

ANTIBIOTIC-RELATED BEHAVIORS AND PERCEIVED HEALTH CONSEQUENCES AMONG THE GENERAL POPULATION IN ARMENIA: A CROSS-SECTIONAL STUDY

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Abstract

Inappropriate antibiotic use contributes substantially to antimicrobial resistance. This study assessed antibiotic-related behaviours, knowledge, self-medication practices, and perceived health consequences among adults in Armenia. A cross-sectional survey of 384 adults was conducted using a structured 26-item questionnaire. Overall, 74.2% reported antibiotic use during the previous 12 months, 68.0% reported self-medication, 45.1% used leftover antibiotics for a new illness, and 47.9% considered using antibiotics prescribed for another person acceptable. The median objective knowledge score was 2 (IQR: 1 - 3). In multivariable analyses, each one-point increase in knowledge score was associated with lower odds of self-medication (aOR = 0.54, 95% CI: 0.43 - 0.68), non-completion of the antibiotic course (aOR = 0.47, 95% CI: 0.38 - 0.58), and leftover antibiotic use (aOR = 0.51, 95% CI: 0.42 - 0.64; all $p < 0.001$). These findings highlight the need for targeted education and antimicrobial stewardship interventions to promote appropriate antibiotic use.

Rezumat

Utilizarea inadecvată a antibioticelor contribuie la dezvoltarea rezistenței antimicrobiene. Acest studiu a analizat modul în care adulții din Armenia folosesc antibioticele, cunoștințele despre acestea, frecvența automedicației și opiniile privind efectele asupra sănătății. A fost realizat un studiu transversal care a inclus 384 de adulți, utilizând un chestionar structurat cu 26 de itemi. În total, 74,2% dintre participanți au declarat că au luat antibiotice în ultimele 12 luni, iar 68,0% au recurs la automedicație. Pentru o nouă infecție, 45,1% au folosit antibiotice rămase de la un tratament anterior. De asemenea, 47,9% au considerat acceptabil să ia antibiotice prescrise altei persoane. Scorul mediu de cunoștințe, evaluat obiectiv, a fost 2 (IQR: 1 - 3). În analiza multivariată, fiecare punct suplimentar la scorul de cunoștințe s-a asociat cu șanse mai mici de automedicație (ORa = 0,54; CI 95%: 0,43 - 0,68). S-a asociat și cu șanse mai mici de întrerupere a tratamentului înainte de termen (ORa = 0,47; CI 95%: 0,38 - 0,58) și de utilizare a antibioticelor rămase (ORa = 0,51; CI 95%: 0,42 - 0,64). Toate asocierile au fost semnificative statistic. Rezultatele arată că sunt necesare programe de educație adaptate grupurilor țintă și de intervenții pentru utilizarea rațională a antimicrobienelelor, care să încurajeze utilizarea lor corectă.

Keywords: antibiotic use, self-medication, antimicrobial resistance, antibiotic knowledge, health consequences

Introduction

Antibiotics are essential therapeutic agents in modern medicine and play a key role in preventing and treating bacterial infections. They are widely used in both outpatient and inpatient settings. However, their clinical effectiveness depends on appropriate indications, correct dosing, and adequate treatment duration (1-3). The inappropriate and excessive use of antibiotics has become a major public health concern. It is recognised as one of the principal drivers of antimicrobial resistance. Inappropriate use includes taking antibiotics for viral infections, self-medication without medical consultation, incorrect dosing, premature discontinuation of therapy, reuse of leftover antibiotics, and the use of antibiotics prescribed for relatives or friends (3-6). These practices may lead

to adverse drug reactions, treatment failure, recurrent infections, and the emergence of antimicrobial resistance (3, 5, 6).

Antibiotic self-medication is particularly common in settings where access to healthcare services is limited or where antibiotics can be obtained without effective prescription control (7). Previous treatment experience, recommendations from relatives, friends, or pharmacy personnel, the cost of medical consultations, time constraints, and difficulties accessing physicians may influence individuals' decisions to use antibiotics without appropriate clinical assessment (8-10).

Educational level, socioeconomic status, and health literacy may also influence antibiotic-related knowledge and behaviours. Misconceptions, such as believing that antibiotics are effective against influenza, the common

cold, or other viral respiratory infections, may further encourage inappropriate antibiotic use (4, 8, 11). The consequences of inappropriate antibiotic use extend beyond the individual patient. Antimicrobial-resistant infections are associated with limited treatment options, prolonged illness, longer hospital stays, increased healthcare costs, and higher morbidity and mortality. Globally, bacterial antimicrobial resistance has been associated with approximately 4.95 million deaths, and this burden is expected to increase if effective control measures are not implemented (12, 13). Resistant infections may require more expensive or toxic antibiotics and may lead to repeated medical consultations, additional diagnostic procedures, productivity losses, and increased financial pressure on patients and healthcare systems (12, 14-16). In Armenia, systemic antibacterial medicines are subject to prescription-based dispensing requirements, and national legislation prohibits the sale of prescription medicines without a valid prescription (17). Nevertheless, non-prescription access to antibiotics has remained a concern in practice. Previous research, including in Armenia, has documented patient demand for and use of antibiotics obtained over the counter from community pharmacies, as well as pharmacist-related factors influencing the sale of antibiotics without prescriptions (18). Armenia has also undertaken national efforts to address antimicrobial resistance, initially through the National Action Plan on Antimicrobial Resistance 2015 - 2020 and, more recently, through the second national AMR strategy and multisectoral action plan for 2024 - 2027, based on the One Health approach (19, 20). This regulatory and policy context is important for interpreting the high prevalence of antibiotic self-medication observed in Armenia.

Improving antibiotic use requires interventions targeting not only healthcare professionals but also the general population. Public education, improved health literacy, stronger prescription regulations, accessible medical services, and effective communication between healthcare professionals and patients are essential for promoting the rational use of antibiotics (6, 21, 22). Understanding how people use antibiotics, why they self-medicate, whether they complete prescribed treatment, and how they perceive the health consequences of inappropriate antibiotic use is essential for developing effective public health interventions.

Despite the global importance of antibiotic misuse, evidence on antibiotic-related behaviours and perceived health consequences among the general population in Armenia remains limited. Local data are needed because healthcare accessibility, medicine-use practices, previous treatment experience, and public trust in healthcare professionals may influence antibiotic-related decisions differently across countries. Therefore, this study aimed to assess antibiotic-

related behaviours among the general population in Armenia, including patterns of antibiotic use, motivations for self-medication, treatment-course completion, the use of leftover or shared antibiotics, knowledge regarding antibiotics, and perceived health consequences associated with inappropriate antibiotic use.

Materials and Methods

Study design and participants

This population-based cross-sectional study was conducted in Armenia in 2026 to assess antibiotic-related knowledge, behaviours, self-medication practices, and perceived health consequences of inappropriate antibiotic use among the general population. Eligible participants were adults aged ≥ 18 years who were permanent residents of Armenia, were able to understand and complete the questionnaire, and provided informed consent to participate. Individuals aged < 18 years, non-residents of Armenia, those unable to complete the questionnaire, and those who declined to participate were excluded.

Sampling technique and recruitment procedure

A multistage probability sampling approach was used to recruit participants from Yerevan and all ten administrative regions of Armenia: Aragatsotn, Ararat, Armavir, Gegharkunik, Kotayk, Lori, Shirak, Syunik, Tavush, and Vayots Dzor. Geographic units, households, and eligible adults were selected successively, with computer-generated random numbers in Microsoft Excel used for random selection. Data were collected through face-to-face administration of a paper-based questionnaire by members of the research team. Recruitment continued until the predetermined target sample size was reached. A total of 388 eligible individuals were invited to participate, of whom 4 declined or did not participate. Consequently, 384 participants completed the questionnaire, corresponding to a response rate of 99.0%. No completed questionnaires were excluded because of incompleteness, and all 384 questionnaires were included in the final analysis.

Sample size calculation

The target sample size was calculated using Cochran's formula for proportions (23). Assuming a 95% confidence level ($Z = 1.96$), an expected proportion of 0.50 ($p = 0.50$), and a margin of error of 5% ($d = 0.05$), the initial sample size was calculated as $n_0 = Z^2 p(1 - p) / d^2 = 384.16$ and based on an estimated total population of Armenia of $N = 3,033,500$ (24), application of the finite population correction resulted in a virtually unchanged estimate ($n \approx 384$). Therefore, the target sample size was set at 384 participants.

Study instrument

Data were collected using a structured questionnaire developed after reviewing World Health Organisation recommendations on antimicrobial resistance and

rational antibiotic use, as well as questionnaires and instruments used in previous international studies (9, 11, 21). The broader questionnaire included 26 items addressing sociodemographic characteristics and various aspects of antibiotic knowledge, awareness, use, and associated behaviours. The present study focused specifically on questionnaire items directly relevant to antibiotic knowledge, antibiotic-use behaviours, and non-physician-directed antibiotic use, in accordance with the study objectives. Additional questionnaire items addressing other aspects related to antibiotic use were beyond the scope of the present study and were therefore not included in the current analysis. The questionnaire consisted predominantly of closed-ended, single-response items. Response formats included dichotomous yes/no responses, yes/no/don't know responses, ordinal frequency categories, and single-choice categorical response options. Where applicable, an "other" option allowed respondents to provide a brief free-text specification. No multiple-response ("select all that apply") items were used. The questionnaire was originally developed and administered in Armenian and was not translated from another language; therefore, a formal forward-backward translation procedure was not applicable. The wording of the items was adapted to the Armenian healthcare and sociocultural context.

Questionnaire validation

The content validity of the questionnaire was assessed by a panel of six independent experts with expertise in pharmacology/clinical pharmacology, pharmacy practice/community pharmacy, antimicrobial stewardship/infectious diseases, and questionnaire/research methodology. Each of the 26 questionnaire items was independently rated for relevance using a four-point scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant). For each item, the item-level Content Validity Index (I-CVI) was calculated as the proportion of experts assigning a relevance rating of 3 or 4. The scale-level Content Validity Index based on the average method (S-CVI/Ave) was calculated as the mean of the I-CVI values across all questionnaire items. An I-CVI of ≥ 0.78 and an S-CVI/Ave of ≥ 0.90 were considered indicative of acceptable and excellent content validity, respectively.

Face validity and pilot testing

Face validity was assessed through pilot testing of the questionnaire among 20 adults from the target population who were not included in the final study sample. Participants were asked to evaluate the clarity, comprehensibility, relevance, and interpretation of the questionnaire items and the appropriateness of the response options. Based on their feedback, minor wording and formatting modifications were made before administration of the final questionnaire. No items were removed.

Internal consistency reliability

Internal consistency reliability was assessed for the three dichotomously scored objective antibiotic knowledge items using the Kuder-Richardson Formula 20 (KR-20). The items assessed the correct definition of antibiotics, appropriate completion of an antibiotic treatment course, and appropriate use of an antibiotic prescribed for another person. Each correct response was assigned one point, whereas incorrect or "do not know" responses were assigned zero points, yielding a total objective knowledge score ranging from 0 to 3. Corrected item-total correlations were also examined.

Data collection

Data were collected between March and May 2026 through face-to-face administration of a paper-based anonymous questionnaire among adults residing in Yerevan and the regions of Armenia. Age was collected using predefined categorical response options based on age in completed years (18 - 29, 30 - 40, 41 - 50, 51 - 60, and ≥ 61 years); exact age in years was not recorded. Participation was voluntary, and each respondent completed the questionnaire only once. All completed questionnaires were reviewed for completeness before statistical analysis.

Operational definitions and scoring

Self-medication with antibiotics was operationally defined as a "Yes" response to questionnaire item B5 (Self-medication with antibiotics). Completion of the prescribed antibiotic course was assessed separately as a self-reported behavioural outcome using item B6 (Completion of the full prescribed antibiotic course), with "Yes" indicating course completion and "No" indicating non-completion.

Objective antibiotic knowledge was assessed using a three-item composite score comprising Q6 (definition of antibiotics), Q11 (appropriate completion of an antibiotic treatment course), and Q13 (appropriateness of using an antibiotic prescribed for another person). Each correct response was assigned one point, whereas an incorrect or "do not know" response was assigned zero points, yielding a total score ranging from 0 to 3. Higher scores indicated greater objective antibiotic knowledge. No categories such as "no" "partial" or "adequate" knowledge were applied because externally validated cut-off values were not available.

No composite scores were calculated for the other questionnaire domains; items within these domains were analysed individually according to their original response categories.

Statistical analysis

Data were entered and analysed using IBM SPSS Statistics, version 23.0. Categorical variables were summarised using frequencies (n) and percentages (%). Associations between categorical variables were examined using Pearson's chi-square test. Statistical significance was defined as a two-sided p-value < 0.05 . For key prevalence estimates, 95% confidence

intervals (CIs) were calculated using the Wilson score method.

Because the objective knowledge score was discrete and non-normally distributed, between-group comparisons were performed using the Mann-Whitney U test for variables with two groups and the Kruskal-Wallis H test for variables with three or more groups. Multivariable binary logistic regression analyses were performed to identify factors independently associated with self-medication, non-completion of the antibiotic course, and use of leftover antibiotics. Each model included the objective knowledge score, age, sex, place of residence, and educational level/status as independent variables. Adjusted odds ratios (aORs) with 95% CIs and corresponding p-values were reported. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test and Nagelkerke R^2 . Multicollinearity among independent variables was assessed using variance inflation factors (VIFs).

Results and Discussion

Questionnaire validation

All 26 questionnaire items demonstrated acceptable content validity. I-CVI values ranged from 0.83 to 1.00; 20 items achieved an I-CVI of 1.00, indicating agreement among all six experts, while six items achieved an I-CVI of 0.83, indicating agreement among five of the six experts. The overall S-CVI/Ave was 0.96, demonstrating excellent content validity.

Pilot testing among 20 adults from the target population indicated that the questionnaire items were generally clear, comprehensible, and relevant. Participant feedback resulted in minor wording and formatting modifications before finalisation of the questionnaire; no items were removed.

The three-item objective antibiotic knowledge index demonstrated acceptable internal consistency (KR-20 = 0.72). Corrected item-total correlations were 0.485, 0.538, and 0.602 for Q6, Q11, and Q13, respectively.

Characteristics of the study population

A total of 384 Armenian residents participated in the survey. The largest age group was 30 - 40 years (140, 36.5%), followed closely by participants aged 18 - 29 years (138, 35.9%). Participants aged 41 - 50 years accounted for 49 (12.8%), those aged 51 - 60 years for 47 (12.2%), and those aged ≥ 61 years for 10 (2.6%) of the sample. Overall, 195 participants (50.8%) resided in the regions of Armenia and 189 (49.2%) in Yerevan, indicating a relatively balanced geographical distribution.

Female participants accounted for 215 (56.0%) of the sample, while 169 (44.0%) were male. Regarding educational level/status, the largest group had secondary vocational education (177, 46.1%), followed by higher education (67, 17.4%), secondary education (57, 14.8%), Bachelor's degree (46, 12.0%), postgraduate education (19, 4.9%), and currently enrolled students whose degree had not yet been completed (18, 4.7%) (Table I).

Table I
Sociodemographic characteristics of the study population (n = 384)

Variable	Category	n (%)
Age, years	18 - 29	138 (35.9%)
	30 - 40	140 (36.5%)
	41 - 50	49 (12.8%)
	51 - 60	47 (12.2%)
	≥ 61	10 (2.6%)
Sex	Male	169 (44.0%)
	Female	215 (56.0%)
Residence	Yerevan	189 (49.2%)
	Regions	195 (50.8%)
Educational level/status	Secondary	57 (14.8%)
	Secondary vocational	177 (46.1%)
	Bachelor's degree	46 (12.0%)
	Higher education	67 (17.4%)
	Postgraduate	19 (4.9%)
	Currently enrolled student (degree not yet completed)	18 (4.7%)

Antibiotic-related behaviours among the general population

During the previous 12 months, 175 respondents (45.6%) reported using antibiotics once, 88 (22.9%) reported using them two to three times and 22 (5.7%) reported using antibiotics more than three times, whereas 99 (25.8%) reported no antibiotic use during this period. Overall, 285 respondents (74.2%; 95% CI: 69.6 - 78.3%)

reported using antibiotics at least once during the previous 12 months (Table II).

Regarding the main source influencing antibiotic selection, 124 respondents (32.3%) reported following a physician's recommendation, 104 (27.1%) relied on advice from pharmacy personnel, 87 (22.7%) selected antibiotics on their own, 48 (12.5%) followed recommendations from relatives or friends, 20 (5.2%)

relied on previous personal experience, and one respondent (0.3%) reported another source (Table II). The main reasons reported for antibiotic self-medication were the high cost of medical consultation (91, 34.9%), previous successful experience with the same antibiotic (62, 23.7%), difficulty accessing a physician or lack of time (48, 18.5%), belief that antibiotics would not cause harm (25, 9.6%), no previous perceived harm (20, 7.8%), and lack of trust in the physician or healthcare system (5, 1.8%). Ten respondents (3.6%) did not provide a response (Table II). Regarding the conditions for which antibiotics were most recently used, sore throat was the most frequently reported indication (91, 31.9%), followed by influenza (61, 21.4%), high fever (48, 16.8%), physician-diagnosed acute infection (40, 14.0%), common cold

(26, 9.1%), and preventive use (14, 4.9%). Other responses were reported by five participants (1.8%) (Table II).

The finding that 74.2% of respondents had used antibiotics at least once during the previous 12 months indicates substantial antibiotic exposure in the study population. Moreover, a considerable proportion of respondents relied on non-physician sources when selecting antibiotics. Pharmacy personnel influenced antibiotic selection for 27.1% of respondents, while 22.7% reported making the decision independently. The substantial contribution of pharmacy personnel is consistent with previous findings from Armenia, where pharmacy employees have been shown to play an important role in medicine selection and counseling (25).

Table II

Patterns of antibiotic use among the study participants

Code	Item	Response	n (%)
B1	Frequency of antibiotic use during the previous 12 months (n = 384)	Once	175 (45.6%)
		2 - 3 times	88 (22.9%)
		> 3 times	22 (5.7%)
		Never	99 (25.8%)
B2	Main source influencing antibiotic selection (n = 384)	Physician	124 (32.3%)
		Pharmacy personnel	104 (27.1%)
		Own decision	87 (22.7%)
		Relatives/Friends	48 (12.5%)
		Previous personal experience	20 (5.2%)
		Other	1 (0.3%)
B3	Main reason for antibiotic self-medication (n = 261)	High cost of medical consultation	91 (34.9%)
		Previous successful experience	62 (23.7%)
		Difficulty accessing a physician or lack of time	48 (18.5%)
		Belief that antibiotics would not cause harm	25 (9.6%)
		No previous perceived harm	20 (7.8%)
		Lack of trust in the physician/healthcare system	5 (1.8%)
		No response	10 (3.6%)
B4	Condition for most recent antibiotic use (n = 285)	Sore throat	91 (31.9%)
		Influenza	61 (21.4%)
		High fever	48 (16.8%)
		Physician-diagnosed acute infection	40 (14.0%)
		Common cold	26 (9.1%)
		Preventive use	14 (4.9%)
		Other responses	5 (1.8%)

The main reasons reported for self-medication were the high cost of medical consultation (34.9%), previous successful experience with the same antibiotic (23.7%), and difficulty accessing a physician or lack of time (18.5%). These findings suggest that antibiotic self-medication may be influenced by both healthcare-access barriers and previous personal experience. Similar factors, including previous experience, healthcare costs, limited access to medical consultation, and time constraints, have been identified as important drivers of antibiotic self-medication in previous studies and systematic reviews (9, 10).

The reported use of antibiotics for influenza (21.4%) and the common cold (9.1%) suggests that misconceptions regarding the effectiveness of antibiotics

against viral respiratory infections remain present among part of the study population. In addition, 4.9% of respondents reported preventive antibiotic use. These findings are concerning because antibiotics are not effective against viral infections such as influenza and the common cold, and unnecessary antibiotic exposure contributes to the development of antimicrobial resistance (4, 6, 21).

Several inappropriate antibiotic-related practices were identified. Overall, 261 respondents (68.0%; 95% CI: 63.1 - 72.4%) reported self-medication with antibiotics. A total of 204 respondents (53.1%; 95% CI: 48.1 - 58.1%) reported completing the full prescribed antibiotic course, whereas 180 (46.9%) reported not completing it. In contrast, only 123 respondents (32.0%;

95% CI: 27.6 - 36.9%) reported consistently following dosage instructions during antibiotic therapy. Furthermore, 173 respondents (45.1%; 95% CI: 40.1 - 50.1%) reported using leftover antibiotics from a

previous treatment for a new illness, while 184 (47.9%; 95% CI: 43.0 - 52.9%) considered it acceptable to use antibiotics prescribed for a family member or friend (Table III).

Table III

Self-reported antibiotic-related practices among the study participants (n = 384)

Code	Item	Yes, n (%) [95% CI]	No, n (%)
B5	Self-medication with antibiotics	261 (68.0%) [63.1 - 72.4]	123 (32.0%)
B6	Completion of the full prescribed antibiotic course	204 (53.1%) [48.1 - 58.1]	180 (46.9%)
B7	Adherence to antibiotic dosage instructions	123 (32.0%) [27.6 - 36.9]	261 (68.0%)
B8	Use of leftover antibiotics for a new illness	173 (45.1%) [40.1 - 50.1]	211 (54.9%)
B9	Acceptance of antibiotics prescribed for a family member or friend	184 (47.9%) [43.0 - 52.9]	200 (52.1%)

CI, confidence interval. 95% CIs were calculated using the Wilson method

The prevalence of antibiotic self-medication observed in the present study was high (68.0%). This proportion exceeds the 40.4% reported in a community-based study from Jordan and the 55.3% reported among community residents in Ethiopia. It is also higher than the global pooled prevalence of 43.0% reported in a recent systematic review and meta-analysis (26-28). Differences between studies may reflect variation in study populations, recall periods, healthcare accessibility, prescription enforcement, and access to antibiotics without medical consultation. Non-completion of antibiotic treatment was another important inappropriate practice, reported by 46.9% of respondents. This finding is comparable to the 48.8% prevalence of non-completion reported in a nationwide survey from Malaysia (29). Previous studies have similarly shown that premature discontinuation of antibiotics, particularly when symptoms improve, remains common (29, 30). These findings indicate that awareness of the importance of completing antibiotic treatment may not necessarily translate into appropriate treatment behaviour.

Leftover antibiotic use was also common, with 45.1% of respondents reporting that they used antibiotics remaining from a previous treatment course for a new illness. This proportion is higher than the 26% prevalence of prior leftover-antibiotic use reported in a recent survey (31) and the mean prevalence of 28.6% reported in an earlier systematic review and meta-analysis of antibiotic misuse in community settings (30). A large international outpatient survey also demonstrated that possession of leftover antibiotics was widespread, although possession and actual re-use represent distinct behaviours (32).

Acceptance of antibiotic sharing was similarly frequent: 47.9% of respondents considered it acceptable

to use antibiotics prescribed for a family member or friend. This proportion was approximately twice that reported in a recent community-based study, in which 23.7% of respondents considered sharing antibiotics with friends or family members for similar symptoms acceptable (33). Together, the high prevalence of self-medication, treatment non-completion, reuse of leftover antibiotics, and acceptance of shared antibiotics indicates that inappropriate antibiotic-use practices remain common and supports the need for interventions addressing both access to antibiotics and public understanding of appropriate antibiotic use. Although both items concern treatment adherence, B6 assessed completion of the full treatment duration, whereas B7 assessed consistent adherence to dosage instructions; therefore, the two items represent related but distinct behaviours.

Subgroup analyses

Subgroup analyses were conducted to examine differences in key antibiotic-related practices according to sex, age, place of residence and educational level/status. Significant differences by age were observed for self-medication, use of leftover antibiotics, and acceptance of antibiotics prescribed for another person (all $p < 0.001$). The highest prevalence of these practices was generally observed among participants aged 30 - 40 years, among whom 82.1% reported self-medication, 59.3% reported using leftover antibiotics, and 60.7% considered the use of antibiotics prescribed for another person acceptable. Significant differences were also observed across educational level/status groups for all three practices (all $p < 0.001$). In contrast, no statistically significant differences were observed according to sex or place of residence (all $p > 0.05$) (Table IV).

Table IV

Subgroup analysis of key antibiotic-related practices by sociodemographic characteristics

Characteristic	Self-medication, n (%)	Leftover antibiotic use, n (%)	Acceptance of shared antibiotics, n (%)
Sex	p = 0.889	p = 0.895	p = 0.761
Male (n = 169)	116 (68.6%)	75 (44.4%)	79 (46.7%)
Female (n = 215)	145 (67.4%)	98 (45.6%)	105 (48.8%)

Characteristic	Self-medication, n (%)	Leftover antibiotic use, n (%)	Acceptance of shared antibiotics, n (%)
Age, years	p < 0.001	p < 0.001	p < 0.001
18 - 29 (n = 138)	91 (65.9%)	59 (42.8%)	61 (44.2%)
30 - 40 (n = 140)	115 (82.1%)	83 (59.3%)	85 (60.7%)
41 - 50 (n = 49)	32 (65.3%)	17 (34.7%)	23 (46.9%)
51 - 60 (n = 47)	17 (36.2%)	11 (23.4%)	12 (25.5%)
≥ 61 (n = 10)	6 (60.0%)	3 (30.0%)	3 (30.0%)
Residence	p = 0.820	p = 0.894	p = 0.531
Yerevan (n = 189)	130 (68.8%)	84 (44.4%)	87 (46.0%)
Regions (n = 195)	131 (67.2%)	89 (45.6%)	97 (49.7%)
Educational level/status	p < 0.001	p < 0.001	p < 0.001
Secondary (n = 57)	37 (64.9%)	30 (52.6%)	27 (47.4%)
Secondary vocational (n = 177)	141 (79.7%)	100 (56.5%)	107 (60.5%)
Bachelor's degree (n = 46)	29 (63.0%)	18 (39.1%)	16 (34.8%)
Higher education (n = 67)	31 (46.3%)	16 (23.9%)	20 (29.9%)
Postgraduate (n = 19)	10 (52.6%)	3 (15.8%)	4 (21.1%)
Currently enrolled student (degree not yet completed) (n = 18)	13 (72.2%)	6 (33.3%)	10 (55.6%)

Data are presented as n (%). P values were obtained using Pearson's chi-square test

Multivariable analyses

In the multivariable logistic regression analyses, a higher objective antibiotic knowledge score was independently associated with lower odds of all three inappropriate antibiotic-use practices. For each one-point increase in the objective knowledge score, the adjusted odds of self-medication decreased by 46% (aOR = 0.54, 95% CI: 0.43 - 0.68, $p < 0.001$), non-completion of the antibiotic course by 53% (aOR = 0.47, 95% CI: 0.38 - 0.58, $p < 0.001$), and use of leftover antibiotics

by 49% (aOR = 0.51, 95% CI: 0.42 - 0.64, $p < 0.001$) (Table V).

The models demonstrated acceptable goodness of fit, with Hosmer-Lemeshow test p-values of 0.935, 0.587, and 0.238 and Nagelkerke R^2 values of 0.266, 0.225, and 0.281 for the self-medication, non-completion of the antibiotic course, and leftover-antibiotic-use models, respectively. No problematic multicollinearity was identified (maximum VIF = 2.59).

Table V

Multivariable logistic regression analysis of factors associated with antibiotic-related practices (n = 384)

Predictor	Self-medication aOR (95% CI), p	Non-completion aOR (95% CI), p	Leftover antibiotic use aOR (95% CI), p
Objective knowledge score, per 1-point increase	0.54 (0.43 - 0.68), < 0.001	0.47 (0.38 - 0.58), < 0.001	0.51 (0.42 - 0.64), < 0.001
Age 18 - 29	Ref.	Ref.	Ref.
Age 30 - 40	2.08 (1.11 - 3.90), 0.022	0.89 (0.51 - 1.54), 0.670	1.82 (1.04 - 3.18), 0.036
Age 41 - 50	0.95 (0.45 - 1.99), 0.890	0.80 (0.39 - 1.67), 0.556	0.70 (0.33 - 1.48), 0.352
Age 51 - 60	0.26 (0.12 - 0.58), < 0.001	0.59 (0.27 - 1.27), 0.174	0.35 (0.15 - 0.81), 0.014
Age ≥ 61	0.63 (0.16 - 2.55), 0.519	1.00 (0.25 - 4.00), 0.998	0.45 (0.10 - 2.01), 0.293
Female	Ref.	Ref.	Ref.
Male	1.00 (0.61 - 1.63), 0.995	0.69 (0.44 - 1.08), 0.104	0.87 (0.55 - 1.39), 0.568
Regions	Ref.	Ref.	Ref.
Yerevan	0.87 (0.52 - 1.45), 0.591	0.78 (0.49 - 1.23), 0.280	0.85 (0.53 - 1.37), 0.513
Secondary education	Ref.	Ref.	Ref.
Secondary vocational	1.22 (0.56 - 2.66), 0.608	1.70 (0.83 - 3.50), 0.147	0.76 (0.37 - 1.56), 0.455
Bachelor's degree	0.80 (0.32 - 2.01), 0.639	1.40 (0.58 - 3.40), 0.454	0.50 (0.21 - 1.22), 0.128
Higher education	0.36 (0.16 - 0.82), 0.016	1.53 (0.69 - 3.41), 0.294	0.23 (0.10 - 0.53), < 0.001
Postgraduate education	0.46 (0.15 - 1.48), 0.195	1.32 (0.41 - 4.28), 0.639	0.12 (0.03 - 0.51), 0.004
Currently enrolled student	0.63 (0.18 - 2.21), 0.466	2.57 (0.73 - 9.02), 0.141	0.21 (0.06 - 0.69), 0.011

aOR, adjusted odds ratio; CI, confidence interval; Ref., reference category. All models were adjusted for objective knowledge score, age, sex, place of residence, and educational level/status. All 384 participants were included in the multivariable regression analyses

A higher objective antibiotic knowledge score was consistently associated with more appropriate antibiotic-use practices. For each one-point increase in the knowledge score, the adjusted odds of self-medication decreased by 46%, non-completion of the antibiotic course by 53%, and use of leftover antibiotics

by 49%. This finding is consistent with evidence from Serbia, where inadequate antibiotic knowledge was associated with approximately threefold higher odds of self-medication (34), and with a Lebanese study in which lower antibiotic knowledge was associated with inappropriate treatment discontinuation and self-

medication (35). A recent systematic review and meta-analysis also found that greater antibiotic knowledge was associated with substantially lower odds of self-medication in low- and middle-income countries (10). These findings suggest that antibiotic knowledge may be an important modifiable factor associated with antibiotic-use behaviour, although the cross-sectional design does not allow causal inference.

Age and educational level/status were also independently associated with selected antibiotic-related practices. Participants aged 30 - 40 years had higher adjusted odds of self-medication and leftover antibiotic use than those aged 18 - 29 years, whereas participants aged 51 - 60 years had lower adjusted odds of both practices. Previous evidence on age has varied across settings, although a systematic review found younger age to be associated with higher odds of antibiotic self-medication in high-income countries (10). Regarding education, participants with higher education had lower adjusted odds of self-medication and leftover antibiotic use compared with those with

secondary education, while postgraduate education was also associated with lower odds of leftover antibiotic use. However, these associations should be interpreted in the context of substantial international variation: a meta-analysis of 85 studies from 42 countries found that the relationship between educational level and antibiotic misuse differed by geographical and economic setting (36).

Knowledge regarding antibiotic use

The objective antibiotic knowledge score, derived from Q6 (definition of antibiotics), Q11 (appropriate completion of an antibiotic treatment course), and Q13 (appropriateness of using an antibiotic prescribed for another person), ranged from 0 to 3. Overall, 87 respondents (22.7%) scored 0, 81 (21.1%) scored 1, 96 (25.0%) scored 2, and 120 (31.3%) achieved the maximum score of 3. The median knowledge score was 2 (IQR: 1 - 3). No statistically significant differences in knowledge scores were observed according to sex ($p = 0.269$), age ($p = 0.740$), place of residence ($p = 0.649$), or educational level/status ($p = 0.899$).

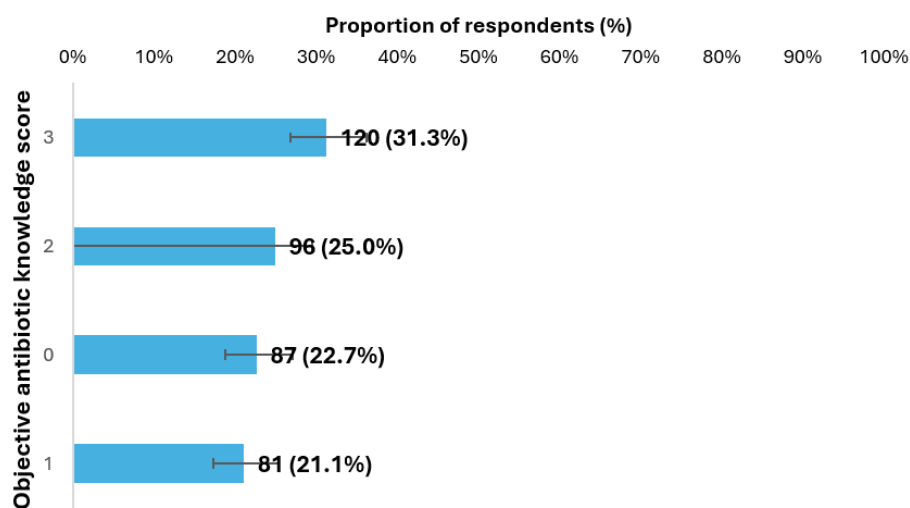


Figure 1.

Distribution of the objective antibiotic knowledge score among study participants ($n = 384$). Error bars represent 95% confidence intervals for the proportions

Objective antibiotic knowledge was significantly associated with self-medication. The prevalence of self-medication decreased progressively with increasing knowledge score, from 87.4% among respondents scoring 0 to 72.8% among those scoring 1, 62.5% among those scoring 2, and 55.0% among those scoring 3 (Pearson's $\chi^2 = 26.49$, $df = 3$, $p < 0.001$) (Figure 2A). The source of antibiotic selection did not differ significantly across objective knowledge-score categories (Pearson's $\chi^2 = 12.12$, $df = 12$, $p = 0.436$) (Figure 2B).

Respondents were also asked about the potential health consequences of inappropriate antibiotic use. Nearly half of respondents (184, 47.9%) recognised

that inappropriate antibiotic use may lead to the need for stronger and more expensive antibiotics. In comparison, 119 (31.0%) identified antimicrobial resistance as a potential consequence, and 58 (15.1%) recognised an increased risk of disease complications. A further 23 respondents (6.0%) believed that there would be no consequences if antibiotics were used for a short period (Figure 3). Nevertheless, the relatively low proportion identifying antimicrobial resistance as a consequence suggests that important knowledge gaps remain. These findings support the need for targeted educational interventions to improve public awareness of antimicrobial resistance and promote the rational use of antibiotics.

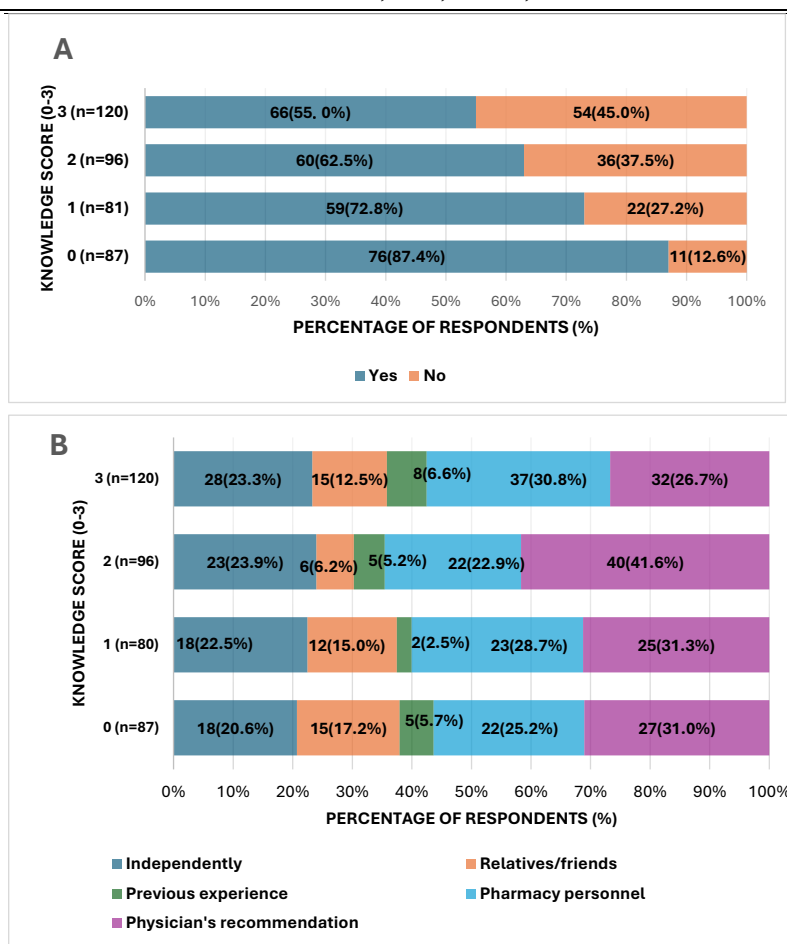


Figure 2.

Association of objective antibiotic knowledge score with antibiotic-related practices. (A) Self-medication according to objective antibiotic knowledge score ($n = 384$; Pearson's $\chi^2 = 26.49$, $df = 3$, $p = 0.000008$). (B) Source of antibiotic selection according to objective antibiotic knowledge score ($n = 383$; Pearson's $\chi^2 = 12.12$, $df = 12$, $p = 0.436$).

The "Other" category ($n = 1$) was excluded from this comparison because of the very small cell count

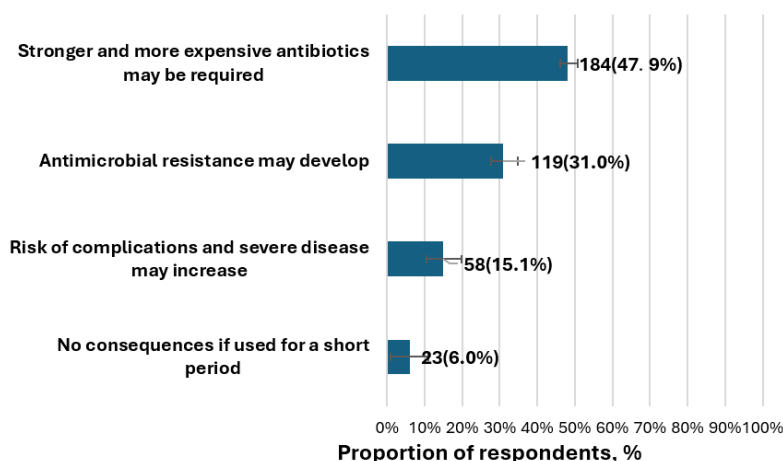


Figure 3.

Consumers' perceptions of the consequences of inappropriate antibiotic use ($n = 384$). Error bars represent 95% confidence intervals for the proportions.

Strengths and limitations of the study

This study has several strengths. It is one of the first population-based studies to evaluate antibiotic-related behaviours and knowledge among the general population in Armenia. The use of a structured and

validated questionnaire and the inclusion of participants from both Yerevan and the regions increase the relevance of the findings.

This study also has several limitations. First, because of its cross-sectional design, causal relationships cannot

be established. Second, the findings are based on self-reported information and may therefore be subject to recall and social desirability bias. Third, although the objective knowledge index demonstrated acceptable internal consistency, it comprised only three items addressing selected aspects of antibiotic-related knowledge and should therefore be interpreted as a brief study-specific measure rather than a comprehensive assessment of antibiotic knowledge. Finally, although the study included participants from Yerevan and all ten administrative regions of Armenia, the findings should be generalised to the entire adult population of Armenia with caution.

Conclusions

Inappropriate antibiotic use remains a significant public health concern among general population in Armenia. High levels of self-medication, non-completion of antibiotic treatment, inconsistent adherence to dosage instructions, and the use of leftover or shared antibiotics indicate that inappropriate antibiotic-related practices remain common. In addition, important gaps in antibiotic-related knowledge were identified, and higher objective knowledge was independently associated with lower odds of self-medication, non-completion of the antibiotic course, and leftover antibiotic use.

These findings highlight the need for targeted public education, improved health literacy, timely access to medical consultation and stronger antimicrobial stewardship initiatives to promote rational antibiotic use. Continued efforts to reinforce prescription regulations and enhance the educational role of physicians and pharmacists may contribute to reducing inappropriate antibiotic use and limiting the development of antimicrobial resistance. The findings provide baseline evidence on the antibiotic-related behaviours in Armenia and may support the development of national educational programmes and health policies aimed at promoting responsible antibiotic use.

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Availability of data and materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Yerevan State Medical University (Protocol No. 6-

10,9/26, dated 19 February 2026). All participants were informed about the purpose of the study and provided informed consent prior to participation. The study was conducted in accordance with the principles of the Declaration of Helsinki.

AI use disclosure

During the preparation and revision of this manuscript, the authors used ChatGPT for language editing and refinement. All content was reviewed and approved by the authors, who take full responsibility for the final content of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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