



A Cross-Sectional Study of Community Knowledge and Behaviors Regarding Antibiotic Use and Antimicrobial Resistance Among the General Population

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ABSTRACT

Background: Antimicrobial resistance (AMR) is a major global public health concern, driven partly by inappropriate antibiotic use, self-medication, and non-prescription access to antibiotics. Understanding community knowledge and behaviors regarding antibiotic use is essential for developing effective antimicrobial stewardship interventions. **Objective:** To assess knowledge, attitudes, and practices (KAP) regarding antibiotic use and antimicrobial resistance among the general adult population in Diyala Governorate, Iraq, and to examine their associations with selected sociodemographic characteristics. **Methods:** A community-based cross-sectional study was conducted among 250 participants aged ≥ 15 years from urban, semi-urban, and rural areas of Diyala Governorate. Participants were recruited using quota-based convenience sampling. Data were collected using a structured questionnaire comprising sociodemographic and background characteristics and 28 KAP items: 10 knowledge, 8 attitude, and 10 practice items. Descriptive statistics, Pearson's chi-square test, Cramér's V, Benjamini–Hochberg false discovery rate correction, and Spearman's rank correlation were used for statistical analysis. **Results:** The mean knowledge, attitude, and practice scores were 5.88/10 (58.8%), 5.57/8 (69.7%), and 6.08/10 (60.8%), respectively, while the overall KAP score was 17.54/28 (62.6%). Overall KAP was moderate in 61.2% of participants. Although 74.0% recognized that unnecessary antibiotic use contributes to AMR, only 44.0% correctly identified that antibiotics are ineffective against viral infections and 41.2% understood that resistance develops in microorganisms rather than the human body. Inappropriate practices included obtaining antibiotics from pharmacies without a physician's prescription (53.2%), stopping or reducing treatment after symptom improvement (51.6%), and using antibiotics for cold or influenza symptoms (45.2%). Knowledge was significantly associated with educational level, health-related educational background, and residence after false discovery rate adjustment. Significant positive correlations were observed among knowledge, attitude, and practice scores. **Conclusion:** The findings indicate moderate overall KAP regarding antibiotic use and AMR, with relatively favorable attitudes but important gaps in knowledge and antibiotic-use practices. Misconceptions regarding viral infections and antimicrobial resistance, together with non-prescription antibiotic use and inappropriate treatment behaviors, highlight the need for targeted community education and strengthened antimicrobial stewardship and antibiotic-dispensing practices in Diyala Governorate. **Keywords:** Antibiotics; Antimicrobial resistance; Knowledge; Attitudes; Practices; Self-medication; General population.

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INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the most important global public health challenges, threatening the effective treatment of infectious diseases and increasing the risk of prolonged illness, treatment failure, disability, and mortality. Although antimicrobial resistance is a naturally occurring evolutionary process, its emergence and spread are substantially accelerated by the misuse and overuse of antimicrobial agents. Recent global surveillance data indicate that approximately one in six laboratory-confirmed bacterial infections worldwide in 2023 was resistant to antibiotic treatment, while bacterial AMR was estimated to be associated with more than 4.7 million deaths globally in 2021 [1].

Antibiotics are essential medicines for treating bacterial infections; however, their inappropriate use in the community creates selective pressure that facilitates the emergence and dissemination of resistant bacteria. Inappropriate behaviors may include using antibiotics when they are not clinically indicated, using them for viral illnesses such as colds and influenza, obtaining antibiotics without appropriate medical guidance, and using antibiotics incorrectly. The World Health Organization has emphasized that misuse and overuse of antibiotics remain major drivers of AMR and that improving appropriate antimicrobial use is essential for preserving the effectiveness of existing treatments [1,2].

Public understanding and behavior are therefore important components of efforts to control antibiotic resistance. Knowledge about the appropriate indications for antibiotics can influence decisions regarding when and how these medicines are used, while attitudes toward prescribing, professional medical advice, and antibiotic resistance may influence actual practices. Nevertheless, misconceptions remain widespread. A multicountry survey involving 8,221 participants across 14 countries in the

WHO European Region found that 84% of participants lacked adequate knowledge regarding appropriate antibiotic use, and antibiotics were frequently reported as being used for conditions such as colds, sore throat, cough, and influenza [3]. Similarly, studies from Arab populations have demonstrated misconceptions concerning antibiotic indications, including their use for fever and viral infections [4].

Patterns of antibiotic-related knowledge and behavior may also vary according to sociodemographic and contextual characteristics. Educational level, age, income, access to healthcare, and exposure to health information may influence knowledge and practices, while the characteristics of local healthcare systems can affect how individuals obtain and use antibiotics. Place of residence may be particularly relevant because urban and rural populations can differ in healthcare accessibility, socioeconomic conditions, and opportunities to receive reliable health information. Previous research comparing urban and rural populations has reported differences in overall antibiotic knowledge and demonstrated associations between knowledge and factors such as education, income, employment, and contact with healthcare-related professions [5]. These findings support the importance of examining residential setting when assessing community antibiotic use.

Evidence from Iraq and neighboring populations also indicates that inappropriate antibiotic-related knowledge and practices remain a concern. An earlier study among Iraqis reported important gaps in understanding appropriate antibiotic use and the causes of antimicrobial resistance, including substantial misconceptions regarding the use of antibiotics for viral diseases [6]. More recent Iraqi research has continued to demonstrate a gap between knowledge and appropriate antibiotic-use

practices, even among medically educated populations [7]. However, further community-based evidence is needed to characterize knowledge, attitudes, and practices among the general population and to explore potential differences across urban, semi-urban, and rural settings.

Therefore, the present study aims to assess knowledge, attitudes, and practices regarding antibiotic use and antimicrobial resistance among individuals aged 15 years and older and to investigate their associations with selected sociodemographic characteristics and area of residence. Identifying gaps in public knowledge and inappropriate antibiotic-use behaviors may provide useful evidence for developing targeted educational interventions and supporting community-level antimicrobial stewardship strategies.

MATERIALS AND METHODS

Study Design and Setting

A community-based cross-sectional study conducted in Diyala Governorate, Iraq, from November 1, 2026, to June 1, 2027, to assess knowledge, attitudes, and practices (KAP) regarding antibiotic use and antimicrobial resistance (AMR) among the adult general population. Participants will be recruited from selected urban, semi-urban, and rural areas of Diyala Governorate to ensure representation of populations from different residential settings.

Study Population

The study population consist of participants aged 15 years and older residing in Diyala Governorate. A total of 250 participants are included from urban, semi-urban, and rural communities.

Inclusion and Exclusion Criteria

Individuals are eligible for participation were aged 15 years or older, currently reside in Diyala Governorate, and they were able to understand and complete the questionnaire, and voluntarily agree to participate. Individuals younger than 15 years, residents outside Diyala Governorate, those who decline

participation, and participants who submit substantially incomplete questionnaires were excluded from the final analysis.

Sample Size and Sampling Technique

A total sample of 250 participants is recruited using a quota-based convenience sampling technique. Recruitment was distributed approximately equally across the three residential categories, with about 83–84 participants from each of the urban, semi-urban, and rural areas.

Eligible adults available at selected community locations are invited to participate until the required quota for each residential category is reached. This approach ensured adequate representation of the three residential settings and facilitate comparisons of antibiotic-related knowledge, attitudes, and practices according to place of residence.

Data Collection Instrument

Data were collected using a structured questionnaire developed and adapted from previously published questionnaires assessing public knowledge, attitudes, and practices regarding antibiotic use and AMR. The questionnaire reviewed and adapted to ensure clarity and relevance to the local population. The questionnaire consisted of a sociodemographic and background information section followed by three KAP domains: knowledge, attitudes, and practices regarding antibiotic use and antimicrobial resistance.

The KAP component contained 28 items, including 10 knowledge items, 8 attitude items, and 10 practice items.

Sociodemographic and Background Information

The first section will collect information on participants' age, gender, place of residence, educational level, occupation, marital status, presence of chronic disease, health-related educational background, presence of a healthcare worker in the family, antibiotic use during the previous 12 months, and main source of antibiotics.

Place of residence will be classified as urban, semi-urban, or rural.

Assessment of Knowledge

The knowledge domain consist of 10 items evaluating participants' understanding of appropriate antibiotic use and basic concepts of antimicrobial resistance. The items covered the effectiveness of antibiotics against bacterial and viral infections, unnecessary antibiotic use, development and transmission of resistant bacteria, adverse effects of antibiotics, and consequences of inappropriate antibiotic use.

Responses were recorded as "True," "False," or "Do not know," as appropriate. Each correct answer was receive one point, while incorrect and "Do not know" responses received zero points. The total knowledge score will range from 0 to 10, with higher scores indicating better knowledge.

Assessment of Attitudes

The attitude domain contain eight items assessing participants' beliefs and perceptions regarding appropriate antibiotic use and AMR. The items address the importance of professional medical advice, expectations regarding antibiotic prescribing, availability of antibiotics without prescription, sharing antibiotics, individual responsibility for appropriate antibiotic use, and perceptions of AMR as a public health problem.

Responses were assessed using a Likert-type scale. Negatively worded items will be reverse-coded when necessary so that higher scores consistently represent more appropriate attitudes toward antibiotic use and AMR prevention.

Assessment of Practices

The practice domain contain 10 items evaluating participants' antibiotic-use behaviors, including self-medication, obtaining antibiotics without a physician's prescription, using antibiotics for symptoms of cold or influenza, stopping or reducing treatment after symptomatic improvement, retaining or reusing leftover antibiotics, sharing antibiotics,

independently changing antibiotic type or dosage, following treatment instructions, and seeking professional healthcare advice.

Responses were coded so that appropriate practices receive higher scores, with higher total scores indicating more appropriate antibiotic-use practices.

KAP Scoring and Classification

Separate scores were calculated for the knowledge, attitude, and practice domains, and an overall KAP score will be derived from the combined domain scores.

For descriptive and comparative analyses, the scores categorized into poor, moderate, and good levels using predefined cut-off points based on the scoring system of the adopted questionnaire and relevant published literature. The scoring criteria were established before analysis of the final study data to avoid data-driven classification.

Questionnaire Review and Pilot Study

Before the main data collection, the questionnaire was reviewed by a panel of experts in relevant disciplines to assess its clarity, relevance, comprehensibility, and content appropriateness for the target population.

A pilot study was then be conducted among a small group of adults with characteristics similar to those of the target population. The pilot study assessed the clarity of the questions, appropriateness of response options, feasibility of administration, and approximate time required to complete the questionnaire.

Participants included in the pilot study were not be included in the final sample of 250 participants. Necessary modifications were made based on expert review and pilot feedback before the main survey begins.

Data Collection Procedure

Eligible participants from the selected urban, semi-urban, and rural areas were approached and informed about the objectives of the study. Participation were voluntary, and

informed consent was obtained before questionnaire completion.

The questionnaire administered using a standardized procedure. No personally identifying information were included in the analytical dataset. Completed questionnaires was reviewed for completeness before data entry and statistical analysis.

Study Variables

The primary outcome variables include knowledge score, attitude score, practice score, overall KAP score, and their corresponding categorical levels (poor, moderate, and good).

The explanatory variables include age, gender, place of residence, educational level, occupation, marital status, chronic disease status, health-related educational background, presence of a healthcare worker in the family, antibiotic use during the previous 12 months, and main source of antibiotics.

Statistical Analysis

Data will be entered, cleaned, and analyzed using IBM SPSS Statistics.

Categorical variables will be summarized as frequencies and percentages, whereas continuous variables will be described using the mean and standard deviation (SD). The median and interquartile range (IQR) will also be reported when appropriate.

The Pearson chi-square test will be used to assess associations between categorical participant characteristics and knowledge, attitude, practice, and overall KAP levels. Cramér's V will be calculated as a measure of effect size for relevant categorical associations. Because multiple comparisons will be performed when examining associations between participant characteristics and the different KAP domains, the Benjamini–Hochberg false discovery rate (FDR) procedure will be applied where appropriate to reduce the likelihood of false-positive findings due to multiple testing.

Relationships among the continuous knowledge, attitude, practice, and overall KAP

scores will be assessed using Spearman's rank correlation coefficient (ρ).

All statistical tests will be two-sided, and a P-value < 0.05 will be considered statistically significant. For analyses subjected to multiple-comparison correction, the corresponding FDR-adjusted P-values will be used to determine statistical significance.

Ethical Considerations

Ethical approval was obtained from the appropriate Institutional Research Ethics Committee in Iraq before commencement of data collection.

All participants received information regarding the objectives of the study and the voluntary nature of participation. Informed consent was obtained from each participant before enrollment. Participants had the right to decline participation or withdraw without consequences.

Confidentiality and anonymity were maintained throughout data collection, analysis, and reporting. No personally identifying information were reported, and all collected information were used solely for scientific research purposes.

RESULTS

Sociodemographic and Background Characteristics

A total of 250 participants were included in the analysis. The mean age of the participants was 32.61 ± 13.92 years, with a median age of 30 years (IQR: 21–42). The largest proportion of participants belonged to the 15–24-year age group (35.2%), followed by those aged 25–34 years (29.6%). Females represented 51.6% of the participants, while males accounted for 48.4%. Participants were almost equally distributed across residential settings, with 34.0% residing in urban areas, 33.2% in semi-urban areas, and 32.8% in rural areas. Regarding educational attainment, secondary education was the most frequently reported level (39.6%). Most participants were married (60.4%), while

39.6% were single. Chronic diseases were reported by 26.4% of participants. Regarding previous exposure to antibiotics, 63.2% of participants reported antibiotic use during the preceding 12 months. The most frequently

reported source of antibiotics was purchase from a pharmacy without a physician's prescription (32.8%), whereas 15.6% reported obtaining antibiotics through a physician's prescription.

Table 1. Sociodemographic and background characteristics of the study participants (N = 250).

%	n	Category	Variable
35.2	88	15-24	Age group (years)
29.6	74	25-34	
13.6	34	35-44	
12.8	32	45-54	
8.8	22	55+	
51.6	129	Female	Gender
48.4	121	Male	
34.0	85	Urban	Residence
33.2	83	Semi-urban	
32.8	82	Rural	
39.6	99	Secondary	Education
23.6	59	Bachelor+	
19.6	49	Primary or less	
17.2	43	Diploma	
30.4	76	Student	Occupation
21.2	53	Employed	
16.4	41	Homemaker	
15.6	39	Self-employed	
9.6	24	Unemployed	
6.8	17	Retired	Marital status
55.6	139	Married	
36.0	90	Single	
8.4	21	Divorced/Widowed	Chronic disease
82.8	207	No	
17.2	43	Yes	
88.4	221	No	Health-related educational background

%	n	Category	Variable
11.6	29	Yes	
80.8	202	No	Healthcare worker in family
19.2	48	Yes	
63.2	158	Yes	Antibiotic use in previous 12 months
36.8	92	No	
36.8	92	None in last 12 months	Main source of antibiotic
32.8	82	Pharmacy without physician prescription	
15.6	39	Doctor prescription	
5.6	14	Family/Friends	
4.8	12	Previous prescription	
4.4	11	Other	

Knowledge, Attitude, Practice, and Overall KAP Scores

The mean knowledge score was 5.88 ± 1.89 out of 10, corresponding to 58.8% of the maximum possible score. The mean attitude score was 5.57 ± 1.41 out of 8 (69.7%), representing the highest standardized score

among the three KAP domains. The mean practice score was 6.08 ± 1.58 out of 10 (60.8%). Overall, the participants achieved a mean total KAP score of 17.54 ± 3.31 out of 28, equivalent to 62.6% of the maximum possible score.

Table 2. Descriptive statistics of knowledge, attitude, practice, and overall KAP scores among the study participants.

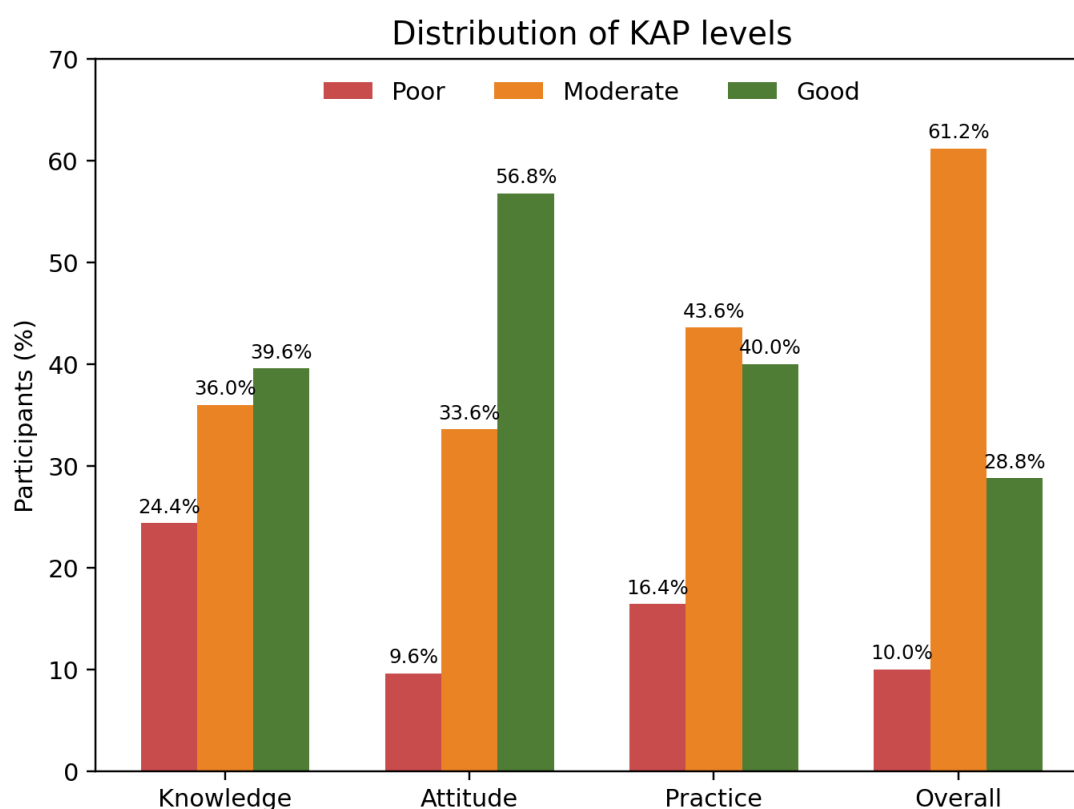
Mean %	Range	Median (IQR)	Mean $\pm$ SD	Maximum	N	Domain
58.8	0-10	6 (5-7)	5.88 ± 1.89	10	250	Knowledge
69.7	2-8	6 (5-7)	5.57 ± 1.41	8	250	Attitude
60.8	1-10	6 (5-7)	6.08 ± 1.58	10	250	Practice
62.6	8-25	18 (15-20)	17.54 ± 3.31	28	250	Overall

Classification of the individual KAP domains showed that 39.6% of participants had good knowledge, while 36.0% had moderate knowledge and 24.4% had poor knowledge. Attitudes were comparatively more favorable, with more than half of the participants (56.8%) demonstrating a good attitude level and only 9.6% classified as having poor attitudes.

Regarding antibiotic-use practices, 40.0% of participants demonstrated good practices, whereas 43.6% had moderate practices and 16.4% had poor practices. When the three domains were combined, the majority of participants (61.2%) were classified within the moderate overall KAP level.

Table 3. Distribution of participants according to knowledge, attitude, practice, and overall KAP levels.

Good	Moderate	Poor	Domain
99 (39.6%)	90 (36.0%)	61 (24.4%)	Knowledge
142 (56.8%)	84 (33.6%)	24 (9.6%)	Attitude
100 (40.0%)	109 (43.6%)	41 (16.4%)	Practice
72 (28.8%)	153 (61.2%)	25 (10.0%)	Overall

**Figure 1. Distribution of poor, moderate, and good levels across knowledge, attitude, practice, and overall KAP domains.**

Comparison of standardized domain scores showed that the attitude domain had the highest mean percentage score (69.7%), followed by the overall KAP score (62.6%), practice (60.8%), and knowledge (58.8%).

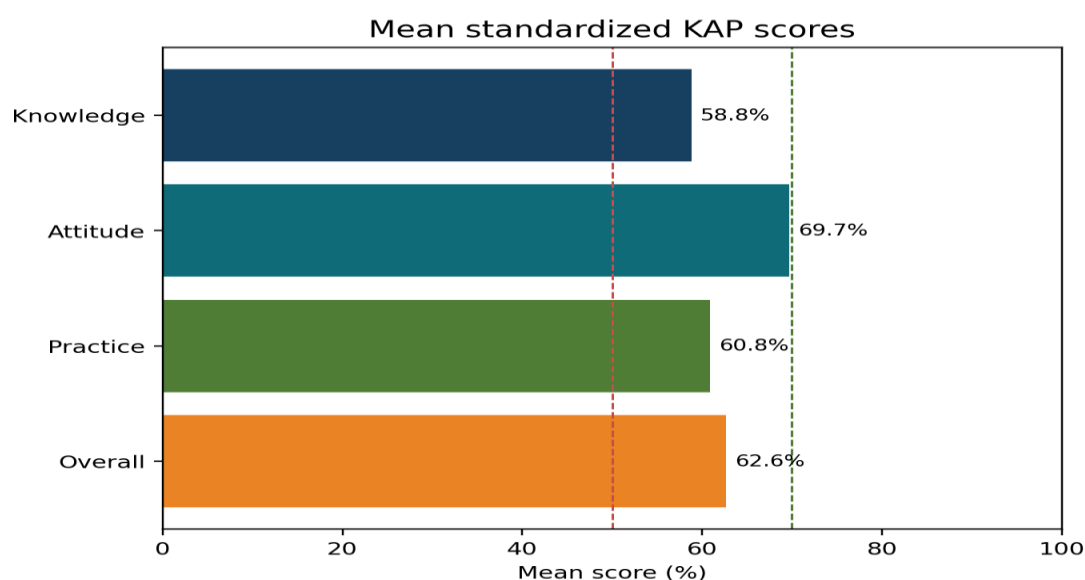


Figure 2. Mean knowledge, attitude, practice, and overall KAP scores expressed as percentages of their maximum possible scores.

Knowledge Regarding Antibiotic Use and Antimicrobial Resistance

Item-level analysis revealed considerable variation in participants' understanding of antibiotics and AMR. The highest proportion of correct responses (74.0%) was observed for the statement concerning the contribution of unnecessary antibiotic use to antimicrobial resistance. In addition, 68.4% correctly recognized the role of antibiotics in treating bacterial infections.

However, several important misconceptions were identified. Only 44.0% correctly recognized that antibiotics are ineffective against viral infections, indicating that more than half of the participants either answered incorrectly or were uncertain. Furthermore, only 41.2% correctly understood that it is bacteria, rather than the human body itself, that become resistant to antibiotics. These findings indicate important gaps in understanding the basic mechanisms and appropriate indications for antibiotic therapy.

Table 4. Participants' responses to individual knowledge items regarding antibiotic use and antimicrobial resistance.

Don't know %	Don't know n	Incorrect %	Incorrect n	Correct %	Correct n	Knowledge statement	Code
14.0	35	42.0	105	44.0	110	Antibiotics work against viruses	K1
14.8	37	34.4	86	50.8	127	Antibiotics treat cold/flu	K2
10.8	27	20.8	52	68.4	171	Treat bacterial infections	K3
4.4	11	21.6	54	74.0	185	Unnecessary use contributes to AMR	K4
12.4	31	46.4	116	41.2	103	Body becomes resistant	K5
9.2	23	29.2	73	61.6	154	Resistant bacteria can spread	K6
8.4	21	29.2	73	62.4	156	Antibiotics can cause adverse effects	K7
6.4	16	28.0	70	65.6	164	One antibiotic does not fit all infections	K8

Don't know %	Don't know n	Incorrect %	Incorrect n	Correct %	Correct n	Knowledge statement	Code
8.8	22	36.0	90	55.2	138	Using another person's antibiotic is unsafe	K9
10.8	27	24.4	61	64.8	162	Changing dose/duration without advice is risky	K10

Attitudes Toward Antibiotic Use and Antimicrobial Resistance

Participants generally demonstrated favorable attitudes toward appropriate antibiotic use and AMR prevention. The strongest positive attitude was observed regarding recognition of AMR as a serious health problem, reported by **88.8%** of participants. In addition, **78.8%** supported the use of antibiotics only with professional medical advice, while 72.0%

recognized that inappropriate antibiotic use by an individual could negatively affect the wider community.

Nevertheless, less favorable responses were observed for some items related to expectations for antibiotic prescribing and access to antibiotics without prescription, indicating that positive awareness of AMR did not uniformly translate into appropriate attitudes toward all aspects of antibiotic use.

Table 5. Participants' attitudes toward antibiotic use and antimicrobial resistance.

Raw mean $\pm$ SD	Positive %	Positive n	Positive direction	Attitude statement	Code
3.99 $\pm$ 1.05	78.8	197	Agree	Use only on professional advice	A1
2.66 $\pm$ 1.32	54.0	135	Disagree	Expect antibiotic for cold	A2
2.40 $\pm$ 1.23	62.8	157	Disagree	OTC acceptable for familiar symptoms	A3
3.69 $\pm$ 1.17	67.6	169	Agree	Support prescription-only policy	A4
2.48 $\pm$ 1.26	61.6	154	Disagree	Disappointed without antibiotic	A5
2.19 $\pm$ 1.16	71.6	179	Disagree	Sharing with family is acceptable	A6
4.23 $\pm$ 0.84	88.8	222	Agree	AMR is serious in Iraq	A7
3.77 $\pm$ 1.18	72.0	180	Agree	Individual misuse affects community	A8

Antibiotic-Use Practices

Several inappropriate antibiotic-use behaviors were reported. The most frequent was obtaining antibiotics through a pharmacist-only purchase without physician prescription (53.2%). More than half of the participants (51.6%) reported stopping or reducing antibiotic treatment after improvement of symptoms.

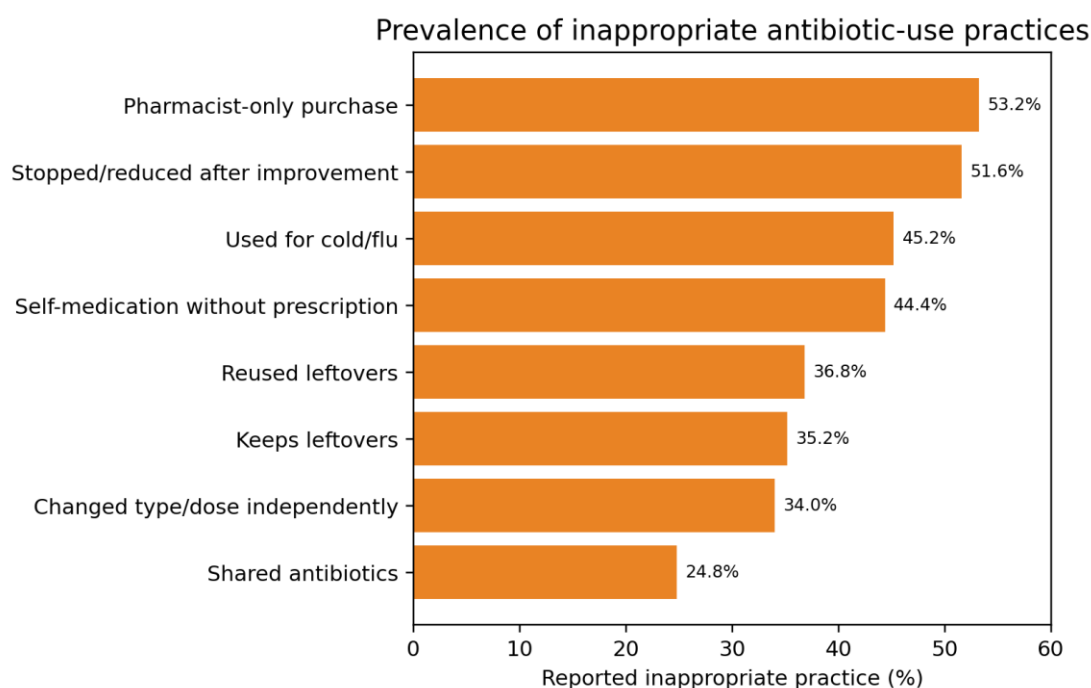
The use of antibiotics for symptoms of cold or influenza was reported by 45.2%, while

44.4% reported self-medication with antibiotics without prescription. In addition, 36.8% reported reusing leftover antibiotics and 35.2% reported keeping leftover antibiotics for possible future use. Sharing antibiotics with another person was less frequent but was still reported by 24.8% of participants.

These findings demonstrate the presence of several potentially inappropriate antibiotic-use practices within the study population.

Table 6. Distribution of reported antibiotic-use practices among the study participants.

Inappropriate %	Inappropriate n	Appropriate %	Appropriate n	Desired response	Practice item	Code
44.4	111	55.6	139	No	Self-medication without prescription	P1
53.2	133	46.8	117	No	Pharmacist-only purchase	P2
45.2	113	54.8	137	No	Used for cold/flu	P3
51.6	129	48.4	121	No	Stopped/reduced after improvement	P4
35.2	88	64.8	162	No	Keeps leftovers	P5
36.8	92	63.2	158	No	Reused leftovers	P6
24.8	62	75.2	188	No	Shared antibiotics	P7
34.0	85	66.0	165	No	Changed type/dose independently	P8
26.8	67	73.2	183	Yes	Reads instructions and follows dose	P9
39.6	99	60.4	151	Yes	Seeks professional advice	P10

**Figure 3. Prevalence of selected inappropriate antibiotic-use practices among the study participants.**

Factors Associated With Knowledge, Attitude, Practice, and Overall KAP Levels

Associations between participants' sociodemographic and background characteristics and KAP levels were initially examined using the Pearson chi-square test. Because multiple comparisons were performed, the Benjamini–Hochberg false discovery rate correction was subsequently applied. Following FDR adjustment, statistically significant associations remained between knowledge level and educational level (adjusted $P = 0.002$), health-related educational

background (adjusted $P = 0.002$), and place of residence (adjusted $P = 0.037$).

The corresponding Cramér's V values were 0.214 for educational level, 0.255 for health-related educational background, and 0.152 for residence. Among these factors, health-related educational background demonstrated the strongest association with participants' knowledge level.

No other examined associations with attitude, practice, or overall KAP level remained statistically significant after adjustment for multiple comparisons.

Table 7. Factors significantly associated with KAP levels after Benjamini–Hochberg false discovery rate adjustment.

Cramer's V	FDR p	Raw p	df	χ^2	Outcome	Predictor
0.214	0.002	<0.001	6	28.812	Knowledge	Education
0.255	0.002	<0.001	2	18.219	Knowledge	Health_Background
0.152	0.037	0.004	4	15.538	Knowledge	Residence

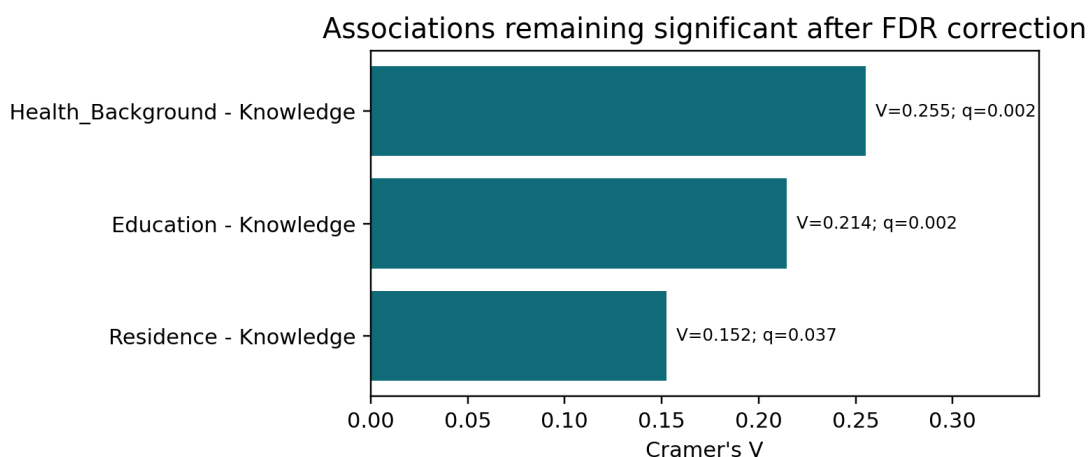


Figure 4. Effect sizes of factors significantly associated with participants' knowledge level after false discovery rate adjustment.

Correlations Among Knowledge, Attitude, Practice, and Overall KAP Scores

Spearman's correlation analysis demonstrated significant positive relationships among the three KAP domains. Knowledge score showed a positive correlation with attitude score ($\rho = 0.247$, $P < 0.001$) and a weaker positive correlation with practice score ($\rho = 0.144$, $P = 0.023$). Attitude was also positively correlated with practice ($\rho = 0.162$, $P = 0.010$).

As expected, each individual domain was strongly associated with the combined overall KAP score. Knowledge demonstrated the strongest correlation with overall KAP ($\rho = 0.750$, $P < 0.001$), followed by attitude ($\rho = 0.629$, $P < 0.001$) and practice ($\rho = 0.610$, $P < 0.001$).

Overall, these findings indicate that greater knowledge was associated with more favorable attitudes and, to a lesser extent, better antibiotic-use practices.

Table 8. Spearman's rank correlations among knowledge, attitude, practice, and overall KAP scores.

N	p-value	Spearman ρ	Score 2	Score 1
250	<0.001	0.247	A	K
250	0.023	0.144	P	K
250	<0.001	0.750	Overall	K
250	0.010	0.162	P	A
250	<0.001	0.629	Overall	A
250	<0.001	0.610	Overall	P

DISCUSSION

The present study assessed knowledge, attitudes, and practices regarding antibiotic use and antimicrobial resistance among the general population. Overall, the findings indicated a moderate level of KAP, with the attitude domain achieving the highest standardized score, followed by practice and knowledge. This pattern suggests that favorable perceptions regarding responsible antibiotic use and AMR may coexist with deficiencies in factual knowledge and inappropriate antibiotic-use behaviors. A recent Iraqi study similarly demonstrated that knowledge about antibiotic use and AMR does not necessarily translate into consistently appropriate practices, highlighting a potential gap between awareness and actual behavior.[8]

Knowledge represented an important area requiring improvement. Although 74.0% of participants recognized that unnecessary antibiotic use contributes to AMR and 68.4% understood the role of antibiotics in treating bacterial infections, substantial misconceptions remained. Only 44.0% correctly recognized that antibiotics are ineffective against viral infections, while 41.2% correctly understood that resistance develops in microorganisms rather than in the human body. These misconceptions are particularly important because misunderstanding the distinction between bacterial and viral infections may encourage unnecessary antibiotic consumption. A large survey involving 8,221 participants across 14 Member States of the WHO European Region similarly demonstrated substantial deficiencies in public knowledge concerning appropriate antibiotic use and AMR.[9]

Previous evidence involving Iraqi populations also supports the presence of antibiotic-related misconceptions. Darwish et al. reported considerable deficiencies in knowledge regarding appropriate antibiotic use and the causes of AMR among an Iraqi community residing in Jordan, including misconceptions concerning the use of antibiotics for viral diseases [10]. Although conducted outside Iraq, the study provides useful earlier evidence of misconceptions within an Iraqi population. When considered alongside the present findings, this suggests that public understanding of the distinction between bacterial and viral infections remains an important target for health education.

In contrast to the knowledge findings, participants demonstrated comparatively favorable attitudes. Most participants recognized AMR as a serious health problem, supported antibiotic use with professional guidance, and acknowledged that inappropriate antibiotic use by an individual could negatively affect the wider community. Nevertheless, favorable attitudes should not be interpreted as evidence of appropriate antibiotic use. Recent findings among medical students in southern Iraq also demonstrated that relatively good antibiotic-related knowledge and awareness may coexist with inappropriate practices [8]. Therefore, educational interventions should aim not only to improve awareness but also to facilitate behavioral change.

One of the most important findings was the frequency of obtaining antibiotics from pharmacies without a physician's prescription. This observation is particularly relevant in the Iraqi context. A recent simulated-client study

conducted across 696 community pharmacies in five Iraqi provinces found that antibiotics were supplied without prescription in 80.6% of visits (95% CI: 77.6–83.5%), while 39.2% of dispensed antibiotics belonged to the WHO Watch category [11]. These findings provide strong contemporary evidence that non-prescription access to antibiotics remains an important antimicrobial stewardship challenge in Iraq.

Earlier evidence from Iraqi community pharmacies also identified inappropriate antibiotic-dispensing practices and deficiencies related to antimicrobial stewardship [12]. Taken together with the more recent multicenter Iraqi evidence [11], these findings suggest that inappropriate community antibiotic use cannot be attributed solely to deficiencies in public knowledge. Accessibility of antibiotics, dispensing practices, professional counseling, and enforcement of prescription requirements may also influence antibiotic consumption. Consequently, interventions targeting the public should be accompanied by stewardship measures involving community pharmacies and other healthcare providers.[11,12]

Other inappropriate practices observed in the present study included stopping or reducing antibiotic treatment after symptomatic improvement, self-medication, using antibiotics for cold or influenza symptoms, and retaining or reusing leftover antibiotics. Similar behaviors have been documented internationally. Effah et al. demonstrated important gaps in public knowledge, attitudes, and awareness regarding antibiotic use and resistance, emphasizing the continuing need for interventions directed toward appropriate antibiotic consumption [13]. These behaviors are particularly concerning because unnecessary and inappropriate antimicrobial exposure contributes to the selection and spread of resistant pathogens, which WHO identifies as a major driver of AMR.[13,14]

The coexistence of relatively favorable attitudes with inappropriate practices suggests a knowledge–attitude–practice gap. Participants may recognize AMR as an important public health problem while continuing behaviors inconsistent with appropriate antibiotic stewardship. The positive but relatively weak correlations observed between knowledge,

attitude, and practice in the present analysis further support this interpretation. Knowledge may contribute to appropriate behavior, but it is unlikely to be sufficient on its own. Recent Iraqi evidence showing inappropriate antibiotic-use practices even among medically educated participants reinforces the importance of addressing behavioral and healthcare-system factors in addition to providing information.[8]

Educational level was significantly associated with knowledge, and participants with a health-related educational background demonstrated the strongest association with better knowledge. This relationship is plausible because individuals exposed to health-related education are more likely to receive formal information regarding infectious diseases, appropriate indications for antimicrobial therapy, and mechanisms of resistance. The finding supports the importance of educational exposure in improving antibiotic-related knowledge; however, the persistence of inappropriate practices among healthcare-related populations indicates that knowledge alone cannot guarantee responsible antibiotic use.[8]

Place of residence was also significantly associated with knowledge, although its effect size was smaller than that observed for health-related educational background. Differences among urban, semi-urban, and rural populations may reflect variation in educational opportunities, accessibility of healthcare services, exposure to reliable health information, socioeconomic circumstances, and patterns of interaction with healthcare professionals. The inclusion of all three residential settings is therefore an important feature of the present study, as it allows identification of geographical differences that could inform more locally targeted educational interventions rather than applying a uniform strategy to all communities.

Correlation analysis demonstrated significant positive relationships among knowledge, attitude, and practice scores. Knowledge was positively correlated with both attitude and practice, while attitude was also positively correlated with practice. However, correlations among the individual KAP domains were relatively weak. These findings suggest that better knowledge may facilitate favorable

attitudes and practices but explains only a limited proportion of behavioral variation. Accordingly, strategies aimed at reducing inappropriate antibiotic use should combine educational interventions with measures addressing antibiotic accessibility, healthcare-seeking behavior, prescribing and dispensing practices, and professional counseling.[8,11,12]

From a public health perspective, the findings identify several potential targets for intervention in Diyala Governorate. Educational programs should emphasize that antibiotics are intended for bacterial rather than viral infections, explain that antimicrobial resistance occurs in microorganisms rather than the human body, and discourage self-medication and inappropriate retention or reuse of antibiotics. However, education should be accompanied by interventions promoting appropriate antibiotic dispensing and professional counseling. This combined approach is consistent with WHO's current AMR strategy, which emphasizes awareness and behavioral change, appropriate antimicrobial use, surveillance, infection prevention, and stronger governance.[14]

The importance of such interventions is reinforced by the current global AMR burden. WHO reported in July 2026 that bacterial AMR was associated with more than 4.7 million deaths globally in 2021, and approximately one in six laboratory-confirmed bacterial infections worldwide in 2023 was resistant to antibiotic treatment. WHO also identifies misuse and overuse of antimicrobials as major drivers of resistance and reports particularly high resistance levels in the Eastern Mediterranean Region [14]. These observations place community antibiotic-use behaviors within a broader regional and global public health context.

Several limitations should be considered when interpreting the present findings. First, the cross-sectional design permits identification of associations but cannot establish causal relationships between sociodemographic factors and KAP. Second, antibiotic-use practices are based on self-reported information and may therefore be influenced by recall and social desirability biases. Third, the use of quota-based convenience sampling may limit the generalizability of the findings to the entire population of Diyala Governorate or Iraq.

Nevertheless, recruiting participants from urban, semi-urban, and rural settings provides an opportunity to explore potentially important geographical differences in antibiotic-related knowledge and behavior.

CONCLUSION

The present findings indicate that relatively favorable attitudes toward AMR may coexist with important deficiencies in knowledge and inappropriate antibiotic-use practices. Misconceptions concerning viral infections and antimicrobial resistance, together with non-prescription antibiotic access, self-medication, premature treatment modification, and reuse of leftover antibiotics, represent important targets for intervention. Community education should therefore be integrated with stronger antimicrobial stewardship, appropriate dispensing practices, and locally targeted interventions to promote responsible antibiotic use and contribute to limiting the development and spread of AMR.

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