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Knowledge, Awareness, Risk Perception, and Antibiotic-Use Practices Related to Antimicrobial Resistance among Adults in Tehran, Iran: A Community-Based Cross-Sectional Study

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ABSTRACT

Background: *Antimicrobial resistance is a major global public health threat that compromises the effectiveness of antimicrobial agents and increases morbidity, mortality, and healthcare costs. Public knowledge, awareness, risk perception, and antibiotic-use behaviors are important determinants of antimicrobial misuse and resistance development.*

Objective: *This study aimed to assess knowledge, awareness, risk perception, and antibiotic-use practices related to antimicrobial resistance among adults living in Tehran, Iran, and to identify demographic and behavioral predictors of adequate knowledge.*

Methods: *A community-based cross-sectional study was conducted among 200 adults in Tehran, Iran. Participants were recruited from public places, pharmacies, outpatient clinics, universities, and community centers using a multistage convenience sampling approach. Data were collected using a structured questionnaire consisting of demographic characteristics, antibiotic-use behaviors, antimicrobial resistance knowledge, awareness and risk perception, and preventive practices. Knowledge scores were categorized as poor, moderate, and good. Descriptive statistics, chi-square tests, independent-samples t-tests, one-way ANOVA, Pearson correlation analysis, and multivariable logistic regression were used to analyze the data.*

Results: *Among 200 participants, 112 were female and 88 were male. The mean age was 36.7±11.9years. Overall, 83 participants, equal to 41.5%, had good knowledge of antimicrobial resistance, while 76, equal to 38.0%, had moderate knowledge and 41, equal to 20.5%, had poor knowledge. Although 72.5% of participants had heard of antibiotic resistance, only 46.0% correctly recognized that antibiotics are ineffective against viral infections. Self-medication with antibiotics during the previous year was reported by 37.0% of participants. Higher educational level, healthcare-related occupation, prior exposure to antimicrobial resistance information, and completion of prescribed antibiotic courses were positively associated with good knowledge. In contrast, antibiotic self-medication and expectation of antibiotics for cold or flu symptoms were negatively associated with good knowledge. In multivariable logistic regression, bachelor's degree or higher education, healthcare-related occupation, and previous exposure to antimicrobial resistance information remained independent predictors of good knowledge.*

Conclusion: *Public knowledge of antimicrobial resistance among adults in Tehran was suboptimal, despite moderate awareness of the issue. Misconceptions regarding antibiotic use for viral infections and self-medication were common. Targeted public health education, pharmacy-based interventions, stricter regulation of non-prescription antibiotic dispensing, and improved physician-patient communication are needed to promote responsible antibiotic use in Iran.*

Keywords
Antimicrobial resistance, Knowledge, Awareness, Risk perception, Self-medication, Tehran, Iran, Public health, Cross-sectional study.

Introduction
Antimicrobial resistance, commonly referred to as AMR, is one of the most serious challenges facing modern medicine [1]. It occurs when bacteria, viruses, fungi, or parasites evolve and no longer respond adequately to antimicrobial agents [2]. As a result, infections become more difficult to treat, leading to prolonged illness, increased hospitalization, higher healthcare costs, and greater risk of death [3].

Antibiotics are among the most frequently used medications worldwide [4]. However, inappropriate use of antibiotics has accelerated the emergence and spread of resistant microorganisms [1]. Common examples of inappropriate antibiotic use include taking antibiotics without a prescription, using antibiotics for viral infections such as the common cold or influenza, stopping treatment before completing the prescribed course, using leftover antibiotics, and sharing antibiotics with family members or friends [5].

Public understanding of antibiotics and antimicrobial resistance is a key component of antibiotic stewardship [6]. Antibiotic stewardship refers to coordinated strategies designed to improve the appropriate use of antimicrobial agents. Although antimicrobial stewardship is often discussed in hospital and clinical settings, community-level behaviors are also highly relevant [7]. The general population plays an important role in antibiotic demand, treatment adherence, self-medication, and expectations from healthcare providers.

In many countries, particularly low- and middle-income settings, antibiotics may be obtained without formal prescription or used based on previous experience [8-10]. Misconceptions about antibiotics can contribute to unnecessary antibiotic consumption. For example, some individuals believe that antibiotics are effective against viral infections, that broad-spectrum antibiotics are always superior, or that symptoms improving means antibiotics can be stopped safely [10].

Iran faces important challenges regarding antibiotic consumption and antimicrobial resistance [11]. Tehran, as the capital and largest metropolitan city of Iran, has a diverse population and extensive access to pharmacies, healthcare facilities, private clinics, and digital health information. Therefore, studying public knowledge and antibiotic-use behaviors in Tehran can provide valuable evidence for designing public health interventions.

Although previous studies have explored antibiotic consumption or antimicrobial resistance awareness in different populations, community-based evidence regarding knowledge, awareness, risk perception, and antibiotic-use practices among adults in Tehran remains limited [12,13]. Therefore, this study aimed to assess these domains among adults living in Tehran and identify demographic and behavioral factors associated with good knowledge of antimicrobial resistance.

Methods
Study Design
This was a community-based cross-sectional study conducted among adults living in Tehran, Iran.

Study Setting
The study was performed in Tehran, the capital city of Iran. Tehran is a large metropolitan area with diverse socioeconomic, educational, and occupational groups. Data collection was conducted in selected public locations, including community centers, pharmacies, outpatient clinics, university areas, public parks, and shopping centers.

Study Period
Data were collected between March and June 2026.

Study Population
The target population consisted of adults aged 18 years and above who were residents of Tehran.

Inclusion Criteria
Participants were included if they met the following criteria:
1. Age 18 years or older.
2. Residence in Tehran for at least 12 months.
3. Ability to read and understand Persian.
4. Willingness to participate in the study.
5. Provision of informed consent.

Exclusion Criteria
Participants were excluded if they:
1. Refused to provide informed consent.
2. Were temporary visitors to Tehran.
3. Had cognitive, psychiatric, or communication difficulties that prevented questionnaire completion.
4. Returned questionnaires with more than 20% missing responses.
5. Were healthcare professionals directly specializing in infectious diseases or clinical microbiology, if the objective was to assess general public knowledge.

Sample Size
A total of 200 participants were included in the study. The required sample size was calculated using a single population proportion formula:

$$n = \frac{Z^2 p(1-p)}{d^2} \text{x}$$

Where:

$$Z = 1.96\text{x}$$

for a 95% confidence level,

$$p = 0.50\text{x}$$

as the expected proportion of adequate knowledge, and

$$d = 0.07\text{x}$$

as the margin of error.
Thus:

$$n = \frac{(1.96)^2 \times 0.50 \times 0.50}{(0.07)^2} \approx 196x$$

To account for incomplete responses, 200 participants were recruited.

Sampling Method

Participants were selected using a multistage convenience sampling method. To improve geographical and socioeconomic diversity, recruitment was performed in different districts of Tehran, including northern, southern, central, eastern, and western areas. Participants were approached in public places and invited to complete an anonymous questionnaire.

Although the sampling approach was non-probability-based, efforts were made to include individuals from various age groups, educational levels, occupations, and socioeconomic backgrounds.

Data Collection Tool

Data were collected using a structured, self-administered questionnaire developed based on previous antimicrobial resistance knowledge, attitude, and practice studies and public awareness materials from international health organizations.

The questionnaire consisted of five sections:

1. Demographic characteristics.
2. Antibiotic-use behaviors.
3. Knowledge about antibiotics and antimicrobial resistance.
4. Awareness and risk perception.
5. Preventive and antibiotic-use practices.

The questionnaire was prepared in Persian. To improve clarity, the draft questionnaire was reviewed by experts in infectious diseases, epidemiology, public health, and clinical pharmacy.

Questionnaire Sections

Section 1: Demographic Characteristics

The demographic section included:

- Age
- Sex
- Marital status
- Educational level
- Occupation
- Household income level
- Health insurance status
- History of chronic disease

Section 2: Antibiotic-Use Behaviors

This section assessed participants' previous antibiotic use and related behaviors. Items included:

1. Use of antibiotics in the previous 12 months.
2. Use of antibiotics without physician prescription.
3. Stopping antibiotics after symptom improvement.
4. Use of leftover antibiotics.
5. Sharing antibiotics with others.
6. Expectation of antibiotics for cold or flu symptoms.
7. Asking physicians to prescribe antibiotics.
8. Purchasing antibiotics directly from pharmacies without prescription.

Responses were recorded as:

- Yes
- No
- Not sure

Section 3: Knowledge of Antibiotics and Antimicrobial Resistance

Knowledge was assessed using 15 statements. Participants responded with:

- True
- False
- Not sure

Each correct answer was scored as 1, while incorrect and "not sure" responses were scored as 0. The total knowledge score ranged from 0 to 15.

Knowledge levels were categorized as:

Knowledge Category	Score Range
Poor knowledge	0–7
Moderate knowledge	8–10
Good knowledge	11–15

Section 4: Awareness and Risk Perception

Awareness and risk perception were assessed using 8 items scored on a 5-point Likert scale:

Response	Score
Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

Total score ranged from 8 to 40. Higher scores indicated greater awareness and perceived risk of antimicrobial resistance.

Section 5: Preventive Practices

Preventive practices were assessed using 8 items. Responses were scored as:

Response	Score
Never	0
Rarely	1
Sometimes	2
Always	3

The total preventive practice score ranged from 0 to 24. Higher scores indicated better antibiotic-use and infection-prevention practices.

Validity and Reliability

The questionnaire was evaluated for content validity by an expert panel consisting of an infectious disease specialist, epidemiologist,

public health researcher, clinical pharmacist, and methodologist. The experts reviewed the questionnaire for relevance, clarity, simplicity, and cultural appropriateness.

A pilot study was conducted among 20 adults who were not included in the final analysis. Feedback from the pilot study was used to revise ambiguous items.

Internal consistency was assessed using Cronbach's alpha and KR-20 coefficients. The reliability indices were acceptable:

Scale	Reliability Index
Knowledge section	KR-20 = 0.76
Awareness/risk perception section	Cronbach's alpha = 0.84
Preventive practice section	Cronbach's alpha = 0.78

Statistical Analysis

Data were analyzed using SPSS version 26.

Descriptive statistics were used to summarize participant characteristics. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as means and standard deviations.

The following statistical tests were used:

1. Chi-square test to examine associations between categorical variables.
2. Independent-samples t-test to compare mean scores between two groups.
3. One-way ANOVA to compare mean scores among more than two groups.
4. Pearson correlation analysis to evaluate associations between continuous scores.
5. Binary logistic regression to identify independent predictors of good knowledge.

For logistic regression, the dependent variable was good knowledge, defined as a knowledge score of 11 or higher.

$$Good\ knowledge = Knowledge\ score \geq 11x$$

A p-value less than 0.05 was considered statistically significant.

Results

Participant Characteristics

A total of 200 adults participated in this study. Of these, 112 participants, equal to 56.0%, were female and 88, equal to 44.0%, were male. The mean age was:

$$36.7 \pm 11.9\ yearsx$$

with an age range of 18 to 68 years.

Most participants were married, and more than half had a university degree.

Antibiotic-Use Behaviors

A total of 124 participants, equal to 62.0%, reported using antibiotics during the previous 12 months. Self-medication with antibiotics was reported by 74 participants, equal to 37.0%. Moreover, 68 participants, equal to 34.0%, reported stopping antibiotics after symptom improvement.

Table 1: Demographic Characteristics of Participants.

Variable	Category	n	%
Sex	Female	112	56.0
	Male	88	44.0
Age group	18–29 years	62	31.0
	30–39 years	58	29.0
	40–49 years	44	22.0
	≥50 years	36	18.0
Marital status	Single	78	39.0
	Married	112	56.0
	Divorced/Widowed	10	5.0
Education	High school or lower	38	19.0
	Diploma/Associate degree	46	23.0
	Bachelor's degree	72	36.0
	Master's/PhD	44	22.0
Occupation	Healthcare-related	28	14.0
	Non-healthcare employee	62	31.0
	Self-employed	38	19.0
	Student	36	18.0
	Homemaker	24	12.0
	Unemployed/retired	12	6.0

Table 2: Antibiotic-Use Behaviors among Participants.

Behavior	Yes n	%
Used antibiotics during the past 12 months	124	62.0
Used antibiotics without prescription	74	37.0
Stopped antibiotics after symptom improvement	68	34.0
Used leftover antibiotics	52	26.0
Shared antibiotics with family/friends	31	15.5
Expected antibiotics for cold/flu symptoms	82	41.0
Asked a physician for antibiotics	46	23.0
Purchased antibiotics directly from pharmacy without prescription	59	29.5

Knowledge of Antimicrobial Resistance

The mean knowledge score was:

$$9.8 \pm 3.1x$$

out of 15.

Overall, 83 participants, equal to 41.5%, had good knowledge. Moderate knowledge was observed in 76 participants, equal to 38.0%, and poor knowledge was observed in 41 participants, equal to 20.5%.

Table 3: Knowledge Level of Participants.

Knowledge Level	Score Range	n	%
Poor	0–7	41	20.5
Moderate	8–10	76	38.0
Good	11–15	83	41.5

Correct Responses to Knowledge Items

The highest correct response rates were observed for the statements that resistant infections are harder to treat and that antibiotics are effective against bacterial infections. However, important misconceptions were observed regarding antibiotic use for viral infections and the meaning of antibiotic resistance.

Table 4: Correct Responses to Knowledge Items.

Knowledge Item	Correct n	%
Antibiotics are effective against bacterial infections	158	79.0
Antibiotics are not effective against viral infections	92	46.0
Antibiotic resistance means bacteria become resistant, not the human body	88	44.0
Taking antibiotics without prescription increases resistance	146	73.0
Stopping antibiotics early contributes to resistance	132	66.0
Using leftover antibiotics is unsafe	118	59.0
Resistant infections are harder to treat	154	77.0
Resistant bacteria can spread between people	126	63.0
Antibiotics are not needed for every fever	103	51.5
Broad-spectrum antibiotics are not always better	84	42.0
Vaccination can reduce antibiotic use	98	49.0
Hand hygiene can reduce infections and antibiotic need	142	71.0

Awareness and Risk Perception

The mean awareness and risk perception score was:

$$31.4 \pm 5.6x$$

out of 40.

Most participants agreed that antimicrobial resistance is a serious public health issue and that physicians should explain when antibiotics are unnecessary.

Table 5: Awareness and Risk Perception Responses.

Item	Agree/Strongly Agree n	%
AMR is a serious public health problem in Iran	151	75.5
AMR can affect me or my family	128	64.0
Antibiotic misuse contributes to resistance	144	72.0
AMR can lead to treatment failure	149	74.5
AMR increases healthcare costs	137	68.5
Public education can reduce antibiotic misuse	162	81.0
Pharmacies should not dispense antibiotics without prescription	133	66.5
Physicians should explain when antibiotics are unnecessary	171	85.5

Preventive Practices

The mean preventive practice score was:

$$16.8 \pm 4.7x$$

out of 24.

The most commonly reported positive practice was not sharing antibiotics with others. However, only 54.0% reported always completing the full antibiotic course, and 58.0% reported always taking antibiotics only with prescription.

Association between Demographic Characteristics and Knowledge

Good knowledge was more frequent among females than males, but this difference was not statistically significant. Knowledge level was significantly associated with education and occupation. Participants with bachelor's degree or higher education and those with healthcare-related occupations had higher proportions of good knowledge.

Table 6: Preventive Practice Items.

Practice Item	Always n	%
Takes antibiotics only with prescription	116	58.0
Completes full antibiotic course	108	54.0
Does not keep leftover antibiotics	97	48.5
Does not share antibiotics	151	75.5
Asks physician whether antibiotics are necessary	86	43.0
Reads medication instructions	122	61.0
Follows vaccination recommendations	104	52.0
Practices hand hygiene regularly	141	70.5

Table 7: Association between Demographic Variables and Good Knowledge.

Variable	Category	Good Knowledge n/N	%	p-value
Sex	Female	50/112	44.6	0.29
	Male	33/88	37.5	
Age group	18–29 years	28/62	45.2	0.42
	30–39 years	25/58	43.1	
	40–49 years	18/44	40.9	
	≥50 years	12/36	33.3	
Education	High school or lower	8/38	21.1	<0.001
	Diploma/Associate degree	14/46	30.4	
	Bachelor's degree	35/72	48.6	
	Master's/PhD	26/44	59.1	
Occupation	Healthcare-related	22/28	78.6	<0.001
	Non-healthcare employee	25/62	40.3	
	Self-employed	12/38	31.6	
	Student	17/36	47.2	
	Homemaker	5/24	20.8	
	Unemployed/retired	2/12	16.7	

Behavioral Factors Associated With Good Knowledge

Prior exposure to antimicrobial resistance information was strongly associated with good knowledge. Participants who reported antibiotic self-medication or expected antibiotics for cold or flu symptoms were less likely to have good knowledge.

Table 8: Behavioral Factors Associated With Good Knowledge.

Variable	Category	Good Knowledge n/N	%	p-value
Prior AMR information exposure	Yes	62/112	55.4	<0.001
	No	21/88	23.9	
Self-medication with antibiotics	Yes	20/74	27.0	<0.001
	No	63/126	50.0	
Completed antibiotic course	Yes	56/108	51.9	0.002
	No	27/92	29.3	
Expected antibiotics for cold/flu	Yes	23/82	28.0	0.001
	No	60/118	50.8	

Correlation Analysis

Knowledge score was positively correlated with both risk perception and preventive practice scores. A moderate positive correlation was observed between knowledge and preventive practices.

Table 9: Correlation between Scores.

Variables	Correlation Coefficient	p-value
Knowledge score and risk perception score	r = 0.46	<0.001
Knowledge score and preventive practice score	r = 0.52	<0.001
Risk perception score and preventive practice score	r = 0.39	<0.001
Age and knowledge score	r = -0.12	0.09

Multivariable Logistic Regression

A multivariable logistic regression model was used to identify independent predictors of good knowledge. The dependent variable was good knowledge, defined as a knowledge score of 11 or higher.

After adjustment for demographic and behavioral variables, bachelor's degree or higher education, healthcare-related occupation, and prior exposure to antimicrobial resistance information were independently associated with good knowledge. Antibiotic self-medication and expectation of antibiotics for cold or flu symptoms were negatively associated with good knowledge.

Table 10: Multivariable Logistic Regression for Predictors of Good Knowledge.

Predictor	Adjusted OR	95% CI	p-value
Female sex	1.21	0.66–2.23	0.53
Age ≥40 years	0.82	0.43–1.57	0.55
Bachelor's degree or higher	2.74	1.39–5.42	0.004
Healthcare-related occupation	4.86	1.82–12.96	0.002
Prior AMR information exposure	3.21	1.68–6.14	<0.001
Self-medication with antibiotics	0.48	0.24–0.94	0.033
Expected antibiotics for cold/flu	0.51	0.26–0.99	0.047
Completed prescribed antibiotic course	1.92	1.01–3.64	0.046

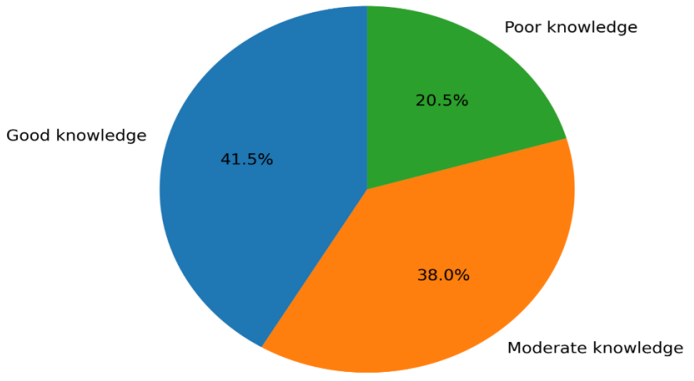

Figure 1: Distribution of participants' knowledge levels about antibiotic resistance.

The largest proportion of participants had good knowledge (41.5%), followed by moderate knowledge (38.0%) and poor knowledge (20.5%).

While 72.5% had heard of antibiotic resistance, only 46.0% correctly recognized that antibiotics are ineffective against viral infections. In addition, 37.0% reported self-medication with antibiotics during the previous year, and 34.0% stopped antibiotics after symptom improvement.

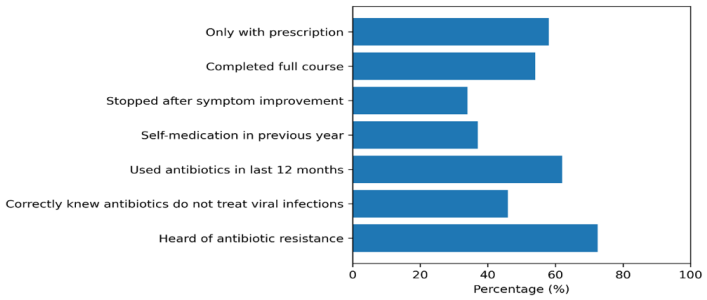

Figure 2: Awareness and antibiotic-use behaviors among participants.

Discussion

Antimicrobial resistance remains one of the most important global public health threats, and public knowledge and behavior play a central role in shaping patterns of antibiotic use at the community level [1,14]. The present study assessed knowledge, awareness, risk perception, and antibiotic-use practices related to antimicrobial resistance among adults in Tehran, Iran. Overall, the findings showed that although a considerable proportion of participants had heard about antibiotic resistance, detailed knowledge regarding its causes, consequences, and prevention was suboptimal. In particular, misconceptions about the use of antibiotics for viral infections, self-medication, and premature discontinuation of treatment were common.

In this study, approximately two-fifths of participants demonstrated good knowledge of antimicrobial resistance, while a notable proportion had poor knowledge. This finding suggests that general awareness does not necessarily translate into accurate understanding. Similar findings have been reported in community-based studies from different countries, where participants may have heard of antibiotic resistance but still incorrectly believe that antibiotics are effective against viral illnesses such as the common cold and influenza [15,16]. This distinction is important because superficial awareness may not be sufficient to promote rational antibiotic use unless it is accompanied by clear understanding of when antibiotics are clinically indicated.

One of the most important misconceptions identified in the present study was the belief that antibiotics can be used for viral infections. This pattern has been repeatedly observed in public surveys from Middle Eastern, South Asian, and North African countries [17-20]. In these settings, public expectation for antibiotics in respiratory tract infections has been described as a major driver of inappropriate antibiotic consumption. The persistence of this misconception in Tehran indicates that educational interventions should specifically target common clinical scenarios, particularly cold, influenza, sore throat, and other self-limiting respiratory illnesses.

The level of self-medication reported in this Tehran sample is also concerning. Self-medication with antibiotics has been

widely documented in low- and middle-income countries and in some regions where antibiotics may be obtained without strict prescription control [21-23]. Studies from Pakistan and India have shown that non-prescription antibiotic use is frequently influenced by previous prescriptions, advice from family members, leftover medicines, and direct pharmacy access [9,22]. Similar behavioral patterns may contribute to inappropriate antibiotic use in urban Iranian settings. Therefore, interventions should not only target individual knowledge but also address medication access, pharmacy practices, and public expectations.

The findings of the present study are broadly consistent with reports from Saudi Arabia and other Gulf countries, where gaps in public knowledge about antibiotic resistance have been reported despite increasing national attention to antimicrobial stewardship [19,24-26]. In several Gulf-based studies, participants were aware that antibiotic misuse could be harmful, but many still reported using antibiotics without prescription or discontinuing treatment once symptoms improved [19,26]. The similarity between these findings and the Tehran results suggests that antimicrobial resistance education in the region should move beyond general awareness campaigns and focus on correcting specific behavioral misconceptions.

In Turkey, previous community-based studies have also reported moderate public knowledge and inappropriate antibiotic-related beliefs, particularly concerning the use of antibiotics for upper respiratory tract infections [27]. These findings resemble the pattern observed in Tehran, where awareness existed but was accompanied by substantial gaps in practical knowledge. Since Turkey and Iran share certain similarities in patterns of urbanization, healthcare access, and antibiotic-use culture, comparative research between these countries may be valuable for designing regionally appropriate antimicrobial stewardship strategies.

In South Asia, studies from Pakistan and India have frequently reported high levels of inappropriate antibiotic use, including self-medication, incomplete treatment courses, and use of antibiotics for viral or non-specific symptoms [27]. Compared with these settings, the Tehran sample may show a somewhat more moderate pattern of misuse, but the underlying issues appear similar. These include limited antibiotic literacy, patient demand, insufficient physician-patient communication, and availability of antibiotics outside formal clinical pathways. This regional comparison highlights the importance of integrating public education with stronger regulation of antibiotic dispensing.

Evidence from the United Arab Emirates also shows that public awareness of antimicrobial resistance has improved in recent years, particularly following national campaigns and stewardship initiatives [28,29]. However, even in settings with relatively strong healthcare infrastructure, misunderstandings about resistance mechanisms and antibiotic indications remain. This suggests that educational exposure can improve awareness but may not fully eliminate incorrect beliefs unless interventions are repeated, targeted, and evaluated over time. The association between prior exposure to AMR-related information and good knowledge in the present study supports this interpretation.

Compared with many European settings, particularly Northern and Western Europe, public antibiotic literacy in Tehran may be lower [30]. European surveys have generally shown higher awareness of the ineffectiveness of antibiotics against viral infections, likely reflecting long-standing public health campaigns, stronger prescription regulations, and antimicrobial stewardship programs [30]. However, even in Europe, knowledge gaps persist, especially in Southern and Eastern regions where non-prescription antibiotic access and self-medication have historically been more common [30]. Therefore, while the Tehran findings may differ from higher-performing European countries, the knowledge-behavior gap remains a global challenge.

Educational level was significantly associated with good knowledge in the present study. Participants with university-level education were more likely to have adequate knowledge of antimicrobial resistance. This finding is consistent with international literature showing that higher education is associated with better health literacy and more rational medication use [31-33]. However, the persistence of misconceptions even among educated individuals suggests that general education alone is insufficient. Specific antibiotic literacy interventions are needed to explain concepts such as bacterial versus viral infections, resistance development, treatment adherence, and the consequences of inappropriate antibiotic use.

Healthcare-related occupation was another strong predictor of good knowledge. Participants working or studying in health-related fields were more likely to understand antimicrobial resistance and appropriate antibiotic use. This is expected and has been reported in studies involving healthcare workers, medical students, and pharmacy students [25,34]. However, because the majority of antibiotic consumption occurs at the community level, antimicrobial stewardship efforts should not be limited to healthcare professionals. Public-facing communication strategies are essential to bridge the gap between professional knowledge and community behavior.

Prior exposure to AMR-related information was independently associated with good knowledge in this study. This finding is important because it suggests that communication campaigns may have measurable benefits. International experience shows that mass media campaigns, school-based education, pharmacy counseling, and physician-led communication can improve public understanding of antibiotic resistance [35]. For Tehran, public health messaging through social media, primary healthcare centers, pharmacies, universities, and community campaigns may be especially useful, given the high level of urban connectivity and access to digital platforms.

The positive correlation between knowledge, risk perception, and preventive practices observed in this study supports the role of health education in improving antibiotic-related behavior.

Participants with better knowledge were more likely to perceive antimicrobial resistance as a serious threat and to report appropriate practices, such as avoiding self-medication, completing prescribed courses, and not sharing antibiotics. Similar associations have been observed in international studies, where higher knowledge is often linked to safer antibiotic-use behavior [36,37]. Nevertheless, knowledge alone may not be sufficient if structural factors, such as easy access to antibiotics without prescription, remain unaddressed.

Public Health Implications

This study has several important implications:

1. **Community-based antibiotic education is urgently needed.** Public campaigns should focus on correcting misconceptions about viral infections and antibiotic effectiveness.
2. **Pharmacy-based stewardship should be strengthened.** Pharmacists should be encouraged and supported to prevent non-prescription antibiotic dispensing.
3. **Physician-patient communication should be improved.** Physicians should explain when antibiotics are unnecessary and provide alternative symptom-management advice.
4. **Educational interventions should target high-risk groups.** Individuals with lower education, non-healthcare occupations, and those reporting self-medication may benefit most.
5. **Digital and social media campaigns may be effective.** Tehran has high digital media penetration, making online education a feasible public health strategy.
6. **AMR education should be integrated into schools and universities.** Early antibiotic literacy can help promote responsible medication use.

Strengths

This study has several strengths. First, it assessed multiple dimensions of antimicrobial resistance, including knowledge, awareness, risk perception, and practices. Second, the study included adults from different areas of Tehran and diverse educational and occupational backgrounds. Third, the questionnaire was structured and evaluated for reliability. Fourth, multivariable regression was used to identify independent predictors of good knowledge.

Limitations

This study also has limitations. First, the cross-sectional design prevents causal inference. Second, the use of convenience sampling may limit generalizability to the entire adult population of Tehran. Third, antibiotic-use behaviors were self-reported and may be affected by recall bias or social desirability bias. Fourth, the sample size was moderate. Fifth, the study was conducted only in Tehran and may not represent other cities or rural areas in Iran.

Conclusion

This study demonstrated that knowledge and awareness of antimicrobial resistance among adults in Tehran were suboptimal. Although many participants had heard of antimicrobial resistance, important misconceptions regarding antibiotic use for viral infections and the meaning of resistance remained common. Inappropriate antibiotic-use behaviors, including self-medication, early discontinuation, and use of leftover antibiotics, were frequently reported.

Higher education, healthcare-related occupation, prior exposure to antimicrobial resistance information, and appropriate antibiotic-use behaviors were associated with better knowledge. These findings highlight the need for targeted public health education, pharmacy-based antimicrobial stewardship, improved physician-patient communication, and stricter regulation of non-prescription antibiotic dispensing in Iran.

Ethics Approval

Ethical approval for this study was obtained from the Ethics Committee of Shahid Beheshti University, Tehran, Iran. All participants were informed about the objectives and procedures of the study before participation. Written informed consent was obtained from all participants prior to data collection. Participation in the study was entirely voluntary. All collected data were kept confidential and used solely for research purposes.

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