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ANTIBIOTIC SELF-MEDICATION PRACTICES AND ANTIMICROBIAL RESISTANCE AWARENESS AMONG STUDENTS OF BAHAUDDIN ZAKARIYA UNIVERSITY, MULTAN: A CROSS-SECTIONAL STUDY

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Abstract

The use of self-prescribed antibiotics is a public health problem, which could lead to the development of antimicrobial resistance (AMR) and inappropriate antibiotic use. Students at university are an important population to evaluate antibiotic usage and awareness of antibiotic resistance. The objectives of this study were to find the prevalence and trend of antibiotic self-medication, knowledge and awareness level of AMR and factors associated with AMR self-medication among the students of Bahauddin Zakariya University (BZU), Multan, Pakistan. A total of 427 undergraduate and post graduate students were used in an analytical cross-sectional study. The sociodemographic data, use of antibiotics, source of antibiotics and reasons for self-medication were collected with a structured questionnaire and AMR knowledge was evaluated using a closed-ended questionnaire. Descriptive statistics, chi-square tests and binary logistic regression were used to explore the prevalence and risk factors of antibiotic self-medication. 60.0% of the participants reported self-medication with antibiotics in the last 12 months. Pharmacies with no current prescription were the most frequently reported site of purchase of antibiotics (55.9%) and the most common indication for use was upper respiratory symptoms (35.5%). While 88.1% agreed that using antibiotics inappropriately helps to spread AMR, only 64.2% were correct that antibiotics are not effective against viral infections. There was a negative association between high AMR knowledge and self medication (adjusted odds ratio: 0.53; 95% confidence interval: 0.31–0.90; P = 0.019). The results emphasize the need to enhance AMR awareness, responsible use of antibiotics, and access to healthcare professionals among university

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students. Training for antimicrobial stewardship campaigns could be a way of addressing knowledge gaps and inappropriate antibiotic-use practices.

1. INTRODUCTION

Antimicrobial resistance (AMR) is a significant public-health problem affecting all countries globally, and poses a threat to the prevention and treatment of infectious diseases. Prolonged emergence and spread of resistant microorganisms is driven by inappropriate use of antimicrobials such as unnecessary use of antibiotics, wrong choice of antibiotic and unsupervised use (Ali et al., 2021; Elmahi et al., 2022). The high burden of antibiotic-resistant infections on the global stage and the importance of improving antimicrobial stewardship, public awareness and responsible antibiotic use have been highlighted in recent global surveillance efforts (World Health Organization 20,23). Antibiotic self-medication, or using antibiotics without a medical prescription or advice, is one of the main types of inappropriate use of antibiotics. This may be even more the case among university students, due to their independence in healthcare choices, previous treatment experience, the availability of pharmacies and their perceived ease of avoiding medical consultations (Rehman et al., 2026). A cross-sectional study was conducted in Bangladesh and revealed that 61.0% of university students had self-medicated using antibiotics in the last six months, highlighting the significance of such practices among university students (Wahab et al., 2023). The same, research conducted in Pakistan on university students showed concerns about antibiotic-use practices, knowledge about antibiotic-resistance and antimicrobial stewardship (Hussain et al., 2021; Shah et al., 2022). Knowledge of AMR doesn't always equate to correct antibiotic-use characteristics. Students may perceive the risks of resistance but still use antibiotics without medical advice due to misunderstandings about the distinction between bacterial and viral infections, the apparent severity of illness, the cost of antibiotics, and/or ready availability of antibiotics without prescription. Variation in antibiotic knowledge and self-medication practices have been revealed through research performed in university students in Bangladesh and Pakistan, indicating the importance of studying knowledge together with its associated behaviors as one unit and not as separate variables (Paul et al., 2022; Iqtadar et al., 2022). Medical education also indicates that significant deficiencies in antibiotic knowledge and antibiotic prescribing beliefs may continue throughout undergraduate training (Precha et al., 2024). Although there are available studies on the use of antibiotics among students in Pakistan, the information from institutions can be valuable due to the differences in academic background, health care access and health information exposure among students. In this context, Bahauddin Zakariya University (BZU), Multan, offers a suitable environment to explore these factors from all walks of academic disciplines. The correlation between the awareness of AMR and antibiotic self-medication may be useful in identifying educational needs and guide appropriate university-based programs on antimicrobial stewardship. Hence, the aim of this study was to assess the prevalence and pattern of self-medication in BZU students, evaluate their knowledge and awareness of AMR and to analyse their sociodemographic, academic and knowledge related factors associated with self-medication.

2. Materials and Methods

2.1. Study Design and Setting

A cross sectional analytical study was conducted to explore the antibiotic self-medication practices and awareness about antimicrobial resistance (AMR) among the students of Bahauddin Zakariya University (BZU), Multan, Punjab, Pakistan. The study was to find the prevalence and pattern of self-medication of antibiotic medicines, study the students' knowledge about AMR and identify the factors associated with self-medication. A university environment was used to study antibiotic usage among students of various study programs.

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2.2. Study Population and Eligibility Criteria

The subject was undergraduate and post-graduate students of BZU. Students aged 18 years or older and currently enrolled at the university and willing to provide informed consent were included. People not enrolled, who rejected the enrolment or who did not provide enough information to be classified as the primary outcome were excluded from the analytical sample. All participation in the research was voluntary and confidentiality was respected throughout the research process.

2.3. Sample Size Determination

A sample size was determined using the single-population proportion formula:

[
n=\frac{Z^2p(1-p)}{d^2}
]

where (n) is sample size needed, (Z=1.96) is the value for a 95% confidence interval, (p=0.50) is the assumed prevalence of antibiotic self-medication, and (d=0.05) is the desired absolute precision. Given the lack of a reliable prevalence estimate from a similar population, an expected prevalence of 50% was chosen for a conservative estimate. A minimum of 384 participants were calculated. The sample size of approximately 427 participants was inflated by 10% for possible non-response.

2.4. Sampling Technique

A stratified sampling approach was recommended to provide representation across disciplines and degrees. The eligible student population would be split according to the relevant academic stratum and the number of eligible students in each stratum would be used to allocate participants. Random sampling within strata was preferred, when available, to ensure a suitable sampling frame. If probability sampling was not possible, the recruitment method would be described in detail and considerations would be given to any potential selection bias and generalizability during interpretation.

2.5. Questionnaire Development and Data Collection

A structured self-administered questionnaire was to be used to gather data on KAPs regarding antibiotics and AMR, based on existing literature. The questionnaire was divided into five domains which included sociodemographic and academic characteristics, antibiotic-use practices, self-medication behavior, AMR knowledge and awareness, and healthcare-seeking behavior. The sociodemographic segment included age, gender, academic discipline, level of degree, academic year and place of residence. The antibiotic-use section was used to determine antibiotic usage in the past, symptoms that encouraged antibiotic use, the frequency of antibiotic use and the types of antibiotic used, that were reported. Questions regarding self-medication included the access to antibiotics without a prescription, re-use of previous prescriptions, use of "old" prescriptions, and reasons for such use. The following items were also evaluated for the source of antibiotic procurement namely: Medicines shop or pharmacy/available antibiotic. In the knowledge section understanding of antibiotic indications, bacterial and viral infection, development of AMR and implications of inappropriate antibiotic use were explored. The aim of the questionnaire was to have clear and standardized questions and predetermined answers to ease data collection and data analysis.

2.6. Questionnaire Validation and Pilot Testing

The questionnaire was to be expert reviewed to judge the relevance of the content, clarity and relevance of the aims of a study. The instrument would be evaluated by experts in public health, microbiology, pharmacology, or epidemiology. Pilot testing would be done on a small sample of students with characteristics similar to the characteristics of the students of the main analytical sample, but not in the main analytical sample. The pilot test will analyze the understanding of the questions, the appropriateness of the answer options, the time required to complete the test and the suitability of the test for administration. The necessary revisions would be made prior to the main survey. In the

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case of multi-items knowledge scales, reliability would be evaluated where appropriate and changes would be noted after pilot testing.

2.7. Operational Definitions and Study Variables

The main outcome was antibiotic self-medication, which was defined as using antibiotics without a prescription or suitable professional authorization to treat the illness in the last 12 months. Subjects who reported at least one qualifying episode were considered as having self-medicated with antibiotics while the subjects who reported no qualifying episode were considered as non-self-medicating. The primary outcome variable was coded as a binary variable, where 1 indicated self-medication and 0 indicated that no self-medication was done. Secondary outcomes were the prevalence of AMR and pattern of antibiotic use, reasons for self-medication, and sources of antibiotic procurement, AMR knowledge scores, and healthcare seeking practices. Explanatory variables tested were age, gender, academic discipline, degree level, academic year, residence, previous use of antibiotics, access to health care and sources of health information, as well as AMR knowledge scores. Antibiotic self-medication was separated from other inappropriate antibiotic use, such as not following the professionals' advice after a prescription has been given.

2.8. Assessment of AMR Knowledge and Awareness

Structured questions to measure AMR knowledge included questions on antibiotic indications, difference between bacterial and viral infections, development of resistance, the role of inappropriate antibiotic use in resistance, consequences of AMR, and risks of sharing/reuse of antibiotics. All of the knowledge items were marked using a standard answer booklet. 1 point was awarded for correct answers and 0 points for incorrect and “do not know” answers. The overall knowledge score is the sum of the scores of the items, where higher scores represent more knowledge of AMR and proper antibiotic use. A defensible scoring approach would be established prior to the main analysis and any categorical classification of levels of knowledge would be explained. The knowledge scores and self-report antibiotic-use behaviours were treated as independent constructs.

2.9. Data Management and Quality Assurance

The filled-out questionnaires were supposed to be checked for internal consistency and completeness prior to data entry. Participants were each given an individual study identification number and extraneous personal identifiers were removed from the analytical data set. Data validation was to be done for entry errors, inconsistencies, multiple entries & missing observations. There was to be a standard coding system and rules to deal with the missing data to ensure data quality and reproducibility.

2.10. Statistical Analysis

The data were analyzed in IBM SPSS Statistics (Version 26.0). Descriptive statistics, chi-square or Fisher's exact tests were used as appropriate to identify factors associated with antibiotic self-medication, and results reported as frequencies, percentages, odds ratios and 95% confidence intervals; statistical significance was defined as $P < 0.05$.

2.11. Ethical Considerations

The study protocol was to be reviewed with the appropriate institutional ethics review committee prior to recruitment of participants and data collection. They consented to participate in the study, and participation was voluntary. Anonymized analytical records, secure data storage and access to study information were used to ensure confidentiality. It was explained to the participants that they were free to refrain from participating or to withdraw from participation without penalty. Final manuscript would contain details of approving ethics committee, approval reference number & approval date (where applicable). Any details of ethics approval would not be reported without formal approval.

2.12. Reporting Standards

The manuscript was organised around the recommendations of the Strengthening the Reporting of Observational Studies in

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Epidemiology (STROBE) for cross-sectional studies. The reporting would include description of study design, selection of participants, definitions of the variables, calculation of sample size, methods used to collect data, statistical analysis, missing data, and possible sources for bias to ensure transparency and reproducibility.

3. Results

3.1. Sociodemographic and Academic Characteristics of Participants

The total number of students in the university that were analysed was 427. Participants came from various age groups, academic disciplines and educational levels. The highest number were aged 21-23 years (47.1%), aged 18-20 years (28.6%) and aged 24 years or above (24.4%). A total of 53.9% of the study population were female students while 46.1% were male students. The majority of the participants were undergraduate (83.1%) and 16.9% were post Graduate students. Academic background, 35.1% of students were from health and biological sciences, 34.0% from other sciences and engineering and 30.9% from arts, social sciences and business. The participation distribution of the categories was used as a basis to analyse the differences in antibiotic self-medication patterns and awareness of AMR by academic and demographic characteristics (Table 1).

Table 1. Sociodemographic and academic characteristics of participants

Characteristic	Frequency (\(n\))	Percentage (%)
Age group (years)		
18–20	122	28.6
21–23	201	47.1
≥24	104	24.4
Gender		
Male	197	46.1
Female	230	53.9
Degree level		
Undergraduate	355	83.1
Postgraduate	72	16.9
Academic discipline		
Health and biological sciences	150	35.1
Other sciences and engineering	145	34.0
Arts, social sciences, and business	132	30.9
Total	427	100.0

3.2. Prevalence and Patterns of Antibiotic Self-Medication

In the past 12 months, 60.0% (95% CI: 55.3–64.5%) of the 427 participants reported using antibiotics for self-treatment. The remaining 171 (40.0%) indicated that they did not practice antibiotic self-medication in the same period. For those who reported self-medicating, upper respiratory symptoms (such as sore throat) were the most common reason to use antibiotics (35.5%), followed by fever (25.4%) and gastrointestinal symptoms (16.8%). Among all symptoms, urinary symptoms constituted 12.1% and other symptoms constituted 10.2%. Pharmacies were the most common source for antibiotics reporting (55.9%) of those respondents who said they self-medicated, and that they got the antibiotic without a current prescription. The remaining antibiotics made up 22.3% of reported sources and 12.5% of those antibiotics were from family members or friends. Other sources represented 9.4%. The most common primary reasons given for self-medication were convenience (29.7%), previous experience of similar symptoms (26.6%) and avoiding cost of consultation (21.1%). Other reasons were

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reported by 8.2% of the participants, and perceived mildness of the illness reported by 14.5% of the participants. The results suggest that all of these elements, namely access to non-prescribed drugs, previous experiences of use, and practical aspects were prominent in the reported self-medication practices (Table 2).

Table 2. Prevalence and patterns of antibiotic self-medication Panel A. Overall prevalence

Self-medication status	Frequency (\(n\))	Percentage (%)
Yes	256	60.0
No	171	40.0
Total	427	100.0

Panel B. Symptoms, sources, and reasons among participants reporting self-medication

Characteristic	Frequency (\(n\))	Percentage (%)
Symptoms prompting antibiotic use		
Sore throat or upper respiratory symptoms	91	35.5
Fever	65	25.4
Gastrointestinal complaints	43	16.8
Urinary symptoms	31	12.1
Other symptoms	26	10.2
Source of antibiotics		
Pharmacy without a current prescription	143	55.9
Leftover antibiotics	57	22.3
Family members or friends	32	12.5
Other sources	24	9.4
Main reason for self-medication		
Convenience or time constraints	76	29.7
Previous experience with similar symptoms	68	26.6
Avoiding consultation costs	54	21.1
Perceived mildness of illness	37	14.5
Other reasons	21	8.2

Each subsection uses 256 participants as the denominator. Percentages may differ slightly from 100% because of rounding.

3.3. Knowledge and Awareness of Antimicrobial Resistance

The level of knowledge of participants around antibiotics and AMR varied. By far the majority of respondents were aware of the value of following the instructions of their professional (89.5%) and knew that improper use of antibiotics may be able to help antimicrobial resistance (88.1%). Moreover, 85.5% correctly said that antibiotics are used to cure bacterial infection, and 82.2% stated that antibiotics should not be used by other people. 77.0% of the participants reported knowing about the risk of resistant bacteria spreading among people. The recognition of the lack of efficacy of antibiotics in the treatment of viral infections (including influenza) was somewhat lower at 64.2% suggesting a potential knowledge gap about antibiotic indications. Moderate knowledge was shown by 190 (44.5%) participants, low knowledge was shown by 120 (28.1%) participants and high knowledge was shown by 117 (27.4%) participants according to the predefined categories of knowledge. Overall, with relatively high knowledge of resistance as such, but with some misconceptions in relation to the indications for antibiotic use (Table 3).

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Table 3. Knowledge and awareness of antibiotics and antimicrobial resistance

Knowledge item	Correct responses, \(n\) (%)
Antibiotics are effective against bacterial infections	365 (85.5)
Antibiotics are not effective against viral infections such as influenza	274 (64.2)
Inappropriate antibiotic use can contribute to AMR	376 (88.1)
Resistant bacteria may spread between people	329 (77.0)
Antibiotics should not be shared with other people	351 (82.2)
Antibiotics should be used according to professional instructions	382 (89.5)
Overall knowledge category	
Low knowledge	120 (28.1)
Moderate knowledge	190 (44.5)
High knowledge	117 (27.4)

AMR, antimicrobial resistance.

3.4. Association Between Participant Characteristics and Antibiotic Self-Medication

There were significant differences between the prevalence of antibiotic self-medication between the different demographic and academic groups. Sixty-six per cent of males and 54.8 per cent of females reported self-medicating. The difference was statistically significant in the bivariate analysis (P=0.019). The prevalence was 57.4% for the 18 to 20-year-old age group, 63.7% for the 21 to 23-year-old age group, and 55.8% for the 24 years and older age group. No statistically significant overall correlation was found between the ages group and self-medication (P=0.465). Notable differences also were found within disciplines of study. Sixty-three percent of the students in health and biological sciences, 62.8 percent of the students in other sciences and engineering, and 53.0 percent of the students in arts, social sciences, and business reported self-medicating. This overall association between academic discipline and self-medication, however, was not statistically significant (P=0.42). There was a clearer gradient across the AMR knowledge categories. People who had low knowledge (68.3%), moderate knowledge (62.1%), and high knowledge (47.9%) had the highest prevalence of self-medication, respectively. The statistical significance (P=0.009) was observed between knowledge category and self-medication. Table 4 shows that the differences in terms of self-medication behavior based on gender and AMR knowledge were statistically different while the differences across age groups and academic disciplines were not significantly different.

Table 4. Bivariate associations between participant characteristics and antibiotic self-medication

Characteristic	Self-medication, \(n/N\) (%)	No self-medication, \(n/N\) (%)	\(P\)-value
Gender			0.019
Male	130/197 (66.0)	67/197 (34.0)	
Female	126/230 (54.8)	104/230 (45.2)	
Age group (years)			0.465
18–20	70/122 (57.4)	52/122 (42.6)	
21–23	128/201 (63.7)	73/201 (36.3)	
≥24	58/104 (55.8)	46/104 (44.2)	
Academic discipline			0.421
Health and biological sciences	95/150 (63.3)	55/150 (36.7)	
Other sciences and engineering	91/145 (62.8)	54/145 (37.2)	

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Arts, social sciences, and business	70/132 (53.0)	62/132 (47.0)	
AMR knowledge category			0.009
Low	82/120 (68.3)	38/120 (31.7)	
Moderate	118/190 (62.1)	72/190 (37.9)	
High	56/117 (47.9)	61/117 (52.1)	

3.5. Association Between AMR Knowledge and Antibiotic Self-Medication

The percentage of participants who reported antibiotic self-medication was found to be lower the higher their knowledge of AMR. 68.3% of participants with low knowledge, 62.1% with moderate knowledge and 47.9% with high knowledge reported self-medication. There was a significant difference in prevalence of self-medication between the knowledge categories (\(P=0.009\)). The prevalence of self-medication was lower in the high-knowledge group than in the low-knowledge group with an absolute difference of ~ 20.4 percentage points. The inverse relationship observed between AMR knowledge and self-medication behaviour in the study population suggests that the higher the knowledge of AMR, the less the self-medication behaviour. However, the use of antibiotics may be influenced not only by knowledge but also by accessibility of the service, previous experience with illness, perceived severity of illness, and seeking health-care. Thus, the observed association should be interpreted in light of the multivariable analysis and limitations of the cross-sectional design. The prevalence of antibiotic self-medication decreased with increasing AMR knowledge, from 68.3% among participants with low knowledge to 47.9% among those with high knowledge (Figure 1).

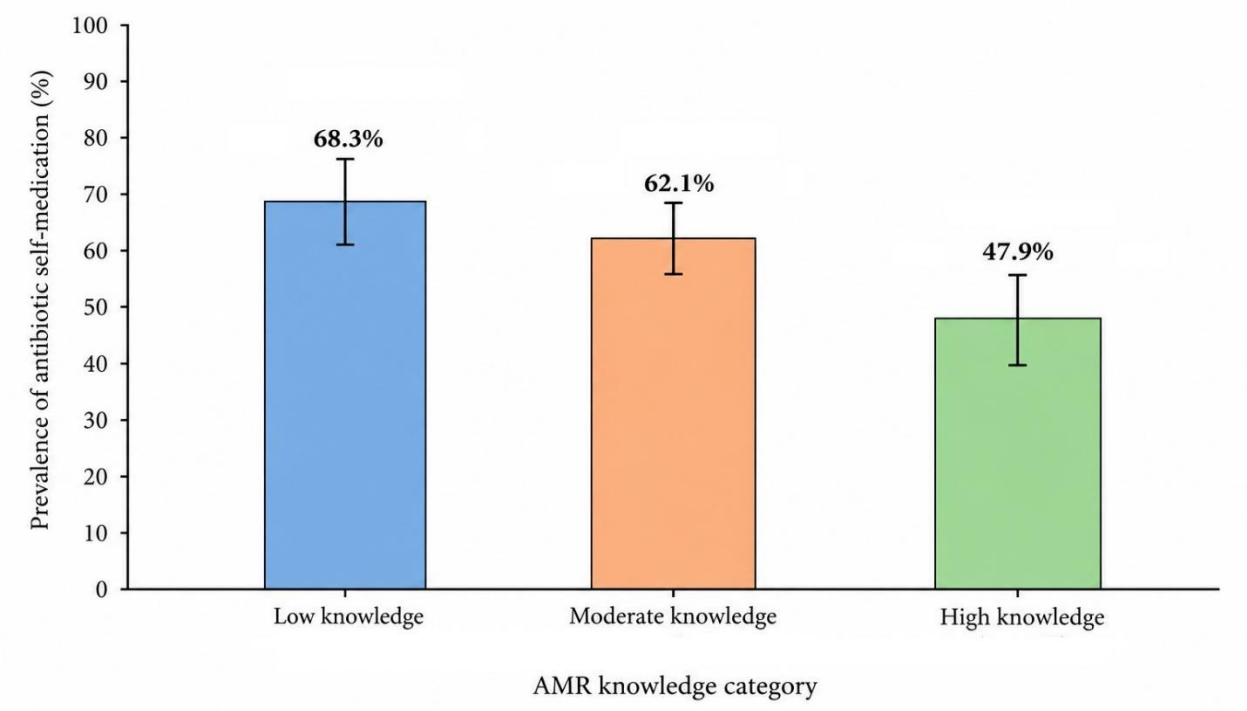


Figure 1. Prevalence of antibiotic self-medication according to AMR knowledge category. Bars represent the percentage of participants reporting antibiotic self-medication in each knowledge category, with 95% confidence intervals.

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3.6. Multivariable Analysis of Factors Associated With Antibiotic Self-Medication

Selected demographic and academic factors were used as a priori considerations in multivariable logistic regression to assess factors associated with antibiotic self-medication. Females were less likely to self-medicate compared to males (adjusted OR: 0.66; 95% CI: 0.44–0.98; \(P=0.040\)). The participants who had high AMR knowledge also had low odds of self-medicating compared with those who had low knowledge (adjusted OR 0.53, 95% CI 0.31–0.90, (P=0.019). Even after adjusting for the other variables entered into the model this association remained statistically significant. The estimated odds were about 47% less in the high-knowledge category, but this does not prove that higher levels of knowledge necessarily lead to a reduction in self-medication rate. No significant association was found between moderate AMR knowledge and self-medication compared to low knowledge, (adjusted OR: 0.78; 95% CI: 0.47–1.29; (P=0.331). In addition, there was no significant independent association between age group or academic discipline in self-medication in the fitted model. Combined, the regression results indicated that gender and level of knowledge about AMR were significant after controlling for the other variables when predicting self-medication behavior. The associations and not causal effects should be considered (Table 5).

Table 5. Multivariable logistic regression analysis of factors associated with antibiotic self-medication

Variable	Adjusted OR	95% CI	\(P\)-value
Gender			
Male (reference)	1.00	Reference	—
Female	0.66	0.44–0.98	0.040
Age group (years)			
18–20 (reference)	1.00	Reference	—
21–23	1.24	0.77–2.01	0.375
≥24	0.98	0.56–1.71	0.941
Academic discipline			
Health and biological sciences (reference)	1.00	Reference	—
Other sciences and engineering	0.95	0.58–1.55	0.837
Arts, social sciences, and business	0.72	0.44–1.17	0.181
AMR knowledge category			
Low (reference)	1.00	Reference	—
Moderate	0.78	0.47–1.29	0.331
High	0.53	0.31–0.90	0.019

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

4. Discussion

Sixty percent of the students self-medicate, indicating that non-prescription antibiotic use may be a significant public health issue with university students. This was similar to a multicentre study conducted among Bangladeshi university students, where 61.0% self-medicated with antibiotics in the last 6 months (Xu et al., 2019). A systematic review of the studies conducted in Pakistani Universities also pointed out that self-medication of antibiotics is common practice (Khaliq et al. 2024). Prevalence estimates should be compared with awareness of differences in recall periods and participant selection and operational definitions. In the current practice dataset, upper respiratory symptoms and fever were a major reason for antibiotic use. These patterns are worrisome because of the potential for using antibiotics to treat diseases that could be viral. Viral infections do not respond to antibiotics and people who use them unnecessarily run the risk of experiencing side effects that they don't need, and ultimately create selection pressure for antimicrobial resistance (WHO, 2025).

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Antibiotics were most commonly reported from a pharmacy. The discovery underscores the need for proper medication dispensing, availability of trained health care providers and enforcement of the current laws. In a systematic review and meta-analysis, Ahmed et al. (2023) found several interacting factors which determined antibiotic self-medication, suggesting that the behavior is not a result of a single factor. Interventions, then, may need to be implemented in addition to public education, due to convenience, prior treatment experiences and perceived financial barriers. While many participants in these results acknowledged the connection between inappropriate antibiotic use and AMR, the knowledge of bacterial versus viral infections was relatively low. This separation is crucial because, while people might be aware of the concept of resistance, this does not mean they have the knowledge to make the right decisions when it comes to treatment options. These have also been reported in studies of university students, where there were still gaps in knowledge, along with inappropriate intentions to use antibiotics, despite some knowledge of AMR (Nogueira-Uzal et al., 2020; Tran et al., 2023). Educational interventions for universities, therefore, should not only be about the definition of antimicrobial resistance. They should describe circumstances for the use of antibiotics and the lack of self-diagnosis as a reliable method, and discuss the need for professional advice before taking antibiotics. These activities are linked to WHO's activities addressing AMR by generating evidence and implementing context-specific interventions to address AMR, especially in LMC countries (WHO, 2023). This finding is important in the dataset: There was an inverse correlation between AMR knowledge and self-medication with antibiotics. The prevalence of self-medication reduced from 68.3% for low knowledge to 47.9% for high knowledge group. High knowledge was found to be negatively associated with self-medication (adjusted OR = 0.53) in the adjusted model. This is in line with Albadrani et al. (2022) who found that higher knowledge about antibiotics was significantly associated with reduced self-medication in LMICs. But even knowledge can be of little help where it is easy to access antibiotics, cost is a barrier, or there are ingrained self-treatment patterns. The results showed that the male participants were found to be more likely to be self-medicating than the female participants. The adjusted association was supported by the overall finding from the meta-analysis that was conducted by Behzadifar et al. (2020) which revealed that the sex of the participant to be associated with antibiotic self-medication. However, it is important not to see gender as a direct cause of the behaviour. Variations in health-seeking behavior, social norms, and access to health care advice could play a role and be explored further. The findings reinforce the need for a multi-faceted strategy based on: AMR education on campus, enhanced access to professional health care, responsible dispensing of antimicrobials and antimicrobial stewardship. These actions align with the WHO's priorities for country-specific interventions and awareness of AMR (Qudrati et al., 2025). The proposed study has strengths, such as a focus of both self-medication and AMR knowledge, and examining the demographic and behavioral correlates. Some limitations are the cross-sectional design, possible recall or social-desirability bias, and generalizability of the results from a single university. The findings also are unable to prove that self-medication led to antimicrobial resistance, as no microbiological resistance testing was done.

Conclusion

Self-medication with antibiotics is an important public-health issue among university students, which could have implications for the use of antibiotics and antimicrobial resistance. The results show that despite the high level of awareness of antibiotic resistance there are knowledge gaps regarding indications for antibiotic use. Self-medication was negatively associated with higher levels of AMR knowledge, highlighting the need for specific educational interventions. University based antimicrobial stewardship programs should encourage responsible use of antibiotics, discourage self-treatment with antimicrobials, and advise the use

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of appropriately trained healthcare professionals. Cooperation among University administrations, health care professionals and pharmacists may contribute to enhancing awareness and access to appropriate treatment. These results need to be confirmed by additional multicenter research.

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