ORIGINAL RESEARCH ARTICLE

Knowledge, Attitudes, and Practices Related to Antibiotic Resistance Among Medical Students in Bangladesh: A Cross-Sectional Study

Md.Towhidur Rahman[1], Sabiha Karim Bably[2], Moinul Hasan Sadik[3]

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Abstract

Background Antibiotic resistance is a major global public health challenge driven largely by inappropriate antibiotic use. Medical students are future prescribers and key targets for antimicrobial stewardship education. This study assessed knowledge, attitudes, and practices related to antibiotics and antimicrobial resistance among medical students in Bangladesh.

Methods A multicenter cross-sectional study was conducted between September 2024 and August 2025 among medical students from seven medical colleges in Bangladesh. Data were collected using a structured self-administered questionnaire. Knowledge scores ranged from 0 to 12. Descriptive statistics, binary logistic regression, and receiver operating characteristic curve analysis were performed using R statistical software.

Results A total of 333 students participated; 52.6% were male, and the mean age was 23.1 years. Correct knowledge was highest for antibiotic use in bacterial infections (94.9%), followed by the fact that resistant infections are harder and costlier to treat (88.6%), that missed doses affect treatment outcomes (85.9%), and that broad-spectrum antibiotics affect both beneficial and harmful bacteria (83.5%). The completion of prescribed courses is important (83.2%). Additionally, 64.9% of students reported not using leftover antibiotics, while 35.1% reported using them. Positive attitudes toward rational antibiotic use were observed in 55.6%. Attitudes and antibiotic demand in mild illness moderately predicted leftover antibiotic use (AUC = 0.639; 95% CI: 0.580–0.698).

Conclusion Medical students demonstrated adequate basic knowledge but had important gaps in policy, non-bacterial infections, and responsible antibiotic use. Targeted antimicrobial stewardship education should emphasize policy awareness, clinical decision-making, and behavior-focused training.

Keywords Anti-Bacterial agents; Antimicrobial Stewardship, Drug resistance, Medical, Students

✉ Md.Towhidur Rahman
towhidurnayeem@gmail.com

1. Department of Zoology, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh
2. Faculty of Medicine, Ibrahim Medical College, Dhaka 1200, Bangladesh
3. Faculty of Medicine, University of Dhaka, Dhaka 1200, Bangladesh

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1 Introduction

Antibiotic resistance (AR) has emerged as one of the most serious global public health challenges, threatening decades of progress in the prevention and treatment of infectious diseases. The World Health Organization (WHO) identifies antimicrobial resistance as a major cause of prolonged illness, increased mortality, and rising healthcare costs worldwide.[1] In 2019, bacterial antimicrobial resistance was directly responsible for an estimated 1.27 million deaths and was associated with nearly 5 million deaths globally.[2] Without effective interventions, the continued escalation of resistance is expected to compromise routine medical procedures, including surgery, chemotherapy, and organ transplantation.[3]

Misuse and inappropriate use of antibiotics remain the principal drivers of antimicrobial resistance. Practices such as self-medication, unnecessary use of broad-spectrum antibiotics, premature discontinuation of treatment courses, and the use of antibiotics for viral and fungal infections significantly contribute to the emergence and spread of resistant pathogens.[1,4] These challenges are particularly pronounced in low- and middle-income countries, where weak regulatory enforcement, over-the-counter availability of antibiotics, and limited public awareness further exacerbate inappropriate antibiotic use.[5,6]

Medical students' knowledge, attitudes, and practices (KAP) regarding antibiotic use are especially important, as prescribing behaviors and professional norms are often established during undergraduate medical training. Evidence suggests that inappropriate attitudes among healthcare trainees are associated with higher rates of unnecessary prescribing, self-medication, and patient-driven antibiotic demand in clinical settings.[2] Globally, 30–50% of medical students incorrectly believe that antibiotics are effective against viral infections, and up to 40% report self-medication without a prescription, with higher proportions reported in South Asia.[2,3,7–9] These findings highlight critical gaps in early medical education and underscore the importance of targeting medical students as future prescribers for antimicrobial stewardship interventions.

In Bangladesh, antibiotic misuse is widespread due to over-the-counter availability, weak regulatory enforcement, and limited public awareness.[9,10] Surveys indicate that 40–60% of university and medical students engage in self-medication, frequently stopping treatment courses prematurely or using leftover antibiotics.[9] Although previous studies in Bangladesh have assessed medical students' knowledge regarding antibiotics, most were limited to single institutions with small sample sizes and did not comprehensively evaluate how attitudes and antibiotic demand predict inappropriate practices. Moreover, few studies have applied analytical models to quantify these relationships, limiting the evidence base for targeted educational interventions.

To address these gaps, we conducted a multicenter cross-sectional study to comprehensively assess medical students' KAP related to antibiotic use and antimicrobial resistance in Bangladesh. The study also aimed to identify predictors of inappropriate antibiotic practices, with particular emphasis on the role of attitudes and antibiotic demand, to inform the integration of antimicrobial stewardship principles into undergraduate medical curricula.

2 Methods

Study Design

A multicenter cross-sectional study was conducted to assess KAP related to antibiotic use and antimicrobial resistance among medical students in Bangladesh.

Setting

The study was carried out in seven medical colleges selected to ensure institutional and geographic representation: Shaheed Ziaur Rahman Medical College, Mymensingh Medical College, Rangpur Medical College, Dinajpur Medical College, Suhrawardy Medical College, Tangail Medical College, and Ibrahim Medical College. Data collection took place between September 2024 and August 2025.

Participants

Undergraduate and graduate medical students enrolled at the selected institutions during the study period were eligible to participate. Inclusion criteria were enrollment at one of the selected colleges, presence during data collection, and provision of written informed consent. Students who were absent during data collection, declined participation, or submitted incomplete questionnaires were excluded.

Study Population and Sample Size

The study population comprised medical students from the seven participating colleges who met the inclusion criteria. The required sample size was calculated using the single population proportion formula: $n = Z^2 \times p \times (1 - p) / d^2$, assuming a prevalence of 50%, a 95% confidence level, and a 5% margin of error. A convenience sampling approach was employed due to logistical constraints and variable academic schedules across institutions. A total of 333 completed questionnaires were included in the final analysis; missing data were not replenished.

Data Collection Instrument and Procedure

Data were collected using a researcher-developed, structured, self-administered questionnaire designed

based on existing literature and established frameworks addressing antibiotic use and antimicrobial resistance.[9,11-13] The questionnaire consisted of four sections: sociodemographic characteristics, knowledge of antibiotics and antimicrobial resistance, attitudes toward antibiotic use, and self-reported antibiotic practices.

Content validity was assessed through expert review by specialists in pharmacology, microbiology, and public health. Reliability was evaluated using Cronbach's alpha, which yielded 0.82, indicating good internal consistency. A pilot test involving 20 medical students from a non-participating institution was conducted to assess clarity and comprehension, and minor modifications were made accordingly. Questionnaires were distributed in person and collected immediately after completion. Anonymity was maintained to minimize social desirability bias and encourage honest responses.

Assessment of Knowledge on Antibiotics and Antimicrobial Resistance

Knowledge was assessed using 12 statements related to antibiotic use and antimicrobial resistance. Participants responded to each statement with "yes," "no," or "I don't know." Correct responses were predefined based on established clinical guidelines and peer-reviewed literature. Each correct answer was awarded one point, resulting in a total possible knowledge score ranging from 0 to 12. No weighting or score transformation was applied. Frequencies and percentages of correct, incorrect, and "don't know" responses were calculated for each statement.

Assessment of Attitudes and Practices

Antibiotic practice was assessed using a primary behavioral indicator: whether leftover antibiotics were used or not. Participants were categorized as reporting either no leftover antibiotic use or leftover antibiotic use. Attitudes toward antibiotic use were evaluated in two dimensions. Overall attitude toward rational antibiotic use was assessed using multiple items and dichotomized into positive or negative categories based on the median score. Demand for antibiotics in cases of mild illness was measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree" and was treated as an ordinal variable in regression analyses.

Data Management and Statistical Analysis

Data were entered, managed, and analyzed using R statistical software (version 4.5.2).[14] Descriptive statistics were used to summarize participant characteristics and KAP variables, presented as frequencies and percentages. Knowledge response patterns were summarized using proportions, and knowledge score distributions were examined descriptively.

Binary logistic regression analysis was conducted to examine associations between attitudes and leftover antibiotic use, with use of leftover antibiotics coded as the dependent variable (yes = 1, no = 0). Independent variables included overall attitude toward antibiotic use (positive vs. negative) and demand for antibiotics in mild illness (ordinal). Model discrimination was evaluated using a Receiver Operating Characteristic (ROC) curve, and the area under the curve (AUC) with 95% confidence intervals was estimated using 2,000 stratified bootstrap replicates. An AUC of 0.5 was considered indicative of no discriminatory ability.

3 Results

Knowledge of Antibiotics and Antimicrobial Resistance

Table 1 summarizes participants' responses to the 12 statements assessing knowledge of antibiotics and antimicrobial resistance. High proportions of correct responses were observed for statements related to the use of antibiotics in bacterial infections (94.9%), the difficulty and cost associated with treating resistant infections (88.6%), the consequences of missed doses affecting treatment outcomes (85.9%), the effects of broad-spectrum antibiotics on both beneficial and harmful bacteria (83.5%), and the importance of completing the full course of treatment (83.2%).

Lower proportions of correct responses were observed for statements regarding the ineffectiveness of antibiotics against fungal infections (39.0%), awareness of government antibiotic policy (39.9%), and the misconception that newer antibiotics are always more effective (16.5%). Knowledge regarding the role of antibiotic misuse in animals in contributing to antimicrobial resistance in humans was also limited, with 56.8% answering correctly and 33.9% reporting no knowledge. In contrast, high levels of correct responses were observed for statements related to bacterial infections, treatment adherence, and the consequences of antimicrobial resistance. Figure 1 presents the percentage distribution of correct, incorrect, and no-knowledge responses for all knowledge statements, highlighting both areas of strong understanding and persistent misconceptions among participants.

Knowledge Score Distribution

Knowledge scores ranged from 4 to 11, with a mean score of 7.2 ± 1.6 (Figure 2). Most participants scored between 6 and 9 (72.0%). The most frequent score was 7 (n = 75, 22.5%), followed by 8 (n = 61, 18.3%) and 9 (n = 52, 15.6%). A smaller proportion of students scored between 4 and 5 (n = 53, 15.9%), while relatively few scored 10–11 (n = 21, 6.3%). No participant obtained the maximum possible score of 12. These results indicate a moderate level of overall knowledge among the study participants.

Table 1 Knowledge about Antibiotics among Participants (N = 333; n= number of frequencies)

No.	Knowledge statement	Correct answer	Correct (n)	Wrong (n)	No knowledge (n)
1	Antibiotics treat bacterial infections.	Yes	316	7	10
2	Antibiotics are suitable for a viral cold.	No	232	91	10
3	Antibiotics help recovery from viral flu/cold.	No	184	115	34
4	Repeated use of antibiotics reduces effectiveness.	Yes	235	76	22
5	Full antibiotic course should be completed.	Yes	277	43	13
6	Missing doses affect treatment outcome.	Yes	286	25	22
7	New antibiotics are always more effective.	No	55	208	70
8	Misuse of antibiotics in animals contributes to antibiotic resistance in humans.	Yes	189	31	113
9	Resistant infections are harder and more costly to treat.	Yes	295	13	25
10	Antibiotics are effective against fungal infections.	No	130	145	58
11	Broad-spectrum antibiotics kill both good and bad bacteria.	Yes	278	25	30
12	Awareness of government antibiotic policy.	Yes	133	141	59

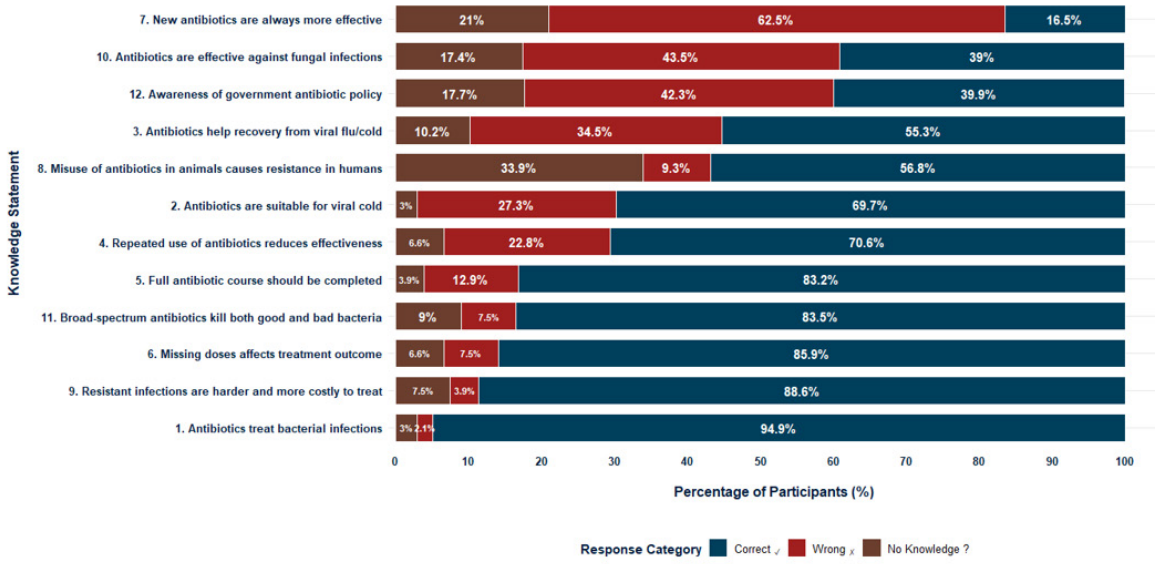

Figure 1 Distribution of participants' responses (correct, incorrect, and no knowledge) to knowledge statements on antibiotic use and antimicrobial resistance (N = 333)

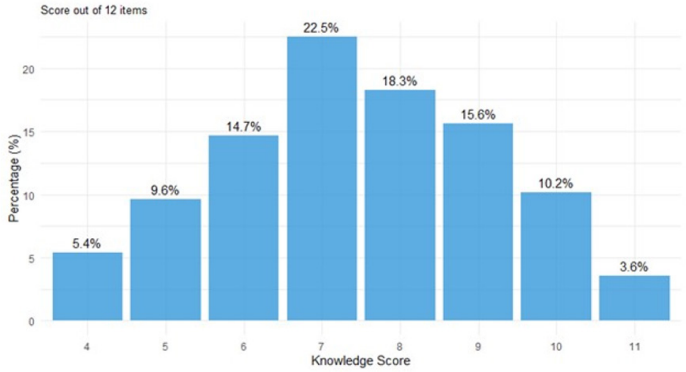

Figure 2 Distribution of knowledge levels regarding antibiotic use and resistance among participants

Practices and Attitudes Toward Antibiotic Use

Participants' antibiotic-related practices and attitudes are presented in Table 2 (a, b). Overall, 64.9% of students reported no leftover antibiotic use, whereas 35.1% reported using leftover antibiotics without medical advice.

Table 2 Practices and attitudes toward antibiotic Use (N = 333)

a. Antibiotic Practice

Practice item	Category	Frequency (n)	Percentage (%)
Use of leftover antibiotics	No leftover antibiotic use	216	64.86
	Use of leftover antibiotics	117	35.14
Total		333	100

b. Attitude toward antibiotic use among participants (N = 333)

Attitude item	Response category	Frequency (n)	Percentage (%)
Overall attitude toward antibiotic use	Positive	185	55.56
	Negative	148	44.44
Demanding antibiotics for mild illness	Strongly disagree	152	45.65
	Disagree	101	30.33
	Neutral	11	3.30
	Agree	42	12.61
	Strongly agree	27	8.11

Regarding attitudes, 55.6% of participants demonstrated a positive attitude toward appropriate antibiotic use. In response to statements about requesting antibiotics for mild illness, 45.7% disagreed, and 30.3% strongly disagreed, while 20.7% agreed and 3.3% were neutral.

Predictive Ability of Attitudes and Antibiotic Demand

Binary logistic regression analysis was conducted to examine whether overall attitude toward antibiotic use and demand for antibiotics in mild illness predicted leftover antibiotic use (use of leftover antibiotics). The ROC curve for the model is shown in Figure 3. The model demonstrated moderate discriminatory ability, with an AUC of 0.639 (95% CI: 0.580–0.698), indicating performance better than chance.

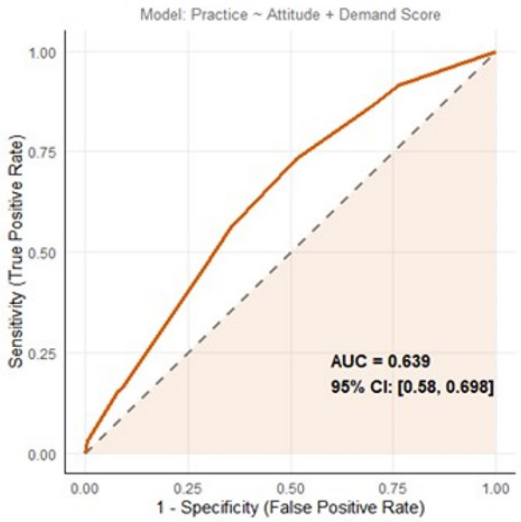

Figure 3 ROC Curve for the logistic regression model predicting leftover antibiotic use using overall attitude and demand for antibiotics in mild illness (AUC = 0.639, 95% CI: 0.580–0.698; N = 333)

4 Discussion

This multicenter cross-sectional study assessed KAP regarding antibiotic use and antimicrobial resistance among medical students in Bangladesh. Overall, students demonstrated a moderate level of basic knowledge, particularly regarding the role of antibiotics in treating bacterial infections. Still, significant gaps persisted in understanding antibiotic ineffectiveness against viral and fungal infections, as well as in awareness of national antibiotic policies.[9,15,16] These findings align with similar research among medical students in Bangladesh, where high recognition of antibiotics' role coexisted with misunderstandings about appropriate use and resistance mechanisms.[6,8] For example, a recent multicenter study reported that although over 78% of Bangladeshi medical students correctly identified antibiotics for bacterial infections, substantial uncertainty remained about use in viral conditions, and self-prescription behaviors were common.[9,16,17]

Misconceptions observed in this study are consistent with international literature. Studies from India and other countries report that medical students often have strong theoretical knowledge but poorer practical application and attitude scores, including confidence in antimicrobial stewardship and engagement with proper antibiotic practices.[18] Similar gaps were observed in systematic reviews, which note that self-medication and improper use patterns persist even among final-year students despite increasing knowledge scores across academic years.[19] Some studies from Bangladesh, Nepal, and Pakistan reported higher knowledge scores among senior medical students, with greater consistency between knowledge and self-reported practices, suggesting that differences in curricula, clinical exposure, or teaching methods may influence the knowledge-practice gap.[20,21]

Conversely, studies conducted in other low- and middle-income countries reported lower awareness and more widespread self-medication than observed in our cohort, highlighting heterogeneity in student experiences and access to stewardship training.[22] These discrepancies underscore the influence of institutional and regional factors, emphasizing the need for context-specific interventions.

A notable concern in our findings was the moderate predictive ability of attitudes and antibiotic demand in predicting leftover antibiotic use, which was used as the primary behavioral indicator of antibiotic practice in this study (AUC = 0.639). While attitudes did show some association with inappropriate behaviors, the modest discrimination reflects that behavioral, cultural, and systemic factors, such as ease of over-the-counter access, weak enforcement of regulations, and entrenched self-medication norms, also play influential roles in shaping antibiotic use patterns in Bangladesh.[9,15] Similar contextual influences have been documented in broader KAP studies among non-medical populations in Bangladesh, where moderate to poor attitudes and practices were strongly associated with misconceptions and socioeconomic variables.[4,6,20]

The findings highlight the limitations of knowledge-only interventions and underscore the necessity for integrated educational strategies that pair cognitive learning with clinical reasoning, policy understanding, and behavior change components. Antimicrobial stewardship programs that include case-based training, simulation, and reflective practice have been recommended in both local and international medical education literature to bridge the gap between knowledge and practice.[18]

A key strength of this study is its multicenter design, which enhances representativeness across different regions of Bangladesh. However, several limitations should be acknowledged. The cross-sectional design precludes causal inference, and self-reported data may be affected by social desirability bias, particularly in reporting desirable attitudes or responsible practices. The use of convenience sampling limits generalizability beyond the studied institutions. In addition, although the calculated minimum sample size was 384 participants, the final analysis included 333 completed questionnaires; therefore, the study was slightly underpowered relative to the initial sample size estimation, which may reduce the precision and generalizability of the findings. Another limitation is that antibiotic practice was assessed using a single behavioral indicator: whether leftover antibiotics were used or not. Although this indicator reflects an important form of inappropriate antibiotic use, it does not capture the full range of antibiotic-related practices, such as sharing antibiotics, self-medication, premature discontinuation of prescribed courses, or unnecessary requests for antibiotics. Therefore, the findings related to antibiotic practice should be interpreted narrowly as leftover-antibiotic use rather than as a comprehensive assessment of overall antibiotic practice. Finally, while the structured questionnaire was based on established tools, concurrent validation in the current population was limited, and future research should include formal psychometric validation.[7,16]

In summary, while baseline knowledge among medical students appears adequate, critical gaps in advanced understanding and practice-oriented attitudes persist. To prepare future physicians for rational antibiotic prescribing, medical curricula in Bangladesh must incorporate comprehensive antimicrobial stewardship education, policy literacy, and behaviorally informed training approaches.

5 Conclusion

This study demonstrates that medical students in Bangladesh have a solid foundational knowledge of antibiotics. Still, important gaps remain in advanced understanding, particularly regarding non-bacterial infections, drivers of resistance, and awareness of antibiotic policy. Although most participants reported no leftover antibiotic use, a considerable proportion still reported using leftover antibiotics, indicating a need for stronger behavior-focused antimicrobial stewardship education. The findings also suggest that attitudes and antibiotic demand are only partial predictors of leftover antibiotic use, meaning broader educational, cultural, and systemic factors likely influence antibiotic-related behaviors. Strengthening antimicrobial stewardship education with clinical, policy, and behavioral components in medical curricula is essential to improve future prescribing behavior and support national efforts against antimicrobial resistance.

Declarations

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Artificial Intelligence Disclosure
AI-based tools were used solely for language editing and readability enhancement. These tools did not contribute to study design, data analysis, interpretation, or scientific content. All responsibility for the manuscript rests with the authors.

Authors' Contributions
Md.Towhidur Rahman contributed to the research concept and study design, data analysis and interpretation, and preparation of the manuscript. Sabiha Karim Bably and Moinul Hasan Sadik contributed to the collection and assembly of data. All authors contributed to the manuscript, critically reviewed its content, and approved the final version for publication.

Availability of Data and Materials
All relevant data are available from the corresponding author

upon reasonable request, subject to ethical considerations.

Conflict of Interest
All authors declare that they have no conflicts of interest in accordance with ICMJE recommendations.

Consent for Publication
Not applicable.

Ethical Considerations
The study was conducted in accordance with the Declaration of Helsinki. Participation was entirely voluntary, and written informed consent was obtained from all participants. Confidentiality and anonymity were strictly maintained throughout the study. Ethical approval was granted by the Institutional Review Board of Ibrahim Medical College, Dhaka. Although no formal reference number was issued for this observational questionnaire-based study, the study protocol was thoroughly reviewed and approved by the committee.

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