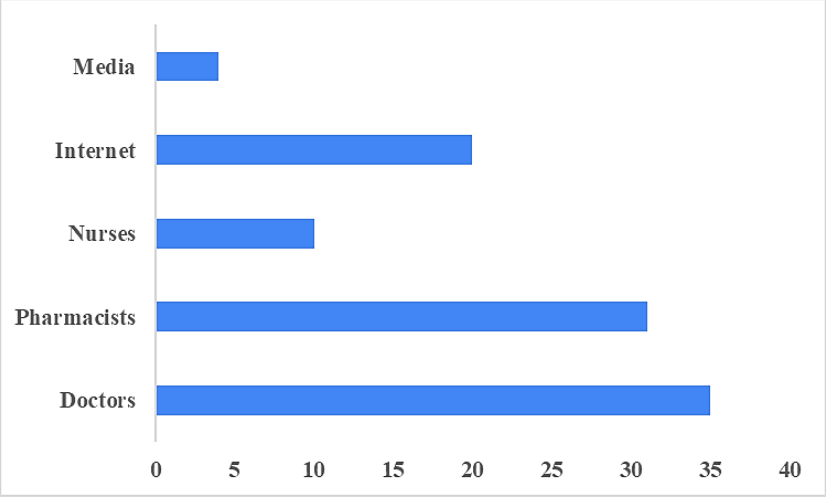

Figure 1: Source of information regarding the knowledge of Antibiotics.

Table 2: Participants' knowledge about antibiotics and antibiotic resistance.

Characteristics	Response
Antibiotics can treat:	
Bacterial infections	233 (55.4)
Viral infections	8 (1.9)
Both bacterial and viral infections	54 (12.8)
I don't know	126 (29.9)
When should antibiotics be used?	
Only when prescribed by a healthcare provider	152 (36.1)
Whenever I feel sick	216 (51.3)
To prevent sickness	43 (10.2)
I don't know	10 (2.4)
Is it safe to stop taking antibiotics once you feel better?	
Yes	342 (81.2)
No	63 (15.0)
I don't know	16 (3.8)
Taking antibiotics without a prescription is:	
Safe and effective	63 (15.0)
Risky and can cause harm	333 (79.1)
I don't know	25 (5.9)
Misuse of antibiotics can lead to side effects such as:	
Stomach upset or allergies	315 (74.8)
Development of resistance to antibiotics	10 (2.4)
Both of the above	80 (19.0)
I don't know	16 (3.8)
Antimicrobial resistance happens when:	
The body becomes resistant to antibiotics	122 (29.0)
Bacteria become resistant to antibiotics	114 (27.1)
Antibiotics lose their strength over time	118 (28.0)
I don't know	67 (15.9)
Misuse of antibiotics (e.g., not completing the course or taking without a prescription) contributes to antimicrobial resistance:	
Yes	136 (32.3)
No	141 (33.5)
I don't know	144 (34.2)
Antimicrobial resistance makes infections:	
Easier to treat	84 (20.0)
Harder to treat	279 (66.3)
I don't know	58 (13.8)
Antimicrobial resistance is a global health issue that affects Saudi Arabia:	
Yes	211 (50.1)
No	133 (31.6)
I don't know	77 (18.3)
I have sufficient knowledge about the Antibiotic Stewardship Program	
Yes	66 (15.7)
No	174 (41.3)
I don't know	181 (43.0)
I believe the Antibiotic Stewardship Program improves the optimal use of antibiotics.	
Yes	217 (51.5)
No	68 (16.2)
I don't know	136 (32.3)

lower odds of a positive attitude (OR: 0.6; 95% CI: 0.4-0.8; p=0.001) relative to those over 40. Married individuals had significantly lower odds of knowledge (OR: 0.1; 95% CI: 0.1-0.2; p=0.01) but higher odds of a positive attitude (OR: 1.2; 95% CI: 1.1-1.6; p=0.01) compared to widowed participants. Regarding education, those with higher education (OR: 0.1; 95% CI: 0.1-0.2; p=0.01) and bachelor's degrees (OR: 0.7; 95% CI: 0.5-0.9; p=0.01) had significantly lower odds of knowledge compared to high school graduates. Employment status also influenced outcomes, with employed individuals showing significantly lower odds of both knowledge (OR: 0.1; 95% CI: 0.1-0.9; p=0.01) and a positive attitude (OR: 0.1; 95% CI: 0.1-0.8; p=0.001) compared to unemployed counterparts. These findings suggest that targeted educational interventions may be necessary to address specific demographic disparities in knowledge and attitudes toward antibiotic use and resistance. These results are explained in Table 4.

Association between knowledge, attitude, and demographic characteristics using Multivariate logistic regression

In Table 5, Married individuals have higher odds of possessing knowledge compared to their unmarried counterparts (Adjusted OR: 1.1; 95% CI: 1.0-1.3; p=0.01). Similarly, those with higher education levels exhibit increased odds of knowledge (Adjusted OR: 1.1; 95% CI: 1.1-1.92; p=0.01). Conversely, individuals holding a bachelor's degree show lower odds of knowledge relative to those with only a high school education (Adjusted OR: 0.1; 95% CI: 0.1-0.9; p=0.01). No significant associations are observed between the examined variables and attitudes toward antibiotic use and resistance, as indicated by p-values greater than 0.05.

DISCUSSION

This study highlights critical insights into knowledge and attitudes toward antibiotic use and AMR among the population in the Eastern Province of Saudi Arabia, revealing both significant

Table 3: Participants' attitude about antibiotics and antibiotic resistance.

Characteristics	Responses
Where do you usually get antibiotics?	
Pharmacy (with prescription)	209 (49.7)
Pharmacy (without prescription)	107 (25.4)
Leftover from previous illness	16 (3.8)
Shared by family/friends	89 (21.1)
I usually get antibiotics without a prescription.	
Strongly agree	11 (2.6)
Agree	15 (3.6)
Neutral	11 (2.6)
Disagree	348 (82.7)
Strongly disagree	36 (8.6)
I usually adhere to the duration of antibiotics prescribed by the doctor or pharmacist.	
Strongly agree	311 (73.9)
Agree	28 (6.7)
Neutral	48 (11.4)
Disagree	30 (7.1)
Strongly disagree	4 (1.0)
The development of antimicrobial resistance is a serious global health issue:	
Strongly agree	332 (78.9)
Agree	69 (16.4)
Neutral	4 (1.0)
Disagree	13 (3.1)
Strongly disagree	3 (0.7)
Overuse of antibiotics can lead to reduced effectiveness in the future	
Strongly agree	53 (12.6)
Agree	287 (68.2)
Neutral	13 (3.1)
Disagree	60 (14.3)
Strongly disagree	8 (1.9)
Antibiotic resistance is a problem that can affect me or my family	
Strongly agree	209 (49.6)
Agree	184 (43.7)
Neutral	9 (2.1)
Disagree	10 (2.4)
Strongly disagree	9 (2.1)
Antibacterial resistance is the only problem for people who regularly take antibiotics	
Strongly agree	151 (35.9)
Agree	111 (26.4)
Neutral	61 (14.5)
Disagree	90 (21.4)
Strongly disagree	8 (1.9)
Healthcare workers can help in limiting bacterial resistance	
Strongly agree	328 (77.9)
Agree	31 (7.4)
Neutral	32 (7.6)
Disagree	24 (5.7)
Strongly disagree	6 (1.4)

gaps and positive trends. A notable proportion of participants (25.4%) reported obtaining antibiotics without a prescription, reflecting the persistence of self-medication practices, which are comparable to findings from studies in the western region of Saudi Arabia and other Middle Eastern countries where non-prescription antibiotic use is common (Almaghrabi, 2024; Muflih *et al*., 2023). Misconceptions were evident, with 51.3% believing antibiotics should be taken whenever sick, a behavior that aligns with reports from similar regions and underscores the need for public education (Gautham *et al*., 2024).

A majority of respondents (55.4%) correctly identified that antibiotics treat bacterial infections, while a significant portion (12.8%) mistakenly believed antibiotics could treat both bacterial and viral infections, highlighting the need for better education on this critical distinction. Similar findings have been reported in previous studies, where confusion between bacterial and viral infections was prevalent among the general population (Liu *et al*., 2021; Claassen-Weitz *et al*., 2021). Furthermore, 81.2% of participants acknowledged the importance of completing an antibiotic course, which is consistent with global guidelines that emphasize the risks of premature cessation of antibiotic therapy (WHO, 2022; Grant *et al*., 2022). However, the study also revealed concerning gaps, such as the fact that only 32.3% of participants understood the role of antibiotic misuse in contributing to AMR, a major global health challenge. This is in line with research by Tang *et al*., (2023), which suggests that awareness of AMR and its consequences remains limited among the public (Tang *et al*., 2023). Notably, while a majority (79.1%) of respondents recognized the risks of taking antibiotics without a prescription, there was a significant portion (33.5%) who were unsure about the impact of misuse on AMR, indicating the need for more targeted educational campaigns. Regarding the Antibiotic Stewardship Program, although over half (51.5%) of participants believed it enhances the optimal use of antibiotics, 43% lacked sufficient knowledge about the program, suggesting a gap in awareness that needs to be addressed through healthcare outreach initiatives (Akkawi *et al*., 2022).

Table 4: Association between knowledge, attitude, and demographic characteristics using Univariate logistic regression.

Variables	Knowledge		Attitude	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Gender				
Male	1.6 (1.2- 1.9)	0.001	0.2 (0.1- 1.01)	0.7
Female	1		1	
Age				
18-30	1.0 (0.7- 1.3)	0.9	0.6 (0.4-0.8)	0.001
31-40	1.1 (0.7- 1.6)	0.5	0.1 (1.2-2.3)	0.2
>40	1		1	
Marital status				
Single	0.8 (0.6-1.2)	0.4	0.1 (0.2-1.7)	0.8
Married	0.1 (0.1- 0.2)	0.01	1.2 (1.1-1.6)	0.01
Divorced	0.8 (0.3-1.7)	0.2	0.2 (0.1-1.9)	0.1
Widowed	1		1	
Education				
High Education	0.1 (0.1- 0.2)	0.01	1.9 (0.4- 1.9)	0.7
Bachelors	0.7 (0.5- 0.9)	0.01	0.2 (0.1-0.5)	0.01
Diploma	0.8 (0.6- 1.5)	0.2	0.1 (0.1-2.1)	0.8
High School	1		1	
Occupation				
Employed	0.1 (0.1- 0.9)	0.01	0.1 (0.1-0.8)	0.001
Unemployed	1		1	

A significant portion of participants (49.7%) reported obtaining antibiotics from pharmacies with prescriptions, while a concerning 25.4% accessed antibiotics without prescriptions, and 21.1% relied on leftover antibiotics from previous illnesses or shared them with family and friends. This aligns with studies from other countries where unregulated access to antibiotics was found to be a contributing factor to the rise of AMR (Endale *et al*., 2023; Sulis *et al*., 2022). Interestingly, 82.7% of respondents stated they disagreed with obtaining antibiotics without a prescription, suggesting that while there is some awareness of the risks, access to antibiotics outside of formal healthcare channels remains prevalent. Participants widely recognized the serious global health threat posed by AMR, with 95.3% either strongly agreeing or agreeing, which is consistent with previous studies that emphasize public awareness of AMR (Bertagnolio *et al*., 2024). However, while 80.8% of participants agreed that overuse of antibiotics can reduce their effectiveness, the perception that antibiotic resistance is a problem that only affects regular antibiotic users was held by 62.3% of participants, reflecting a common misconception that AMR is not an immediate concern for infrequent users. This highlights a need for more widespread public health education regarding the universal threat of AMR (Al-Haboubi *et al*., 2021). In multi-logistic regression analysis, age did not show a significant association with either knowledge or attitude, suggesting that age may not play a major role in influencing these aspects within the studied population. However, marital status and education level were found to be significant factors influencing knowledge and attitudes. Specifically, married individuals had better knowledge about antibiotic use (adjusted odds ratio [OR]: 1.1, 95% CI: 1.0-1.3, *p*-value: 0.01), aligning with prior research that indicates marital status as a potential determinant of health-related knowledge due to increased household responsibilities (Zanobini *et al*., 2021; Jilani *et al*., 2021). Education level also emerged as a key factor, with those having higher education levels demonstrating significantly better knowledge (adjusted OR: 1.1, 95% CI: 1.1-1.92, *p*-value: 0.01), while those with a bachelor's degree showed lower knowledge levels (adjusted OR: 0.1, 95% CI: 0.1-0.9, *p*-value: 0.01). This finding contrasts with previous studies that suggest bachelor's degree holders tend to have higher health knowledge (Ashiru-Oredope *et al*., 2021), indicating that in this specific context, the effect of education on antibiotic knowledge might vary based on other factors such as health literacy or the quality of education received.

The study's strength lies in its large sample size and comprehensive analysis, offering valuable insights into demographic and socioeconomic determinants of antibiotic knowledge and attitudes. However, the cross-sectional design limits causal inferences, and self-reported data may be prone to recall or social

Table 5: Association between knowledge, attitude, and demographic characteristics using Multivariate logistic regression.

Variables	Knowledge		Attitude	
	Adjusted Odds ratio (95% CI)	p-value	Adjusted Odds ratio (95% CI)	p-value
Age				
18-30	------	------	1.2 (0.4-1.2)	0.1
Marital status				
Married	1.1 (1.0- 1.3)	0.01	0.2 (0.1-1.2)	0.1
Education				
High Education	1.1 (1.1- 192)	0.01	0.9 (0.4- 0.9)	0.02
Bachelors	0.1 (0.1- 0.9)	0.01	0.2 (0.2-1.5)	0.1
Occupation				
Employed	1.1 (0.1- 2.9)	0.9	0.9 (0.1-1.3)	0.8

desirability bias. Additionally, the study did not explore healthcare provider influences or the role of policy enforcement in curbing non-prescription antibiotic sales, which could have provided a more holistic understanding. Despite these limitations, the findings emphasize the urgent need for targeted interventions, such as public health campaigns and stricter enforcement of prescription-only antibiotic sales, to enhance knowledge, reshape attitudes, and address the growing threat of AMR in the region.

CONCLUSION

Participants reported having moderate knowledge and a negative attitude toward antibiotic use and resistance. Thus, healthcare personnel should provide patients with comprehensive information on the proper administration and intake of antibiotics. Paired with these efforts to educate patients on proper antibiotic usage, there should also be tighter controls regarding the administration of antibiotics, including extensive evaluation of whether a case can be treated only with antibiotics or not; and reducing the cases of using antibiotics unnecessarily. Additionally, local governments are required to spread awareness about AMR by setting up educational campaigns and following WHO recommendations by ensuring a robust national action plan to tackle antibiotic resistance is in place and regulate and promote the appropriate use and disposal of quality medicines.

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During the preparation of this manuscript/study, the author did not used any AI tool. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

ABBREVIATIONS

AMR: Antimicrobial Resistance; **WHO:** World Health Organization; **SPSS:** Statistical Package for the Social Sciences; **OR:** Odds Ratio; **CI:** Confidence Interval; **IBM:** International Business Machines.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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DATA AVAILABILITY STATEMENT

All data is contained in the manuscript and data does not contains any supplementary files

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