Journal of Health Research and Society
2025, 4(2), 161-175. https://doi.org/10.34002/jhrs.v4i2.208
ISSN: 2599-4387 | e-ISSN: 2651-8279

Research Article

Exploring the Perception of Antimicrobial Resistance among the Higher Secondary Students of Bangladesh

Tahmina Sheikh Awal*[1], Khandakar Imdadul Haque[2]

[1]Asscociate Professor, Institute of Education and Research, University of Dhaka, Dhaka-1000, Bangladesh
[2]M.Phil. Researcher, Institute of Education and Research, University of Dhaka, Dhaka-1000, Bangladesh

*Corresponding author: stawal@du.ac.bd

Received: September 07, 2025 | Accepted: July 23, 2026 | Published: July 31, 2026

Abstract

Antimicrobial resistance (AMR) is a growing global health challenge and especially a serious problem in low- and middle-income countries like Bangladesh. Previous studies have examined AMR among healthcare providers and community populations; however, limited evidence on AMR among higher secondary students in Bangladesh. A mixed-methods sequential explanatory study was conducted to explore the knowledge, attitudes, and practices (KAP) of higher secondary students towards AMR. The data were collected by analysis of the National Curriculum and Textbook Board (NCTB) Higher Secondary Curriculum (Classes XI–XII) and Biology textbooks (First and Second Papers). Followed by a survey of 160 students, 20 interviews, and four focus group discussions from four districts. Textbook and curriculum analysis revealed minimal coverage of the AMR concept. Based on Rosenstock's Health Belief Model (HBM), the results demonstrate that generally, students lack knowledge of AMR and a lot of misconceptions exist regarding antibiotic efficacy and usage. The students' attitudes towards responsible antibiotic use were positive, whereas their self-efficacy and personal responsibility were still limited. Use of informal information sources and lack of self-efficacy were found to be detrimental to the responsible use of antibiotics by the students. Incorporating AMR education into secondary and higher secondary education curricula, enhancing public awareness about AMR, and better control of non-prescription antibiotics are important measures for responsible antibiotic use in Bangladesh.

Keywords: *health education, antimicrobial resistance education, student awareness, curriculum integration, school-based interventions*

How to Cite: Awal, T.S., Haque, K.I. (2026). Exploring the Perception of Antimicrobial Resistance among the Higher Secondary Students of Bangladesh. *Journal for Health Research and Society, 4*(2), 161-175. https://doi.org/10.34002/jhrs.v4i2.208

Introduction

AMR is one of the most serious public health threats in the twenty first century. It happens when microorganisms such as bacteria, viruses, fungi and parasites have developed resistance to the antibiotic, meaning that infections become more resistant to treatment, recovery takes longer, and people are more likely to become disabled or die (World Health Organization, 2019). In 2016, the Review on AMR estimated that if the current trajectory continues, deaths due to AMR would increase to 10 million per year by 2050 (O'Neill, 2016). More recent estimates project 1.91 million AMR-attributable and 8.22 million AMR-associated deaths annually by 2050, with South Asia expected to bear a substantial share of this burden (Naghavi et al., 2024). Bangladesh is

particularly vulnerable because AMR is driven by inappropriate antibiotic use, incomplete treatment courses, and self-medication (Lucas et al., 2019; Primeau et al., 2023). Additional factors include the availability of over-the-counter antibiotics, poor hygiene and sanitation, limited access to quality healthcare, inadequate diagnostics, and weak enforcement of drug regulations. Together, these conditions accelerate the spread of resistant pathogens (Arju, 2018; Islam, 2021; Orubu et al., 2021; Chowdhury, 2019). These factors contribute to delayed recovery, increased hospitalisation, treatment costs, and mortality from resistant infections, threatening progress in maternal and child health and the control of tuberculosis, malaria, and other priority conditions (Bonna et al., 2022). To examine these behaviours among students, this study applies the Health Belief Model (HBM), which has been widely used to explain how perceptions of risk and self-efficacy influence antibiotic stewardship (Arju, 2018; Primeau et al., 2023).

Statement of the Problem

AMR poses a growing threat to the efficacy of available antimicrobial medicines and reduces treatment choices for common infections. Antibiotic self-medication is a widespread issue in Bangladesh that is exacerbating the problem of antimicrobial resistance. Education has been acknowledged as a critical element in AMR prevention (McMaster et al., 2020), but most studies conducted in Bangladesh have targeted healthcare providers and rural populations (Darj et al., 2019; Chowdhury, 2019). The awareness of AMR among secondary and higher secondary students is still under-investigated, though the country has a huge student population (BANBEIS, 2023).

Research Gap

The existing literature on AMR in Bangladesh has examined pharmacists' perceptions, community-level perceptions and antibiotic-use practices, healthcare providers' prescribing behaviours, and university students' knowledge, attitudes, and practices (Biswas et al., 2014; Chowdhury, 2019; Hoque et al., 2020). Broader policy and practice issues across the human, animal, and environmental health sectors have also been investigated (Orubu et al., 2021). All these studies highlight that AMR is a severe and rapidly growing public health problem in Bangladesh (Bonna et al., 2022; Islam, 2021). Perceptions of AMR among higher secondary school students have not been fully explored in Bangladesh. This population is important because students are transitioning from school to higher education and developing health behaviours that often persist into adulthood, making school-based AMR education essential for antimicrobial stewardship. AMR literacy refers to the ability to access, understand, appraise, and apply information related to antimicrobial use and resistance to make informed health decisions (Nutbeam, 2000; World Health Organization, 2021). Increasingly, the importance of strengthening AMR literacy as an educational strategy for promoting responsible antibiotic use and antimicrobial stewardship among young people is recognised (McMaster et al., 2020; World Health Organization, 2019).

Purpose of the Study and Research Questions

This study aimed to address the identified research gap by systematically exploring the knowledge, attitudes, and practices (KAP) of higher secondary students regarding AMR in Bangladesh. It is designed to reveal gaps in knowledge, consider the social and cultural factors affecting student perceptions, and build evidence for a specific intervention that will promote the responsible use of antibiotics. The research questions of the study are:

1. What is the level of knowledge of higher secondary students in Bangladesh about antimicrobial resistance?
2. What are the attitudes of higher secondary students toward antibiotic use?
3. What are the practices of higher secondary students related to antibiotic use?
4. What are the factors influencing the perception of antimicrobial resistance among higher secondary students?

Materials and Methodologies

Experimental Design

A mixed-methods sequential explanatory design was used to explore AMR knowledge, attitudes, and practices (KAP) among higher secondary school students in Bangladesh. Quantitative data were analyzed initially to determine patterns, and then qualitative data were analyzed to explain and illuminate the findings.

Conceptual Framework

The Health Belief Model (HBM) is a well-known theoretical model used in the study of health -related behaviour that was first developed in the 1950s and subsequently expanded to include self-efficacy (Becker, 1974; Rosenstock, 1974; Rosenstock, Strecher, & Becker, 1988). According to the model, an individual's behaviour is influenced by each of six basic constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to



Figure 1.

The Review Framework Followed in this Study.

action, and self-efficacy. The HBM is conceptually appropriate for the present study as it has been applied in many countries to examine variation in knowledge, attitudes, and practices associated with antibiotic resistance.

The HBM was used in this study as the analytical lens to look at the knowledge, attitudes, and practices of the higher secondary students of Bangladesh. Perceived susceptibility was defined as students' perceived susceptibility of risk of acquiring an AMR infection, and perceived severity was defined as students' awareness of the health (including individual and community), social, and economic consequences of antimicrobial resistance. Perceived benefits captured students' beliefs that taking antibiotics correctly and adopting preventive behaviours can contain AMR. Perceived barriers included both individual- and structural-level limitations related to responsible antibiotic use, such as lack of confidence, lack of knowledge, cultural norms regarding self-medication, and lack of formal education. Cues to action included formal and informal sources that stimulate students' action, such as school instruction, textbooks, discussions at home, and media. Self-efficacy was defined as students' self-confidence in using antibiotics properly. Each construct was operationalised through survey indicators (Tables 1, 2, 3, and 4) and qualitative probes to enable systematic interpretation of the KAP findings.

Source Data

Primary data were collected from 160 students of Grade 12 from 8 Higher Secondary schools in four districts: Dhaka, Chattogram, Cumilla, and Kishoreganj. Measurable trends and insights were captured at the contextual level through survey responses and semi-structured interviews, FGDs, and curriculum documents. Purposive sampling was conducted to select the research sites and institutions, while convenience sampling was used to select the participants. Four districts were purposively selected to provide representation of regional variation. According to the urban–rural classification of Bangladesh Bureau of Educational Information and Statistics (BANBEIS) 2023, Dhaka and Chattogram were categorized as metropolitan districts, whereas Cumilla and Kishoreganj were categorized as semi-urban/rural districts. The institutions selected comprised government and non-government higher secondary schools in urban, metropolitan, and semi -urban (rural) settings. Using purposive institutional sampling, all eligible and willing Grade 12 students from the eight selected institutions (two per district) were surveyed during the data collection period, yielding approximately 20 students per institution.

A sample-size sensitivity analysis indicated that approximately 84 participants would be required to detect a medium-sized Spearman correlation ($\rho \approx 0.30$) at $\alpha = 0.05$ (two-tailed) with 80% power. The achieved sample of 160 participants therefore exceeded this threshold and was adequate for the planned descriptive and exploratory correlational analyses; however, the study was not specifically powered to detect smaller correlation effects with the same level of precision.

Method and Tools of Data Collection

This study examined four research questions on knowledge, attitudes, practices, and influencing factors of AMR. Data collection techniques comprised a structured survey questionnaire, 20 semi-structured individual interviews carried out based on an interview protocol (Kvale & Brinkmann, 2015), and four FGDs that were held using a structured discussion guide (Krueger & Casey, 2014). These tools were retrieved from the literature and adapted to the research context, and 20 students piloted the survey; after minor revisions, those 20 were excluded, and 160 new students were recruited. In addition, a document analysis framework (Bowen, 2009) was used to analyse the curriculum and textbooks to identify the representation of AMR in formal education.

Eligible participants were Grade 12 students (16–18 years) who provided parental consent and student assent. The survey required approximately 15–20 minutes and was administered during school hours under researcher supervision. Twenty interviews and four focus group discussions (approximately seven to eight

students each) were conducted on school premises using semi-structured protocols and audio-recorded with participant assent. Interviews and FGDs were conducted in Bengali, audio-recorded, transcribed verbatim, and relevant excerpts were translated into English for analysis.

Instrument Development, Validity, and Reliability

The survey instrument was modified from preexisting validated knowledge, attitude, and practice (KAP) surveys on AMR (Fowler, 2013; Marzan et al., 2021) and based on the Health Belief Model (HBM) (Becker, 1974; Rosenstock, 1974). Content validity was determined through faculty review by experts from the fields of public health and education, and slight modifications were made to make the content contextual and understandable to higher secondary school students in Bangladesh.

Cronbach's alpha was used to assess the internal consistency of the multi-item constructs. Reliability coefficients were acceptable for the knowledge domain (8 items; $\alpha = 0.76$), attitude domain (6 items; $\alpha = 0.74$), and influencing-factors domain (6 items; $\alpha = 0.70$) (Tavakol & Dennick, 2011). The influencing-factors scale was at the lower bound of acceptable reliability, which was expected because it intentionally captured diverse informational and contextual influences, including school, textbooks, family, media, access to information, and the ability to follow guidelines.

Practice indicators were analysed individually because they represented conceptually distinct behaviours (e.g., frequency of illness, antibiotic use, and non-prescription antibiotic use) rather than a single underlying construct; therefore, internal consistency reliability was not calculated for the practice domain (Tavakol & Dennick, 2011). The final instrument comprised 20 core items (8 knowledge, 6 attitude, and 6 influencing-factor items) and three practice indicators.

Data Analysis

Survey data were analysed in SPSS using descriptive statistics and Spearman's rank correlation. Interviews and FGDs were transcribed and thematically analysed, while curriculum documents were examined through content analysis. Triangulation across quantitative, qualitative, and documentary evidence strengthened interpretation (Creswell & Creswell, 2018; Creswell & Plano Clark, 2018; Tashakkori & Teddlie, 2003). Composite mean scores were calculated for the knowledge, attitude, and influencing-factor domains using a four-point response scale coded from 1 to 4. The numerical coding was consistent across items, whereas the verbal response anchors were tailored to item content (e.g., "Not at all" to "Frequent" for frequency-related items and "Not at all" to "Strongly agree/most positive" for attitude-related items). Spearman's rank correlation (two-tailed) was used to examine associations among the KAP domains and influencing factors. Because these correlation analyses were exploratory, p-values are reported without adjustment for multiple comparisons and should be interpreted as exploratory evidence rather than confirmatory hypothesis tests. Practice indicators were analysed individually because they represented conceptually distinct behaviours.

Curriculum and textbook analysis were also conducted using a document analysis framework (Bowen, 2009) to identify how AMR topics were represented in formal education. The documentary analysis included the National Curriculum and Textbook Board (NCTB) Higher Secondary Curriculum (Classes XI–XII) and Biology textbooks (First and Second Papers).

Ethical Considerations

The study was conducted in accordance with the ethical principles for research involving human participants. Under the host institution's procedures for minimal-risk educational research, formal institutional review board approval was not required. Written parental consent and student assent were obtained from all participants before data collection. Permission to conduct the study was obtained from the relevant educational authorities and participating institutions. The participants were informed about the purpose of the study, its voluntary nature, and the right to withdraw without any consequences. All data were collected anonymously and kept confidential; no personally identifiable data were collected, data were stored securely, and only aggregate data were analysed for research purposes.

Results and Discussion

The findings are based on survey data, interviews, focus group discussions, and curriculum documents that provide an overall picture of students' knowledge, attitudes, practices and influencing factors related to AMR (Creswell & Creswell, 2018; Creswell & Plano Clark, 2018; Tashakkori & Teddlie, 2003).

Analysis of RQ 1: Knowledge of Antimicrobial Resistance

The first research question examines the level of knowledge of higher secondary students in Bangladesh about antimicrobial resistance. In Figure 2, the distribution of responses for each of the eight knowledge indicators is shown, and the

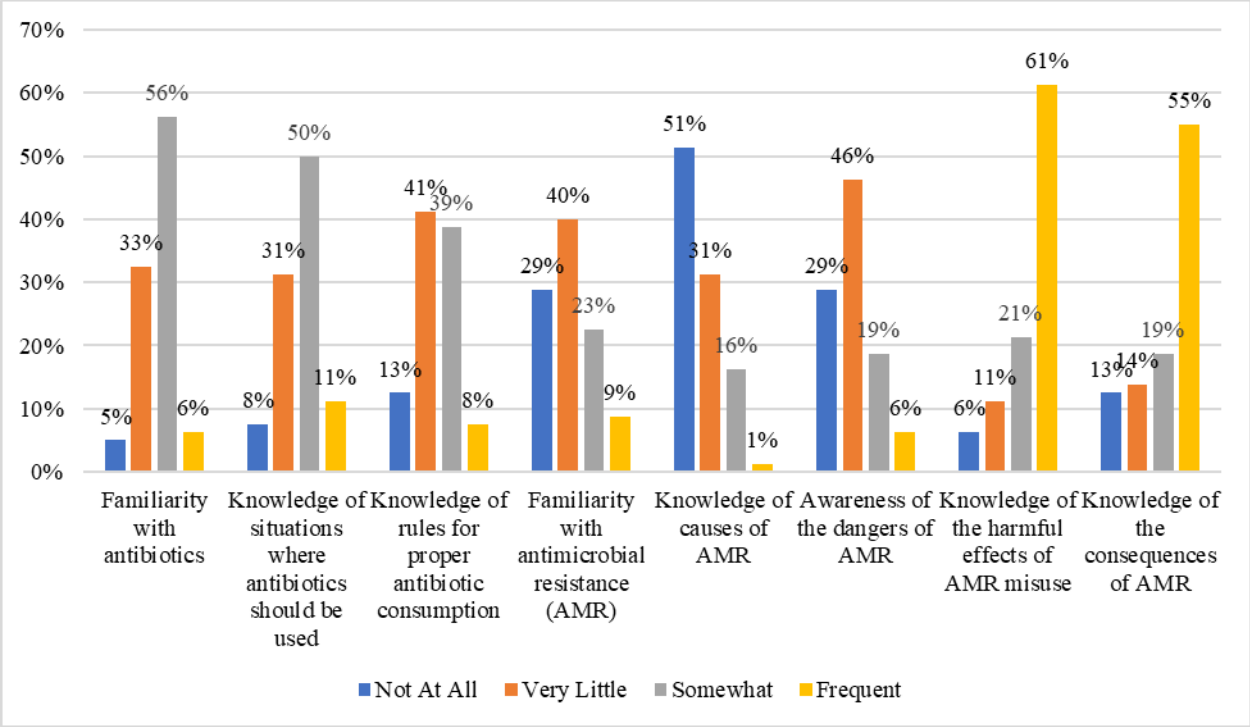


Figure 2.

Level of Knowledge about Antimicrobial Resistance

frequencies and mean scores of the knowledge indicators are summarised in Table 1.

Figure 2 shows that students demonstrated uneven knowledge of antimicrobial resistance. Knowledge of the harmful effects and consequences of AMR was relatively high, but knowledge of the causes of AMR, familiarity with AMR, and knowledge of appropriate antibiotic use were limited. This pattern indicates that the outcomes of AMR were more familiar to students than the mechanisms of developing resistance.

This trend is reflected in Table 1. The amount of knowledge was highest for the harmful effects of AMR misuse (M = 3.35) and the consequences of AMR (M = 3.18), lowest for the causes of AMR (M = 1.65), suggesting an experience-rich but concept-poor understanding of AMR. A similar situation has been described by students in China, Italy, and Nepal who were more aware of the consequences of AMR than of the biological mechanisms that underlie resistance (Huang et al., 2013; Scaioli et al., 2015; Shah et al.,

Table 1.

Knowledge Indicators of Antimicrobial Resistance: Frequencies and Mean Scores

Knowledge Indicator	Not at all (%)	Very little (%)	Somewhat (%)	Frequent (%)	Mean score (M)
Knowledge of the harmful effects of AMR misuse	6	11	21	61	3.35
Knowledge of the consequences of AMR	13	14	19	55	3.18
Knowledge of situations where antibiotics should be used	8	31	50	11	2.64
Familiarity with antibiotics	5	33	56	6	2.63
Knowledge of rules for proper antibiotic consumption	13	41	39	8	2.44
Familiarity with AMR	29	40	23	9	2.14
Knowledge of the dangers of AMR	29	46	19	6	2.02
Knowledge of causes of AMR	51	31	16	1	1.65

Note. Percentages are rounded to the nearest whole number; therefore, row totals may not equal 100%.

2019).

Qualitative research provides further insight to explain this difference. Interviews showed that many students received incorrect information regarding antibiotic use from other family members, not from formal education. “A lot of what I knew about antibiotics I learned from my family, not from school; and many of these things just were not correct,” said one student. One interviewee was informed by her parent that antibiotics would not be effective, but no explanation was provided. One focus group member said, “Most of us thought that the human body becomes immune to antibiotics, not the bacteria.” This phenomenon of misconceptions is not unique to Bangladesh. The same misconceptions have been reported elsewhere in the world, and people are generally led to think that AMR is the resistance of the body, not the resistance of the bacteria (Huang et al., 2013; Scaioli et al., 2015; Shah et al., 2019). The disparity indicates that students learn about AMR mostly through their own experiences and media exposure, not from formal education. A comparable pattern has been noted outside Bangladesh: In Zambia, students indicated a high level of concern but lacked conceptual knowledge, and in Germany, medical students admitted a significant lack of understanding in the context of AMR (Feufel & Gastmeier, 2023).

Analysis of the National Curriculum and Textbook Board (NCTB) Higher Secondary Curriculum (Classes XI–XII) and the approved Biology textbooks (First and Second Papers) revealed that AMR was not explicitly addressed, with only a single chapter devoted to microorganisms. This absence of AMR content indicates that students receive little formal education on antimicrobial use, resistance, or responsible antibiotic practices, making their understanding largely dependent on informal sources such as family, community, and media. All interview and focus group respondents consistently indicated that little learning about AMR was occurring in school, with family members and media sources being the main sources of information. The pattern is similar to the Health Belief Model, which focuses on awareness of a health threat, perceived susceptibility and severity, perceived benefits/barriers, and self-efficacy (Becker, 1974; Rosenstock, 1974). Similar educational activities in schools or online can also enhance awareness of AMR and antibiotic stewardship in Bangladesh; such interventions have been found to contribute to improved AMR knowledge and awareness in India and Nigeria (Ramanarayanan et al., 2024; Orok et al., 2025).

Analysis of RQ 2: Attitudes toward Antibiotic Use

Exploring higher secondary students’ attitudes toward antibiotic use reveals a more positive picture than their knowledge levels. Although AMR knowledge is still disjointed, students generally acknowledged the significance of responsible behaviours and were willing to take action. Nonetheless, results based on surveys and qualitative data indicate uncertainty and inconsistency, which are weak but encouraging perspectives on AMR prevention.

Figure 3 indicates generally positive attitudes toward responsible antibiotic use among

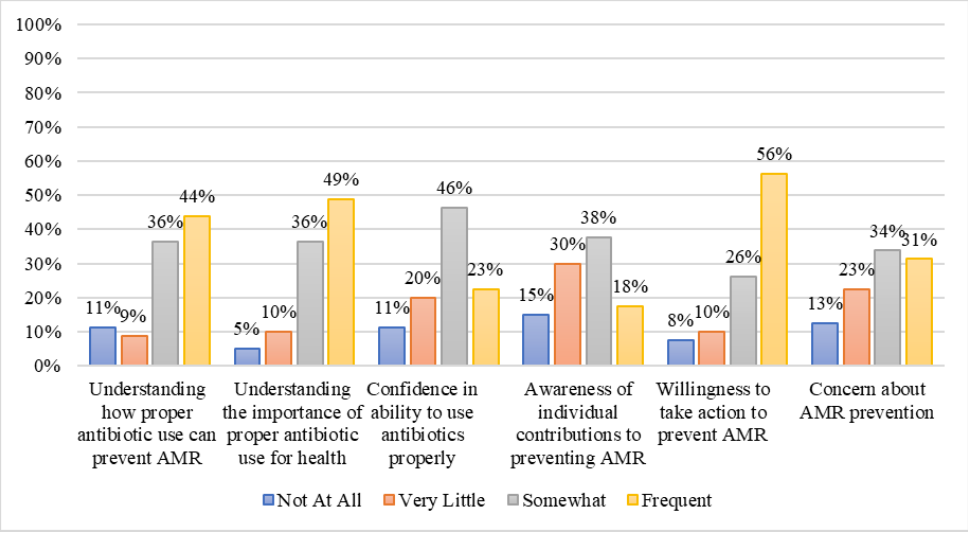


Figure 3.

Attitudes toward Antibiotic Use

Table 2.

Attitude Indicators of Antimicrobial Resistance: Frequencies and Mean Scores

Attitude Indicator	Not at all (%)	Very little (%)	Some-what (%)	Frequent (%)	Mean score (M)
Willingness to take action to prevent AMR	8	10	26	56	3.30
Understanding the importance of proper antibiotic use for health	5	10	36	49	3.29
Understanding how proper antibiotic use can prevent AMR	11	9	36	44	3.13
Concern about AMR prevention	13	23	34	31	2.85
Confidence in ability to use antibiotics properly	11	20	46	23	2.81
Awareness of individual contributions to preventing AMR	15	30	38	18	2.61

Note. Percentages are rounded to the nearest whole number; therefore, row totals may not equal 100%.

higher secondary students. Most students recognised the importance of proper antibiotic use and expressed willingness to take preventive action, although confidence in using antibiotics correctly and awareness of their own role in preventing AMR remained comparatively weaker. Overall, the pattern suggests that students were willing to act responsibly but lacked confidence and a clear sense of personal responsibility for preventing antimicrobial resistance.

The attitude indicators of AMR, their frequencies and mean scores are presented below in Table 2.

Table 2 confirms that willingness to take action to prevent AMR (M = 3.30) and understanding the importance of proper antibiotic use (M = 3.29) recorded the highest mean scores, whereas confidence in using antibiotics properly (M = 2.81) and awareness of individual contributions to preventing AMR (M = 2.61) were comparatively lower. Overall, students expressed positive attitudes toward responsible antibiotic use despite relatively low confidence and self-efficacy. A similar disparity between attitude and confidence has been noted in students from Nepal, Italy and Egypt, in which awareness of AMR was not always accompanied by confidence and readiness to engage in responsible antibiotic use (Shah et al., 2019; Scaioli et al., 2015; El-Sokkary et al., 2022).

The qualitative findings add important context to these results by revealing a gap between students' knowledge of responsible antibiotic use and their confidence in applying it. While the majority of the participants understood that antibiotics should not be used incorrectly, and showed a willingness to follow medical recommendations, many were unsure of how to use them in their daily life. As one student explained, "I know antibiotics should not be used the wrong way; I will do what the doctors say, but at the same time I want to be doing the right thing, and I don't always know what that is." The focus group discussions also revealed that the students felt that physicians, pharmacies, and government were mainly responsible for addressing the issue of AMR, which means that they felt that they themselves had limited roles and they believed the roles were regulated by external factors. One participant stated, "I would not use antibiotics if they were not available at the pharmacy without a prescription." At the same time, students were generally willing to follow clearly communicated antibiotic-use guidelines. As another interviewee remarked, "I will not buy antibiotics on my own; I need to be careful, because I do not want them to stop working." Media exposure also influenced perceptions, with many students reporting increased concern about AMR after watching television news or health programmes. Similar gaps between awareness and preparedness for responsible antibiotic use have been reported among students in other countries (Dyar et al., 2014; Shah et al., 2019; El-Sokkary et al., 2022).

These results align with other international studies that have found that students are generally aware of AMR as an issue but are not necessarily confident and ready to act responsibly as consumers of antibiotics (Dyar et al., 2014; Shah et al., 2019; El-Sokkary et al., 2022). The Health Belief Model explains these trends. Students clearly recognise the importance of AMR as a serious concern and feel the effects it could have on them, but are not aware of the likelihood of contracting it, nor of their role in preventing it. Their self-efficacy, or sense that they can make a difference, is low (Becker, 1974; Rosenstock, 1974). This gap creates a disconnect between

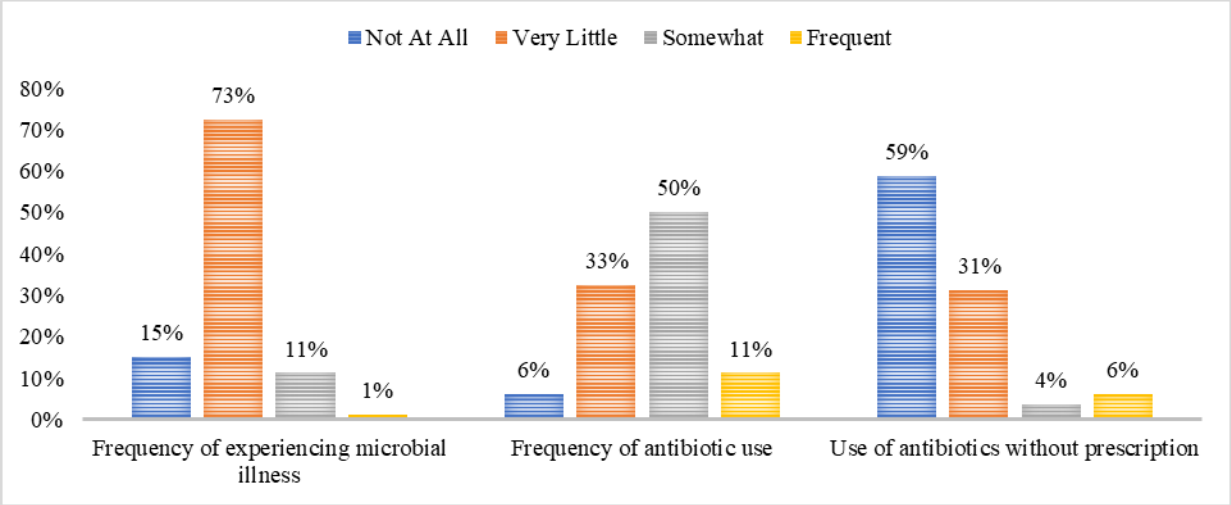


Figure 4.

Practices Related to Antibiotic Use

students' favourable attitudes and the self-efficacy required to translate those attitudes into consistent practice. AMR education should be incorporated in the school curriculum, emphasizing personal responsibility, and integrated with public health programs for Bangladeshi students. Attitudes can be linked to action with confidence, and students can be valuable contributors to the fight against AMR.

Analysis of RQ 3: Practices Related to Antibiotic Use

A careful analysis of the practices of higher secondary school students shows that there are some patterns of concern, which reflect the daily health reality as well as the problems of the health system in Bangladesh. The survey results indicate that students were not frequent users of antibiotics; however, a small but important proportion reported obtaining antibiotics without a prescription.

Figure 4 shows that reported infectious illness was relatively low, while antibiotic use was more common. Although most students reported that they did not obtain antibiotics without a prescription, a small but important proportion acknowledged non-prescription use, indicating the persistence of risky antibiotic practices.

The practice indicators of AMR, their frequencies and mean scores are presented in Table 3.

Table 3 shows that antibiotic use had the highest mean score (M = 2.66), followed by the frequency of experiencing microbial illness (M = 1.98), whereas non-prescription antibiotic use recorded the lowest mean score (M = 1.57). These findings suggest that although non-prescription antibiotic use was reported less frequently, it remains a significant public health concern in Bangladesh because weak regulatory enforcement and easy access to antibiotics through community pharmacies facilitate inappropriate use and contribute to the development of AMR (Biswas et al., 2014; Nahar et al., 2020).

Qualitative insights enhanced this depiction. Students reported that it was normal for their parents to buy antibiotics without consulting a doctor: “Sometimes my parents go to the pharmacy

Table 3.

Attitude Indicators of Antimicrobial Resistance: Frequencies and Mean Scores

Practice Indicator	Not at all (%)	Very little (%)	Somewhat (%)	Frequent (%)	Mean score (M)
Frequency of antibiotic use	6	33	50	11	2.66
Frequency of experiencing microbial illness	15	73	11	1	1.98
Use of antibiotics without prescription	59	31	4	6	1.57

Note. Percentages are rounded to the nearest whole number; therefore, row totals may not equal 100%.

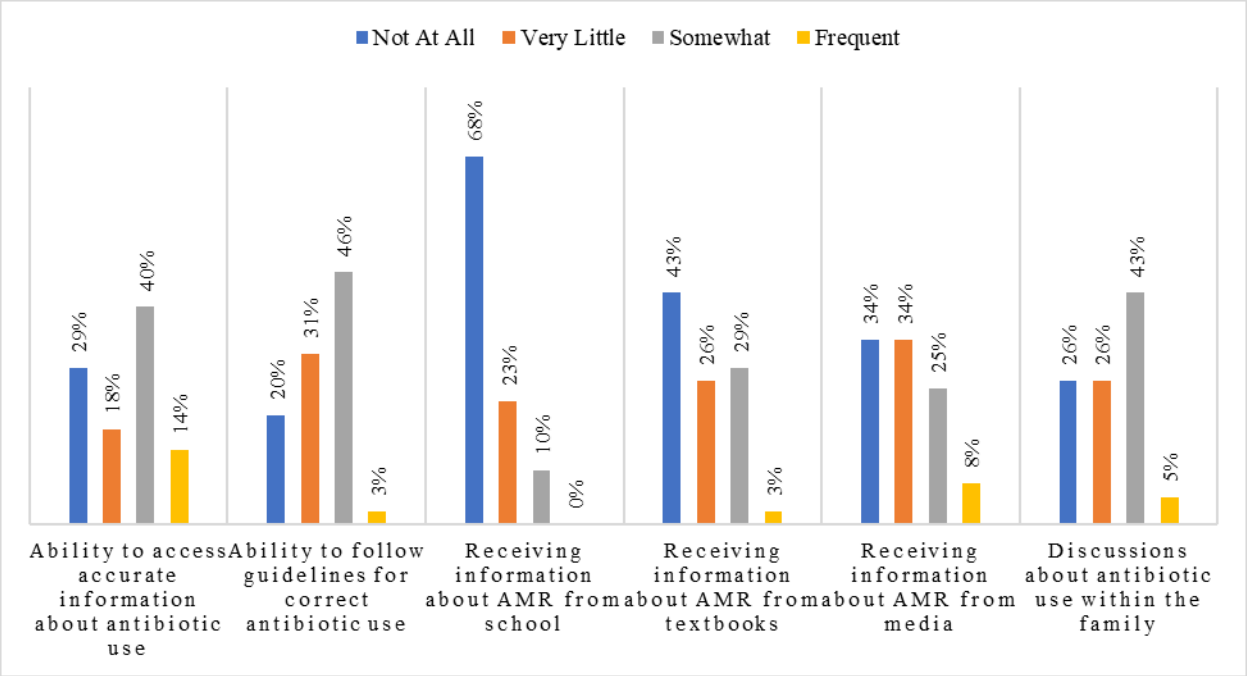


Figure 5.

Factors Influencing Perception of Antimicrobial Resistance

and when I feel really weak or have a fever they buy antibiotics without talking to the doctor." A few students admitted that they had ended their courses prematurely or taken leftover medications at home, indicating that dangerous practices are increasing.

While non-prescription antibiotic use was reported less frequently than in some international studies, qualitative results highlight that informal antibiotic use is culturally acceptable and may be underreported (Gillani et al., 2017; Huang et al., 2013; Jifar & Ayele, 2018; Scaioli et al., 2015; Shah et al., 2019).

Analysis of RQ 4: Factors Influencing Perception of Antimicrobial Resistance

Students' perceptions of AMR were shaped primarily by informal sources of information, while limited school-based education allowed misconceptions and knowledge gaps to persist. Figure 5 illustrates the factors that can affect the perception of antimicrobial resistance.

Figure 5 shows that higher secondary students relied more on informal sources of AMR-related information, particularly family and the media, than on schools and textbooks. Most students reported limited access to reliable information about antibiotic use. They also reported low confidence in following appropriate antibiotic-use guidelines. These findings indicate

Table 4.

Attitude Indicators of Antimicrobial Resistance: Frequencies and Mean Scores

Factor Indicator	Not at all (%)	Very little (%)	Somewhat (%)	Frequent	Mean score (M)
Ability to access accurate information about antibiotic use	29	18	40	14	2.41
Ability to follow guidelines for correct antibiotic use	20	31	46	3	2.32
Discussions about antibiotic use within the family	26	26	43	5	2.27
Receiving information about AMR from media	34	34	25	8	2.09
Receiving information about AMR from textbooks	43	26	29	3	1.94
Receiving information about AMR from school	68	23	10	0	1.44

Note. Percentages are rounded to the nearest whole number; therefore, row totals may not equal 100%.

weak school-based AMR education and inadequate textbook coverage. Similar patterns have been reported in Ethiopia and Pakistan, where limited curriculum integration contributes to low AMR awareness (Jifar & Ayele, 2018; Gillani et al., 2017). Students in China and Italy also relied heavily on family, media, and other informal networks rather than formal education (Huang et al., 2013; Scaioli et al., 2015). Overall, inadequate school-based AMR education appears to increase students' reliance on incomplete and sometimes unreliable informal sources. This reliance may hinder responsible antibiotic use (Hoque et al., 2020).

The factor indicators, their frequencies, and mean scores of AMR are presented in Table 4.

School-based information received the lowest mean score (M = 1.44), whereas family discussions (M = 2.27) and media exposure (M = 2.09) were modestly higher. Students relied on informal sources of information considerably more than on formal educational sources, and this is consistent with other studies from Ethiopia, Pakistan, China and Italy, where poor quality school-based AMR education led students to rely mostly on family, peers and media for information about AMR and antibiotics (Gillani et al., 2017; Jifar & Ayele, 2018; Huang et al., 2013; Scaioli et al., 2015).

These tendencies are explained in more detail through qualitative research. Interviews revealed that students rarely learned about antibiotics from their teachers. Rather, they were made aware of them by pharmacies or family members. One student stated, "I have never heard anything about AMR in school; I learned from my uncle who works in a drug store." This was also reflected in the FGDs with participants who reported that teachers and textbooks rarely discussed antibiotics and antibiotic resistance. The media, particularly television, also influenced thoughts of students. "Maybe antibiotics will no longer work," said one student, "because I heard a news report about that." Students reported that their families influenced their AMR-related KAP in both positive and negative ways. Positive influences included encouragement to complete prescribed antibiotic courses, whereas negative influences included advice to discard leftover antibiotics or stop taking antibiotics before completing the prescribed course.

These findings are consistent with studies conducted globally. Students from Ethiopia also relied on friends and family for information about antibiotics, resulting in self-medication (Jifar & Ayele, 2018). In Pakistan, familial and pharmaceutical cultures significantly influenced antibiotic behaviour (Gillani et al., 2017). Chinese students identified the media as their primary source of worry over AMR (Huang et al., 2013). Even in Europe, where AMR is taught in schools, medical students reported feeling unprepared to prescribe responsibly (Dyar et al., 2018), and students in Italy reported learning a lot about it from their friends and family (Scaioli et al., 2015).

The absence of AMR education in Bangladeshi schools has important public health implications, as many students rely on informal sources of information about antibiotic use and resistance rather than structured classroom instruction. From a Health Belief Model (HBM) perspective, this difference can be explained by the fact that exposure to cues to action, such as information from the media or family members, is insufficient on its own; individuals also require adequate knowledge and self-efficacy to translate these cues into appropriate antibiotic-related behaviours, particularly in the absence of institutional support (Becker, 1974; Rosenstock, 1974). To fill this gap, AMR must be included in secondary school curricula, and there should be credible and accessible media campaigns that promote accurate and useful information.

Table 5.

Attitude Indicators of Antimicrobial Resistance: Frequencies and Mean Scores

Association	ρ (Spearman)	p-value
Influencing factors ↔ Knowledge (mean score)	0.49	<0.001
Influencing factors ↔ Attitudes (mean score)	0.31	<0.001
Knowledge (mean) ↔ Attitudes (mean)	0.52	<0.001
Influencing factors ↔ Non-prescription antibiotic use	−0.24	0.002
Knowledge (mean) ↔ Non-prescription antibiotic use	−0.22	0.005
Attitudes (mean) ↔ Non-prescription antibiotic use	−0.09	0.279

Note. ρ = Spearman's rank correlation coefficient. All p-values are two-tailed and unadjusted for multiple comparisons; therefore, the correlations should be interpreted as exploratory associations.

Association between Influencing Factors and KAP Domains

To examine associations between influencing factors and students' knowledge, attitudes, and practices regarding AMR, Spearman's rank correlation analyses were conducted. Influencing factors were summarized as a composite mean score (six indicators), and knowledge and attitudes as domain mean scores based on their respective multi-item indicators.

Influencing factors showed a moderate positive association with knowledge ($\rho = 0.49$, $p < 0.001$), indicating that students reporting stronger informational access/exposure and capacity to follow guidance tended to report higher AMR knowledge. Influencing factors were also positively associated with attitudes ($\rho = 0.31$, $p < 0.001$). Knowledge and attitudes were strongly related ($\rho = 0.52$, $p < 0.001$), consistent with conventions for interpreting correlation strength adapted for Spearman (Rosenstock et al., 1988).

Because the practice indicators reflect conceptually distinct behaviours, the study examined practice at the indicator level. Influencing factors were negatively associated with non-prescription antibiotic use ($\rho = -0.24$, $p = 0.002$), suggesting that stronger informational support was associated with lower reported non-prescription use. Knowledge was similarly negatively associated with non-prescription use ($\rho = -0.22$, $p = 0.005$). Non-prescription use was not, however, significantly correlated with attitudes ($\rho = -0.09$, $p = 0.279$). Overall, the findings suggest that stronger informational support is associated with better knowledge and more positive attitudes, although translation into consistent antibiotic-related practices remains uneven.

The Spearman correlation analysis revealed significant relationships that support the study's theoretical framework. Informational and contextual factors showed a moderate positive association with knowledge ($\rho = 0.49$, $p < 0.001$) and a positive association with attitudes ($\rho = 0.31$, $p < 0.001$). Several influencing factors, particularly those representing HBM cues to action, were negatively correlated with non-prescription antibiotic use ($\rho = -0.24$, $p = 0.002$). This suggests that stronger informational support and access to accurate guidance directly reduce risky self-medication practices.

However, while knowledge was negatively associated with non-prescription use ($\rho = -0.22$, $p = 0.005$), attitudes showed no significant correlation with this practice ($\rho = -0.09$, $p = 0.279$). Theoretically, this null result is significant. It suggests an attitude-practice disparity because it is possible for students to have positive beliefs about stewardship in theory but not the same self-efficacy or specific knowledge to counteract cultural practices of self-medication. As predicted by HBM, perceived severity (positive attitude) alone is not enough to motivate students to change their behaviour if they do not have perceived susceptibility or the cues to action which come from formal education.

Synthesis of Findings: Knowledge, Attitudes, Practices, and Influencing Factors

This section synthesises the findings of the survey, interviews, focus group discussions, curriculum analysis, and correlational findings to draw a broader conclusion about the perceptions of higher secondary students on AMR in Bangladesh. Instead of restating the results for each research question, the section covers the interactions between knowledge, attitudes, practices, and influencing factors that shape the understanding of AMR and antibiotic use among students.

Knowledge and Attitudes in Shaping AMR Perception

The quantitative and qualitative findings suggest that students' knowledge and attitudes developed unevenly across different dimensions of antimicrobial resistance. Knowledge of the consequences of AMR ($M = 3.18$) was substantially higher than knowledge of its causes ($M = 1.65$), while willingness to take action ($M = 3.30$) exceeded awareness of individual responsibility for preventing AMR ($M = 2.61$). Together with the positive association between knowledge and attitudes ($\rho = 0.52$, $p < 0.001$), these findings indicate that awareness of AMR does not necessarily lead to a deeper understanding of how resistance develops or to confidence in acting appropriately. Similar patterns have been reported among students in China, Italy, and Nepal, where concern about AMR coexisted with persistent misconceptions regarding antibiotics and bacterial resistance (Huang et al., 2013; Scaioli et al., 2015; Shah et al., 2019).

Attitudes and Practices in Responsible Antibiotic Use

The findings also demonstrate that favourable attitudes toward responsible antibiotic use were not consistently reflected in students' practices. Although most students recognised the importance of proper antibiotic use, 10% reported obtaining antibiotics without a prescription, and attitudes were not significantly associated with non-prescription antibiotic use ($\rho = -0.09$, $p = 0.279$). This suggests that positive attitudes alone are insufficient to predict responsible antibiotic behaviour, particularly when practical knowledge and self-efficacy remain limited. Similar attitude–practice disconnections have been reported in Pakistan, Ethiopia and Italy, where positive

attitudes toward antibiotic stewardship were not associated with the absence of self-medication or other inappropriate antibiotic use (Gillani et al., 2017; Jifar & Ayele, 2018; Scaioli et al., 2015). From the perspective of the Health Belief Model, behavioural change requires not only perceived severity but also self-efficacy and clear cues to action (Becker, 1974; Rosenstock, 1974; Rosenstock et al., 1988).

Influencing Factors in the Formation of AMR Perception

The curriculum analysis and qualitative findings indicate that students' perceptions of AMR were shaped primarily by informal information sources rather than formal educational experiences. School-based information received the lowest mean score among the influencing factors (M = 1.44), whereas family discussions (M = 2.27) and media exposure (M = 2.09) played a more prominent role. The correlation analysis further showed that stronger informational support was associated with higher knowledge ($\rho = 0.49$, $p < 0.001$), more favourable attitudes ($\rho = 0.31$, $p < 0.001$), and lower non-prescription antibiotic use ($\rho = -0.24$, $p = 0.002$). Similar reliance on family, pharmacies, and media has been reported in Bangladesh and other low- and middle-income countries, where limited curriculum integration contributes to persistent misconceptions about antibiotic use and resistance (Gillani et al., 2017; Jifar & Ayele, 2018; Hoque et al., 2020).

Interrelationships among Knowledge, Attitudes, Practices, and Influencing Factors

Taken together, the findings suggest that higher secondary students' perceptions of AMR are produced through the interaction of educational experiences, family and community influences, media exposure, and the broader regulatory environment. Limited formal education contributes to fragmented knowledge; fragmented knowledge weakens self-efficacy and personal responsibility; and these limitations reduce the likelihood that positive attitudes will be translated into consistent antibiotic stewardship. Similar interconnections among knowledge, attitudes, information sources, and antibiotic practices have been reported across a range of educational and public-health contexts (Marzan et al., 2021; Scaioli et al., 2015; Shah et al., 2019). These findings indicate that curriculum reform, teacher preparation, family-targeted public messaging, and stronger regulation of non-prescription antibiotic sales should be viewed as complementary interventions for strengthening antimicrobial stewardship in Bangladesh (McMaster et al., 2020; Orok et al., 2025; Ramanarayanan et al., 2024; World Health Organization, 2019).

Limitations

This study recruited participants through convenience sampling from eight purposively selected institutions in four of Bangladesh's 64 districts, and the findings should therefore not be generalised to all higher secondary students. Because participants were enrolled Grade 12 students from purposively selected institutions, the findings may not represent out-of-school youth, students in institutions that were not included in the study, or the broader higher secondary student population in Bangladesh. Although the purposive design enabled contrasts between metropolitan and semi-urban/rural districts, inferential tests of district-level differences were not performed because the sample was not drawn to support such comparisons. Behavioural indicators such as non-prescription antibiotic use are subject to social-desirability bias and may be underreported. The cross-sectional design does not permit causal inference between influencing factors and KAP outcomes. The study was conducted under institutional procedures for minimal-risk educational research that did not require formal institutional review board approval; however, ethics review requirements may differ across journals and institutions. Because the Health Belief Model primarily focuses on individual cognitive determinants, it does not fully capture broader socio-cultural influences such as family authority, pharmacy practices, and community norms that emerged in the qualitative findings. Bengali transcripts were independently verified by a second researcher to ensure translation accuracy; reconcilable discrepancies in English phrasing were resolved through discussion.

Conclusion and Recommendations

This study demonstrates that higher secondary students' perceptions of AMR are shaped by the interaction of knowledge, attitudes, practices, and broader socio-cultural influences. Although students reported positive attitudes toward responsible antibiotic use, their conceptual understanding of AMR and their self-efficacy were weak. Their attitudes were shaped by informal sources of information (family, media, and digital sources) and were not necessarily linked to responsible antibiotic use. Furthermore, the absence of AMR in the school curricula and textbooks implies that formal education has not yet realised its full potential in fostering AMR literacy among young people. This study's findings indicate that raising awareness alone is insufficient to effect

sustainable behaviour change; enhanced school-based education, strengthened family-community influences, and improved enforcement of regulations are required.

The study adds to the expanding body of work on AMR in Bangladesh and is one of the first mixed-methods studies of AMR among secondary school students. The findings indicate that inappropriate use of antibiotics is not just a personal decision. Students' choices regarding antibiotic use are influenced by their educational experiences, family practices, media exposure, and the wider regulatory context. The results highlight the importance of AMR interventions in the social and educational sector, as well as in the health sector.

Guided by the Health Belief Model, this study examined AMR perceptions among higher secondary students in Bangladesh using quantitative, qualitative, and curriculum data. The results have both policy and practical implications. AMR education should be planned, targeted, and incorporated into the secondary and higher secondary school curriculum in a systematic manner and delivered in an age-appropriate, inquiry-based approach with teacher capacity building and textbook modifications. Strengthening school-based AMR education, engaging families and the media, and enforcing restrictions on non-prescription antibiotic sales are essential to building a culture of antimicrobial stewardship in Bangladesh.

Acknowledgments

The authors are grateful to the participating students, teachers, and school management authorities for their cooperation throughout this research. The authors also thank their colleagues for their assistance with the literature review, data processing, language support, and constructive feedback that improved the manuscript.

Data Availability Statement

The survey instrument and qualitative guides are available from the corresponding author upon reasonable request. De-identified quantitative data may be shared for academic purposes in accordance with institutional ethical guidelines.

References

Arju, K. S. (2018). Knowledge, attitude, and practice towards rational use of antibiotics among Bangladeshi medical tourists in Bangkok, Thailand (Master's thesis, Chulalongkorn University). Chulalongkorn University Theses and Dissertations. https://digital.car.chula.ac.th/chulaetd/2600

Bangladesh Bureau of Educational Information and Statistics [BANBEIS]. (2023, April). Pocket Book of Bangladesh Education Statistics 2022. Ministry of Education, Government of the People's Republic of Bangladesh. https://banbeis.portal.gov.bd/sites/default/files/files/banbeis.portal.gov.bd/files/ffec58c5_aef1_46ea_9f43_65fe5e7f1394/BES_Pocket_Bookl_2022.pdf

Becker, M. H. (1974). The Health Belief Model and personal health behaviour. Health Education Monographs, 2(4), 324–473. https://doi.org/10.1177/109019817400200407

Biswas, M., Roy, M. N., Manik, M. I. N., Hossain, M. S., Tapu, S. T. A., Moniruzzaman, M., & Sultana, S. (2014). Self-medicated antibiotics in Bangladesh: A cross-sectional health survey. BMC Public Health, 14, 847. https://doi.org/10.1186/1471-2458-14-847

Bonna, A. S., Zaman, S., & Karim, M. R. (2022). Antimicrobial resistance: A growing threat to public health in Bangladesh. Journal of Global Antimicrobial Resistance, 28, 238–245. https://doi.org/10.1016/j.jgar.2022.01.018

Bowen, G. A. (2009). Document analysis as a qualitative research method. Qualitative Research Journal, 9(2), 27–40. https://doi.org/10.3316/QRJ0902027

Chowdhury, N. (2019). Perceptions of rural communities in Bangladesh regarding antimicrobial resistance: A qualitative exploration. BMC Public Health, 19, 1234. https://doi.org/10.1186/s12889-019-7556-y

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). Sage.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). Sage.

Darj, E., Newaz, M. S., & Zaman, M. H. (2019). Pharmacists' perceptions of antimicrobial resistance and antibiotic prescribing in Bangladesh. International Journal of Pharmacy Practice, 27(3), 205–213. https://doi.org/10.1111/ijpp.12488

Dyar, O. J., Pulcini, C., Howard, P., & Nathwani, D. (2014). European medical students: A first multicentre study of knowledge, attitudes, and perceptions of antibiotic prescribing and resistance. Journal of Antimicrobial Chemotherapy, 69(3), 842–846. https://doi.org/10.1093/jac/dkt440

Dyar, O. J., Beović, B., Vlahović-Palčevski, V., Verheij, T., & Pulcini, C. (2018). How can we improve antibiotic prescribing in primary care? Expert Review of Clinical Pharmacology, 11 (6), 525–536. https://

doi.org/10.1080/17512433.2018.1463508

El-Sokkary, R. H., Badr, S. G., El Seif, O. S., El-Fakharany, Y. M., & Tash, R. M. E. (2022). Antibiotic prescribing etiquette: An elective course for medical students. BMC Medical Education, 22, 500. https://doi.org/10.1186/s12909-022-03949-9

Feufel, M. A., & Gastmeier, P. (2023). Appropriate antibiotic use and antimicrobial resistance: What do medical students know? Antimicrobial Resistance & Infection Control, 12, 48. https://doi.org/10.1186/s13756-023-01251-x

Fowler, F. J. (2013). Survey research methods (5th ed.). Sage.

Gillani, A. H., Chang, J., Aslam, A., Saeed, A., Shukar, S., Khanum, F., … Yang, C. (2017). Public knowledge, attitude, and practice regarding antibiotics in Pakistan's southern Punjab. International Journal of Environmental Research and Public Health, 14(10), 1152. https://doi.org/10.3390/ijerph14101152

Hoque, R., Ahmed, S. M., & Huda, T. (2020). Tackling antimicrobial resistance in Bangladesh: Policy and practice challenges across human, animal, and environmental health. Health Policy and Planning, 35(1), 70–78. https://doi.org/10.1093/heapol/czz130

Huang, Y., Gu, J., Zhang, M., Ren, Z., Yang, W., Chen, Y., … Zhang, F. (2013). Knowledge, attitude, and practice of antibiotics: A questionnaire study among 2500 Chinese students. BMC Medical Education, 13, 163. https://doi.org/10.1186/1472-6920-13-163

Islam, M. M. (2021). Bacterial resistance to antibiotics: access, excess, and awareness in Bangladesh. Expert Review of Anti-Infective Therapy, 19(8), 973–981. https://doi.org/10.1080/14787210.2021.1865804

Jifar, A., & Ayele, Y. (2018). Assessment of knowledge, attitude, and practice toward antibiotic use among Harar City and its surrounding community, Eastern Ethiopia. Antimicrobial Resistance & Infection Control, 7, 118. https://doi.org/10.1186/s13756-018-0414-8

Krueger, R. A., & Casey, M. A. (2014). Focus groups: A practical guide for applied research (5th ed.). Sage.

Kvale, S., & Brinkmann, S. (2015). Interviews: Learning the craft of qualitative research interviewing (3rd ed.). Sage.

Lucas, P. J., Uddin, J., & Khisa, N. (2019). Self-medication with antibiotics in developing countries: A systematic review. Tropical Medicine & International Health, 24(9), 1011–1023. https://doi.org/10.1111/tmi.13285

Marzan, M., Akter, S., & Rahman, M. M. (2021). Knowledge, attitude, and practice towards antimicrobial resistance among university students in Bangladesh. PLOS ONE, 16(9), e0257779. https://doi.org/10.1371/journal.pone.0257779

McMaster, D., Courtenay, M., Santucci, C., Tonkin-Crine, S., Cotta, M. O., Robinson, J., & Ashiru-Oredope, D. (2020). Consensus-based antimicrobial resistance and stewardship competencies for UK undergraduate medical students. JAC-Antimicrobial Resistance, 2(4), dlaa096. https://doi.org/10.1093/jacamr/dlaa096

Naghavi, M., Vollset, S. E., Ikuta, K. S., Swetschinski, L. R., Gray, A. P., Wool, E. E., Robles Aguilar, G., Mestrovic, T., Smith, G., Han, C., Hsu, R. L., Chalek, J., Araki, D. T., Chung, E., Raggi, C., Gershberg Hayoon, A., Davis Weaver, N., Lindstedt, P. A., Smith, A. E., … Murray, C. J. L. (2024). Global burden of bacterial antimicrobial resistance 1990–2021: A systematic analysis with forecasts to 2050. The Lancet, 404(10459), 1199–1226. https://doi.org/10.1016/S0140-6736(24)01867-1

Nahar, P., Unicomb, L., Lucas, P. J., Uddin, M. R., Islam, M. A., Nizame, F. A., Khisa, N., Akter, S. M. S., & Rousham, E. K. (2020). What contributes to inappropriate antibiotic dispensing among qualified and unqualified healthcare providers in Bangladesh? A qualitative study. BMC Health Services Research, 20(1). https://doi.org/10.1186/s12913-020-05512-y

Nutbeam, D. (2000). Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century. Health Promotion International, 15(3), 259–267. https://doi.org/10.1093/heapro/15.3.259

O'Neill, J. (2016). Tackling drug-resistant infections globally: Final report and recommendations. The Review on Antimicrobial Resistance. https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf

Orubu, E. S. F., Samad, M. A., Rahman, M. T., Zaman, M. H., & Wirtz, V. J. (2021). Mapping the Antimicrobial Supply Chain in Bangladesh: A Scoping-Review-Based Ecological Assessment Approach. Global Health: Science and Practice, 9(3), 532–547. https://doi.org/10.9745/GHSP-D-20-00502

Orok, E., Ikpe, F., Williams, T., & Ekada, I. (2025). Impact of educational intervention on knowledge of antimicrobial resistance and antibiotic use patterns among healthcare students: A pre- and post-intervention study. BMC Medical Education, 25(1), 283. https://doi.org/10.1186/s12909-025-06856-x

Primeau, C. A., McWhirter, J. E., Carson, C., McEwen, S. A., & Parmley, E. J. (2023). Exploring medical and veterinary student perceptions and communication preferences related to antimicrobial resistance in Ontario, Canada using qualitative methods. BMC Public Health, 23(1), 483. https://doi.org/10.1186/s12889-023-15193-x

Ramanarayanan, V., Prabhu, A. S., Sundareswaran, A., & Boban, D. (2024). Effectiveness of a training program on the knowledge and awareness of antimicrobial resistance and stewardship among dental house-surgeons. Public Health and Toxicology, 4(2), Article 9. https://doi.org/10.18332/pht/189989

Rosenstock, I. M. (1974). The Health Belief Model and preventive health behaviour. Health Education Monographs, 2(4), 354–386. https://doi.org/10.1177/109019817400200405

Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the Health Belief Model. Health Education Quarterly, 15 (2), 175–183. https://doi.org/10.1177/109019818801500203

Scaioli, G., Gualano, M. R., Gili, R., Masucci, S., Bert, F., & Siliquini, R. (2015). Antibiotic use: A cross-sectional survey assessing the knowledge, attitudes, and practices among students of a school of medicine in Italy. PLOS ONE, 10(4), e0122476. https://doi.org/10.1371/journal.pone.0122476

Shah, P., Shrestha, R., Mao, Z., Chen, Y., Chen, Y., Koju, P., Liu, X., & Li, H. (2019). Knowledge, attitude, and practice associated with antibiotic use among university students: A survey in Nepal. International Journal of Environmental Research and Public Health, 16 (20), 3996. https://doi.org/10.3390/ijerph16203996

Tashakkori, A., & Teddlie, C. (2003). Handbook of mixed methods in social and behavioural research. Sage.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. International Journal of Medical Education, 2, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

World Health Organization. (2019). No time to wait: Securing the future from drug-resistant infections. World Health Organization. https://www.who.int/publications/i/item/no-time-to-wait

World Health Organization. (2021). Health promotion glossary of terms 2021. World Health Organization. https://www.who.int/publications/i/item/9789240038349