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Article

Antibiotic use patterns and trends in the FDMN population and rural Bangladeshi population: a cross-sectional study

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Abstract: Global antibiotic resistance is a pressing issue, especially in Bangladesh, due to its widespread use, poor surveillance, and high treatment costs. This study compared antibiotic use between Rohingya and rural Bangladeshi residents, aiming to predict the frequency and tendency of commonly used antibiotics across different community levels. This was a cross-sectional descriptive study using a questionnaire. It involved Cox's Bazar camp, Tangail, and Bogura rural areas. Most participants were male, with 46.8% graduates and 20.8% untrained from mixed economic backgrounds. The study revealed that 62% adhered to doctors' orders, 28.5% followed pharmacists' recommendations, 6% sourced antibiotics from various places, 3% self-medicated, and 1% relied on advice from friends or relatives. Alarmingly, 25.3% did not complete their antibiotic courses. Age, region, advisor status, and education level were correlated with antibiotic use (P<0.05), whereas socioeconomic status was not. The most commonly used medications among both rural and FDMN populations were azithromycin, ciprofloxacin, amoxicillin, and metronidazole. These findings highlight gaps in antibiotic use and adherence, with many not completing their treatments. Despite educational and economic variations, there is a general lack of concern about AMR, emphasizing the need for better awareness of and adherence to guidelines.

Keywords: socioeconomic relationship; commonly used antibiotics; antimicrobial resistance; self-medication; health education

1. Introduction

The discovery of "miracle drugs" for infectious diseases, notably antibiotics, approximately a century ago marked a profound milestone in medical history. Antibiotics play a key role in treating common infections and reducing postsurgical complications. However, their misuse has led to a significant challenge: the emergence of antimicrobial resistance (AMR) in human populations (Frieri *et al*., 2017; Zhuang *et al*., 2021). AMR is a critical issue affecting both human health and the global economy. Without global action, AMR spread via physiological and biochemical mechanisms could result in an estimated 10 million deaths and over USD 100 trillion in economic losses by 2050, with Asia and Africa expected to account for approximately 90% of these fatalities (Shibl *et al*., 2001; Aslam *et al*., 2018; Islam *et al*., 2019).

Previous studies have maintained social (education, occupation) and economic (income, land ownership) indicators to assist researchers and policymakers in Asia and Africa, highlighting the importance of addressing antimicrobial resistance (AMR) (Amitha *et al*., 2023; Woldegeorgis *et al*., 2023).

Rising AMR rates disproportionately affect low- and middle-income countries (LMICs), such as Bangladesh (Sulis *et al*., 2021). The main drivers include irrational and subtherapeutic antibiotic usage, which is exacerbated by the proliferation of unlicensed drug stores, aggressive marketing, over-the-counter distribution, and prescription by unqualified physicians (Islam, 2020). A study according to the WHO classification of the outpatient dispensing rate of antibiotics revealed that half of the customers in Bangladesh (50.9%) purchased these life-saving drugs without a registered physician's prescription (Ariful *et al*., 2022). A lack of AMR awareness and elements linked to indicators of poverty, such as poor health care, malnutrition, chronic infections, and the inability to pay for better medications, are the leading causes of prescription noncompliance in low-income communities (Sutradhar *et al*., 2014; Makhdum *et al*., 2022). Additionally, antimicrobial overuse combined with unsanitary animal husbandry techniques is a significant risk factor for emerging zoonotic diseases and resistant bacteria that infect humans via the food chain (Roess *et al*., 2015; Ferdous *et al*., 2019; Samun *et al*., 2019). Recent studies have also indicated a high prevalence of resistance to the most common antibiotics, such as amoxicillin, ceftazidime, metronidazole, and ceftriaxone, in patients in Bangladesh (Aftab *et al*., 2016; Ahmed *et al*., 2019; Jain *et al*., 2021). Inadequate implementation of regulatory requirements, surveillance, and stewardship programs has hampered efforts to reduce AMR in the human and animal health sectors (Hoque *et al*., 2020).

AMR carriage correlated with human migration, such as foreign travel and forcible displacement, fuels the global transmission of AMR infections (Ghany *et al*., 2020; Patel *et al*., 2022). Although the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) have guided the implementation of stewardship programs in refugee camps, such as Cox's Bazar Rohingya camps, the population suffers from weak healthcare systems and sanitary and hygiene measures in LMICs (Turner *et al*., 2012; Dinleyici and Borrow, 2020; Mahmud *et al*., 2020; Jablonka *et al*., 2021). Moreover, a lack of education on proper antibiotic use, easy access, and high population density make the refugee population a prime region for the evolution and carriage of multidrug-resistant bacteria (Velez *et al*., 2016; Jasmine *et al*., 2018; Tahir *et al*., 2021).

AMR poses a growing global health threat, particularly in low- and middle-income countries (LMICs), such as Bangladesh, where irrational antibiotic use is rampant. The misuse of antibiotics, driven by factors such as unregulated access, poor health literacy, and economic constraints, exacerbates the AMR crisis. Despite global efforts to combat AMR, populations such as the forcibly displaced Myanmar nationals (FDMNs) in refugee camps and rural Bangladeshi communities continue to be vulnerable due to inadequate healthcare infrastructure, lack of awareness, and inconsistent adherence to antibiotic treatment guidelines. This study seeks to address the critical gaps in understanding antibiotic use patterns and trends among these two distinct populations. By identifying the factors influencing antibiotic use, evaluating adherence to prescribed treatments, and assessing the impact of socioeconomic and educational variables, this research aims to provide insights that could inform targeted interventions to mitigate the spread of AMR in Bangladesh.

This study aims to compare antibiotic usage patterns between Rohingya refugees (FDMNs) and rural Bangladeshi residents, identify factors that influence antibiotic use, assess adherence to treatment protocols, and propose strategies to summarize current user practices regarding antibiotic use in Bangladesh.

2. Materials and Methods

2.1. Ethical approval and informed consent

This is a cross-sectional descriptive study with a questionnaire that collects data or records containing only non-identifiable data on human beings and negligible risk research. For this purpose, we conducted this study as an exemption from ethics review. Rather, we obtained informed consent from the participants and took measures to protect their confidentiality and privacy. To avoid identifying individuals, all the data collected were anonymized or de-identified. Store and handle data securely to reduce the possibility of unauthorized access or disclosure. Both the Bangladeshi and the FDMN provided informed consent, and both groups of people signed the consent form.

2.2. Study sites and population

This was a descriptive cross-sectional questionnaire-based study. Data were collected from January 2022 to May 2022. The study was conducted on random individuals over the age of 15 years residing in rural areas of Bangladesh, specifically Tangail and Bogura, along with Rohingya refugees (forcibly displaced from Myanmar in 2018) residing in Cox's Bazar refugee camp 24 (Figure 1). A total of 600 individuals from three different

regions of Bangladesh (Tangail, Bogura, and 'Cox's Bazar) were included in the study. We collected data from rural Bangladesh in Tangail (200) and Bogura (200). The remaining data (200) were collected from the Rohingya people in FDMN camp 24, Cox's Bazar. The study sites included heavily populated areas with varying degrees of access to healthcare and pharmacies. The participants were predominantly from lower socioeconomic demographics. The participants' consent was obtained verbally and signed and was anonymous, and their identity was kept confidential. Data were collected from January 2022 to May 2022. The study was conducted on randomly selected individuals over the age of 15 years residing in rural areas of Bangladesh, specifically Tangail and Bogura, along with Rohingya refugees (who were forcibly displaced from Myanmar in 2018) residing in Cox's Bazar refugee camp 24. A total of 600 participants were surveyed, with 200 individuals each from the Tangail, Bogura and Rohingya communities in Cox's Bazar. The current study included 61.8% males (n=371) and 38.2% females (n=229). The study sites integrated densely populated regions with varying levels of access to healthcare facilities and pharmacies. The participants were predominantly those with lower socioeconomic demographics.

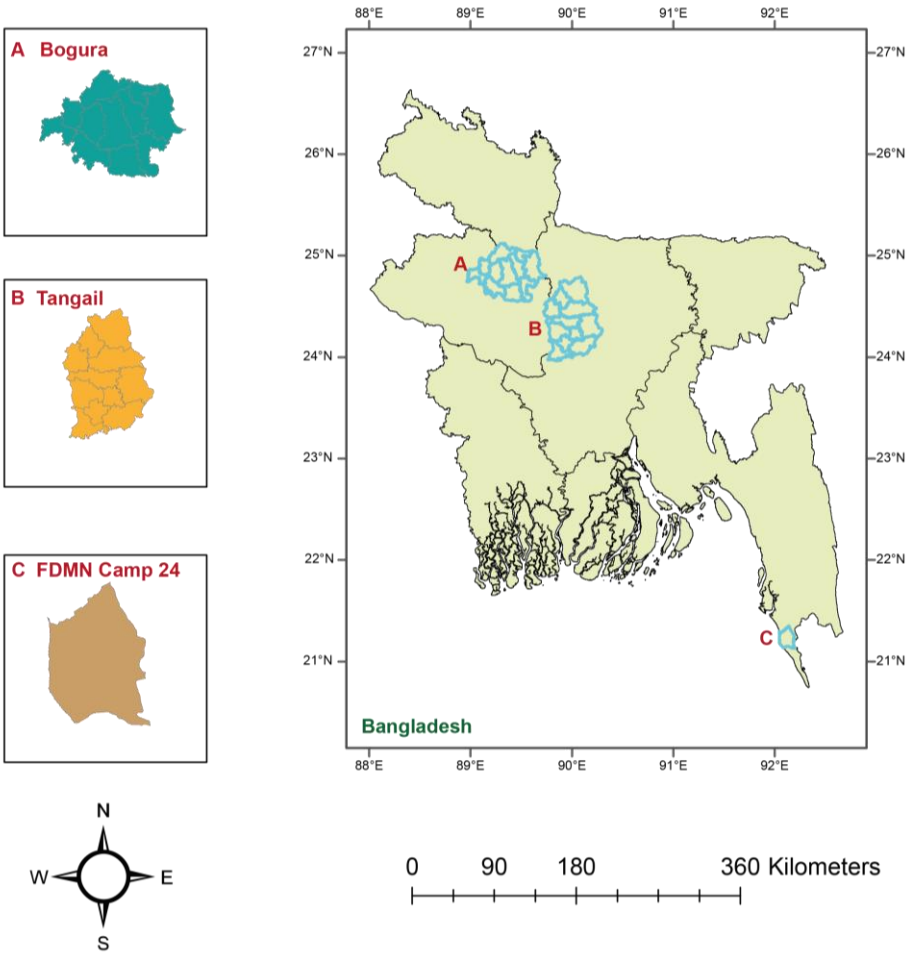

Figure 1. Map showing the geographical locations of the study areas in Bangladesh: Bogura (A), Tangail (B), and FDMN Camp 24 (C).

2.3. Questionnaire design

The questionnaire consisted of open-, close-ended, and multiple-choice answers based on relevant literature reviews (Olayemi *et al*., 2010; Napolitano *et al*., 2013; Horvat *et al*., 2017; Ajibola *et al*., 2018; Raupach-Rosin *et al*., 2019), with some modifications based on common practices in Bangladesh and prepared by a physician, biologist, and pharmacist research team. The questionnaire was designed in Bengali, the native language of Bangladesh, which is also convenient for Rohingya. A group of undergraduate and postgraduate life science students collected the data. The questionnaire consists of 27 questions investigating five main areas—the participants' socio-demographic and economic information (10 questions): age, gender, address, educational level, marital and economic status, and family. The history and knowledge of 'participants' use of antibiotics.

Knowledge regarding antibiotic action, consequences, and causes of antimicrobial resistance. The role of healthcare professionals in antibiotic prescription and use among participants. Differences in perceptions of antibiotic use among participants from mainland Bangladesh and those from refugee camps.

2.4. Statistical analysis

The data were analyzed via SPSS version 24.0. All collected data were summarized and tabulated in the MS Excel sheet and analyzed via SPSS version 24.0. Data analysis involved quantitative statistics and testing for significant associations between sample demographic variables and antibiotic use and antimicrobial resistance awareness. Significance was examined via chi-square tests, and $P<0.05$ was considered significant. We used ArcGIS version 10.8.1 for generating the sample site map and R version 4.3.3 for the figures.

3. Results and Discussion

3.1. Socio-demographic characteristics of the participants

This study highlights the socioeconomic factors that influence antibiotic use among the general population in Bangladesh. This study reveals a variety of significant findings related to the usage of antibiotics, including the levels of knowledge regarding their appropriate use and awareness of antibiotic resistance and its consequences. Our survey revealed frequent antibiotic use, with 75.5% of young people (n=453), 14.3% of older people (n=86), and 10.2% of adults (n=61) having taken antibiotics in the last six months (Table 1). Most participants were well educated: 46.8% (n=281) had a school certificate, 32.3% (n=194) were graduates, and 20.8% (n=125) were uneducated (Table 1). Education level was strongly linked to understanding antibiotics and resistance. These results suggest that despite formal education, knowledge about proper antibiotic use remains limited. Research has shown that knowledge about AMR significantly varies with educational level, and despite interventions, students exhibit an inadequate understanding of several AMR determinants (Fernandes *et al*., 2019; Fuller *et al*., 2023).

Table 1. Overview of the demographics and antibiotic utilization profiles in the study.

Gender and age demographics in the study								
Gender	Demographic variable	Male	Female			Young	Adult	Old
	Frequency	371	229			453	61	86
	Percentage	61.80%	38.20%			75.50%	10.20%	14.30%
Educational and socioeconomic demographics in the study sample								
Education	Demographic variable	School certificate	Graduate	Uneducated	**Socioeconomic condition**	Lower class	Lower middle class	Middle class	Higher class
	Frequency	281	194	125		246	194	157	3
	Percentage	46.80%	32.30%	20.80%		41.00%	32.00%	26.00%	1%
Antibiotic utilization and completion profile								
Antibiotic use profile	Antibiotic use/course status	Yes	No	'Do not remember	**Antibiotic course completion profile**		Completed	In-completed
	Frequency	527	28	45			448	152
	Percentage	87.80%	4.70%	7.50%			74.70%	25.30%

In addition to educational factors, our study examined the financial status of participants on the basis of Bangladeshi living expenses, defining the lower class as less than 94.73 USD, the lower middle class as between 94.74 and 142.10 USD, the middle class as between 142.11 and 189.46 USD, and the upper class as over 189.46 USD. The majority of participants were from the lower class (41.00%, n=246), followed by the lower middle class (32.00%, n=194), middle class (26.00%, n=157), and a small proportion from the upper class (1%, n=3) (Table 1). These findings suggest that antibiotic use is more random and unregulated among lower-class and lower-middle-class individuals, indicating a need for targeted public health interventions in these socioeconomic groups. The current findings could be related to LMCs (lower-middle-income nations) and other findings from Germany, the United Kingdom, Sweden, Italy, Poland, Lithuania, Cyprus, Siberia, and Hong Kong (McNulty *et al*., 2007; Napolitano *et al*., 2013; World Health Organization, 2015; Horvat *et al*., 2017; Raupach-Rosin *et al*.,

2019). A significant association (P<0.05) between the use of antibiotics and age, area, advisor, and educational level was found, but an association was not found with socioeconomic conditions.

3.2. Antibiotic knowledge and frequency of antibiotic use and resistance

More than two-thirds of the participants (87.8%, n=527) reported using antibiotics, whereas 4.7% (n=28) stated that they did not, and 7.5% (n=45) could not recall an antibiotic name at the time of the study (Table 1). When asked about their antibiotic use practices, 74.7% of the respondents reported completing their antibiotic course, whereas 25.3% did not. This completion rate is relatively higher than the 71% reported in Saudi Arabia and the 36% reported in Kuwait, who did not complete their antibiotic courses. These findings highlight varying levels of adherence to antibiotic courses across different populations, emphasizing the need for improved education on the importance of completing antibiotic treatments.

A comparison of common antibiotics used among rural Bangladeshi people and FDMNs revealed that azithromycin, metronidazole, ciprofloxacin, and amoxicillin are the most frequently utilized antibiotics (Figure 2A). Azithromycin was the most commonly used agent (n=253), followed by metronidazole (n=181), ciprofloxacin (n=169), and amoxicillin (n=166). Other antibiotics used included doxycycline (n=88), cephalexin (n=25), clindamycin (n=11), sulfamethoxazole (n=5), and trimethoprim (n=2) (Figure 2A). These findings highlight that azithromycin, metronidazole, ciprofloxacin, and amoxicillin are the primary antibiotics used within these populations. Another study reported that the largely resistant character of amoxicillin has been noted in several European countries, including Poland, Belgium (Somashekara *et al*., 2014), India (Somashekara *et al*., 2014), and Senegal (Theodore, 2012). Therefore, we can easily say that, worldwide, most people use these antibiotics. Similar findings from Bangladesh indicate that metronidazole is the most often prescribed antibiotic by college students (Abasaeed *et al*., 2009; Olayemi *et al*., 2010; Togoobaatar *et al*., 2010; Ajibola *et al*., 2018).

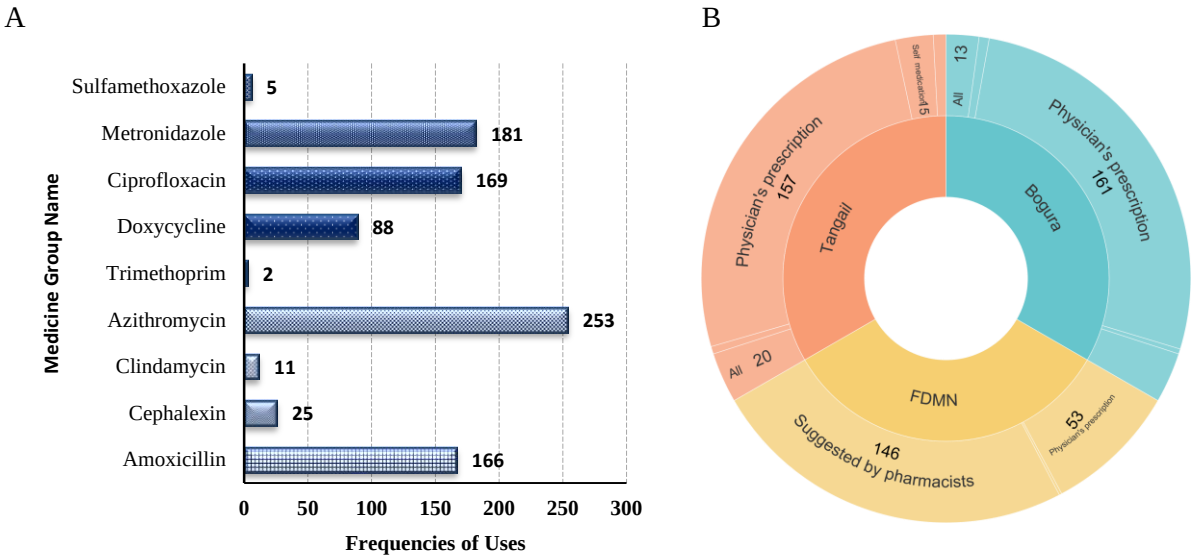

Figure 2. Figure illustrates (A) the variance in frequency among distinct antibiotic groups concerning their usage and (B) the distribution of antibiotic use status categorized by the types of advisors' recommendations across different areas (Bogura, FDMN, and Tangail).

3.3. Interactions between patients and medical professionals about antibiotic use

The results of the survey questions on how people received advice revealed that a sizable number of respondents said they had received their last course of antibiotics or a prescription for them, with 62.00% (n=371) from a doctor, 28.50% (n=171) from a pharmacist, 3.00% (n=18) from self-medication, 1.00% (n=7) from other people, and 6.00% (n=33) from all options taking medications (Table 1). Figure 3A shows the prevalent use of certain medication groups among rural and FDMN populations, whereas Figure 3B shows the frequent use of pharmacists by FDMN individuals compared with rural populations, who rely primarily on physicians' prescriptions.

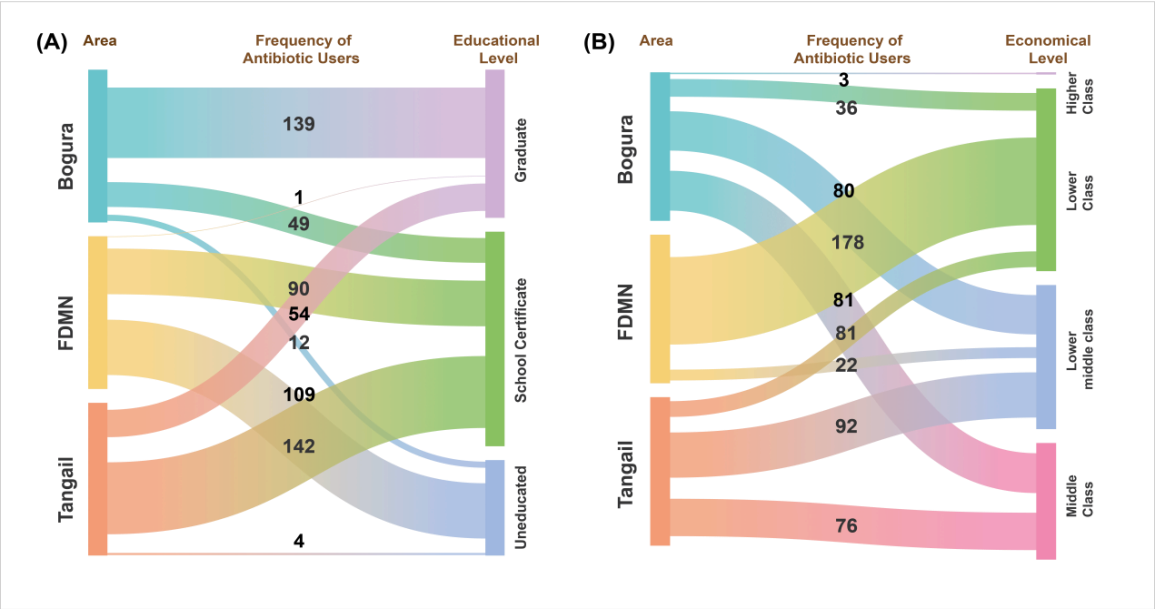

Figure 3. The Sankey diagram illustrates the distribution of antibiotic users' status by education and socioeconomic condition in different areas.

Antibiotic self-medication is a widespread problem that has been linked to improper practices in industrialized European nations, including Spain (15.2%), Romania (15.2%), and Lithuania (21%)**.** Antibiotic self-medication has been reported in Karachi (47.6%), Rajshahi, Bangladesh (26.69%), and Dhaka, Bangladesh (8%)**.** In this study, fewer people had taken antibiotics by themselves. This figure is only 3% in rural areas (Tangail, Bogura & FDMN). The current study also revealed that participants who bought antibiotics without a prescription or without first consulting a doctor had relatively less knowledge than did others and people with comparable diseases. According to our research, self-medication was a prevalent behavior.

Age was positively correlated with antibiotic use (Pearson coefficient = 0.109). Following advice from physicians and pharmacists was significantly associated with completing antibiotic courses (Pearson coefficient = 0.217). There was a weak negative correlation between area and antibiotic use (Pearson coefficient = -0.118, P = 0.05) and a moderate negative correlation between education level and antibiotic course completion (Pearson coefficient = -0.227). Location and education also showed a moderately negative correlation (Pearson coefficient = -0.414, P = 0.05) (Table 1). Age influences antibiotic use, suggesting a need for targeted interventions for older populations. Guidance from healthcare professionals enhances antibiotic course completion. Regional disparities and educational levels impact antibiotic use, highlighting the importance of adapting strategies to improve adherence and combat antimicrobial resistance.

Our analysis revealed that area, educational level, and economic status do not solely account for the indiscriminate use of antibiotics. Many individuals use antibiotics on the basis of personal choices or recommendations from pharmacists and rural doctors. Ensuring that healthcare professionals have sufficient knowledge about antibiotics and prescribe them after an accurate diagnosis is crucial. Future research should aim to investigate healthcare professionals' antibiotic prescribing practices, particularly when comparing rural and urban doctors across broader geographic regions.

We are also interested in studying antibiotic resistance patterns in the future. Effective public health responses will require adequate funding for genomic and resistance marker studies. Comparing blood and urine samples from FDMN and rural residents, alongside tests such as susceptibility and biofilm testing, can provide insights into antimicrobial effectiveness.

Bangladesh, a developing nation in Southeast Asia, poses significant threats due to escalating antibiotic use, misuse, and abuse. Urgent legislative measures and initiatives are necessary to address these issues promptly (Ahmed *et al*., 2019). Effective policies and monitoring efforts are crucial for promoting responsible antibiotic use, raising awareness, and ensuring patient safety by prescribing antibiotics judiciously (Hossain *et al*., 1982). Future studies will focus on assessing AMR knowledge and antibiotic misuse at rural and urban levels in Bangladesh.

4. Conclusions

This study aimed to compare antibiotic usage patterns between Rohingya refugees (FDMNs) and rural Bangladeshi residents, explore the factors influencing antibiotic use and adherence to treatment protocols, and propose strategies to address current practices in Bangladesh. Our findings underscore the significant role of healthcare professionals in guiding proper antibiotic use and highlight disparities in education and regional influences on antibiotic practices. According to surveys, most participants knew little about antibiotic use and resistance, and a sizeable percentage did not finish all prescribed antibiotic courses. Our findings underscore the significant role of healthcare professionals in guiding proper antibiotic use and highlight disparities in education and regional influences on antibiotic practices. In short, this study revealed that regardless of their educational or economic background, people in these areas are not concerned about the effects of antimicrobial resistance (AMR). Developing nations such as Bangladesh should develop antimicrobial stewardship programs and apply infection prevention and control techniques in healthcare settings to address the morbidity, mortality, and costs of antibiotic resistance.

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Data availability

No metadata were used for this study.

Conflict of interest

None to declare.

Authors' contribution

Rasna Sharmin Keya: conceptualization, data curation, methodology, validation, writing – original draft; Ashok Kumar Barman: formal analysis, investigation, methodology, project administration, software; Salman Istiak Sabbir: data curation, methodology, visualization; Sabiha Shirin Nupur: data curation, formal analysis, methodology; Nusrat Hasan Kanika: investigation, project administration, supervision, visualization, writing – review & editing. All authors have read and approved the final manuscript.

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