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Original Article

ANTIBIOTIC MISUSE AND ANTIMICROBIAL RESISTANCE KNOWLEDGE AMONG UNIVERSITY STUDENTS IN BANGLADESH: CURRENT TRENDS AND FUTURE PROSPECTS

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ABSTRACT

Antimicrobial resistance (AMR) is a growing global health concern threatening both human and animal health. Misuse and overuse of antibiotics, especially through self-medication, are major contributors in developing countries. This study aimed to assess the knowledge, attitude, and practices regarding antibiotic misuse and AMR among university students in Bangladesh. A cross-sectional questionnaire-based survey was conducted from September 2024 to February 2025 among 398 students from different disciplines at the University of Rajshahi. Systematic random sampling was applied, and the data were analyzed by using SPSS, version 27, to identify associations with socio-demographic factors. Overall knowledge of antibiotics and AMR was unsatisfactory. While 90.7% of students knew about antibiotics, only 64.07% and 63.32% were aware of antimicrobial drugs and AMR, respectively. Science students showed significantly higher AMR awareness ($p<0.001$) than arts and commerce students. About 46.33% practiced self-medication, with males being more prone ($p=0.001$). Moreover, 40.25% used antibiotics irregularly, and 45.57% stopped treatment once they felt better. Arts students were more likely to discontinue antibiotic courses ($p=0.001$). Despite moderate awareness, the high prevalence of self-medication and inappropriate antibiotic use among university students remains alarming and highlights the urgent need for targeted educational actions to promote rational antibiotic use.

Keywords: Antimicrobial resistance, Antibiotic misuse, Self-medication, Irrational antibiotic use, Knowledge and attitudes

1. INTRODUCTION

Antimicrobial resistance (AMR) is a global and public health threat in medical science, where microorganisms such as bacteria, viruses, fungi and parasites become resistant to antimicrobial drugs rendering their treatment effectiveness (Roca *et al*., 2015; Antimicrobial Resistance Collaborators, 2022). It also affects animal health, reduces animal production, increases treatment costs, and threatens food safety issues (WHO, 2023). The misuse and overuse of antimicrobials or antibiotics in humans and animals significantly influence the development of antimicrobial resistance by a mutation in genetic elements, horizontal gene transfer, structural modification of drug-receptor sites and enzyme secretion to degrade drugs in microbes or bacteria (Egorov *et al*., 2018; WHO, 2023). According to previous studies, the irrational use of antibiotics (stopping taking antibiotics when they feel better without completing the antibiotic course) in developed countries varied between 3-6% (Grigoryan *et al*., 2006; Morgan *et al*., 2011; Muscat *et al*., 2006; Mboya *et al*., 2018), but in contrast it was significantly alarming for the developing countries, such as Tanzania (88.8%) (Mboya *et al*., 2018), Bangladesh (56.72%) (Hossain *et al*., 2023), India (52%) (Nguyen *et al*., 2022), Pakistan (56.09%) (Javed *et al*., 2023), Saudi Arabia (71.1%) (Zowalaty *et al*., 2016). In addition, several previous studies have been conducted to understand the knowledge of antimicrobial resistance among university students, health workers, and the general population in different developed or developing countries. These reports highlighted that people are not well concerned about antimicrobial resistance and rational antibiotic use (Barchitta *et al*., 2021; Shahpawee *et al*., 2020; Simegn & Moges, 2022; Singh-Phulgenda *et al*., 2023). However, growing antimicrobial resistance in microbes leads to less efficient, more prolonged therapy or therapeutic failure and increases treatment costs for microbial infections (Michael *et al*., 2014; Naghavi *et al*., 2024), even causing death every year to around 700,000 worldwide (Barchitta *et al*., 2021). According to a recent report by the World Health Organization, antimicrobial resistance may lead to 10 million deaths globally by 2050 if urgent action is not taken (Naghavi *et al*., 2024). In addition, AMR will be one of the most threatening health crises and exceed deaths from other causes; cancer or infectious diseases (O'Neill, 2014). Therefore, raising awareness among the public through educational strategies regarding antimicrobial drug use and antimicrobial resistance has been highly recommended by the WHO (WHO, 2015). Furthermore, information on the knowledge regarding antimicrobial or antibiotic use and antibiotic resistance among people help to develop an effective educational strategy to make people aware and prevent the misuse of antibiotics (Nguyen *et al*., 2022). Thus, this study aimed to investigate the knowledge, attitude, and behavior about antibiotic misuse and antimicrobial resistance among university students in Bangladesh.

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2. MATERIALS AND METHODS

Study Design and Area:

From September 2024 to February 2025, a cross-sectional questionnaire-based survey was conducted at the University of Rajshahi, Bangladesh. This university is one of the largest universities in Bangladesh with an estimated of approximately 36,000 students.

Participants and sampling:

This study was conducted using a door-to-door questionnaire-based survey method. The data were collected from students with different educational backgrounds under three academic disciplines including Science (Pure science, Engineering & Biological science), Arts, and Commerce. The target samples were taken by applying a systematic random sampling method (Hossain *et al*., 2021) and the following formula suggested by Yamane was applied to estimate the sample size (Yamane, 1967):

$$n = \frac{N}{1 + (N \times d^2)} \quad (1)$$

where n and N represent the estimated sample and population size, respectively. In addition, d signifies the 5% alpha value with a 95% confidence interval. Based on this calculation, the calculated sample size was 396 and 398 responses were collected and analyzed to ensure reliable and representative data.

Sampling Method:

A questionnaire was prepared by following different scientific literature on the irrational use of antibiotics and antimicrobial resistance knowledge (Buke *et al*., 2005; Hossain *et al*., 2023). The questionnaire included different socio-demographic data about participants, antimicrobial knowledge, antibacterial knowledge, knowledge on antimicrobial resistance, irrational antibiotic use, and self-medication. Additionally, a limited number of open-ended questions were included to validate participant responses and improve the accuracy level of the findings.

Statistical Analysis:

The data were coded and analyzed using SPSS, version 27 (Statistical Package for the Social Sciences, IBM). First, descriptive statistics analysis was conducted to tabulate and organize several socio-demographic factors with their frequency and prevalence. Then, to assess the correlation at a significant level ($p< 0.05$) of various socio-demographic factors and several parameters including irrational use of antibiotics, knowledge of the antibiotics, antimicrobial drugs, and antimicrobial resistance was implemented.

3. RESULTS

Socio-demographic Characteristics of the Participants:

A total of 398 students from different disciplines at the University of Rajshahi took part in the questionnaire survey and the male and female participants were equal in number. As shown in Table 1, 0.5% of students were in the age group of 16-20 years, 92.7% of students were in the age group of 21-25 years, and 6.8% were in the age group of 26-30 years. In terms of the educational background of the participants, 50% were in science (biological science: 25.6% and pure science or engineering: 24.4%), 27.6% were in arts, and 22.4% were in commerce. Finally, most of the participants, 85.7% were undergraduate students (currently enrolling in honors program), while 14.3% were enrolled in master's program.

Knowledge of Antimicrobials, Antibiotics, and AMR :

This study found a significant correlation between participants' knowledge of antimicrobials, antibiotics, and antimicrobial resistance and their academic disciplines ($p< 0.001$) (Table 2). Students from science discipline had the highest awareness, with 86.4% of participants knowing about antimicrobial drugs, 97.5% knowing about antibiotics, and 81.9% knowing about antimicrobial resistance. In contrast, only 39.1% of art students and 44.9% of commerce students were aware of antimicrobial drugs.

Among male students, 60.3% heard about antimicrobial drugs, while 89.9% were familiar with antibiotics, and 64.8% heard about antimicrobial resistance. In contrast, female participants showed slightly higher awareness. 67.8% of female participants knew about antimicrobial drugs, 91.5% knew about antibiotics and 61.8% knew about antimicrobial resistance. However, no statistically significant in knowledge about antibiotics, antimicrobials, and antimicrobial resistance was found between male and female participants ($p> 0.05$).

Although most of the participants were undergraduate students, postgraduate (master's) students showed a slightly better knowledge of antimicrobial resistance (75.4%) compared with undergraduate students (61.3%) ($p=0.040$).

Table 1: $\chi 2$ test for assessing several sociodemographic and irrational use of antibiotics related potential factors associated with self-medication among antibiotic users of the study participants (N = 395).

Variables	Options	Experience on Self-Medication				P-value
		Yes		No		
		N	%	N	%	
Gender	Male	108	27.34	91	23.04	**0.001**
	Female	75	18.99	121	30.63	
Educational Background	Science	82	20.76	115	29.11	0.108
	Arts	59	14.94	50	12.66	
	Commerce	42	10.63	47	11.90	
Age (yrs)	16-20	2	0.51	0	0	0.307
	21-25	169	42.78	197	49.87	
	26-30	12	3.04	15	3.80	
Education Level	Honors	159	40.25	179	45.32	0.489
	Masters	24	6.08	33	8.35	
Heard about Antimi. Drugs	Yes	103	26.08	152	38.48	**0.001**
	No	80	20.25	60	15.19	
Heard about Antibiotics	Yes	163	41.27	197	49.87	0.179
	No	20	5.06	15	3.80	
Heard about Res.	Yes	111	28.10	140	35.44	0.268
	No	72	18.23	72	18.23	

Bold values are statistically significant

Table 2: $\chi 2$ test for Awareness of Antimicrobial and Antibiotic Substances, and Antimicrobial/Antibiotic resistance (N = 398).

Variable	Category	Antimicrobial Knowledge						P Value
		Did you hear about Antimicrobial Drugs?		Did you hear about Antibiotic Drugs?		Did you hear about Antimicrobial/Resistance?		
		Yes	No	Yes	No	Yes	No	
Gender	Male	120	79	179	20	129	70	0.533
	Female	135	64	182	17	123	76	
Discipline	Science	172	27	194	5	163	36	**<0.001**
	Arts	43	67	96	14	46	64	
	Commerce	40	49	71	18	43	46	
Age (yrs)	16-20	2	0	2	0	2	0	0.147
	21-25	235	134	335	34	229	140	
	26-30	18	9	24	3	21	6	
Education Level	Honors	221	120	307	34	209	132	**0.040**
	Masters	34	23	54	3	43	14	

Bold values are statistically significant

Self-Medication Behaviors Among the Participants:

Table 1 describes the self-medication behaviors among the participants. This study found that 27.34% of male and 18.99% of female students experienced self-medication (p=0.001). The antibiotics were commonly used fever (22.86%), pain (12.81%), weakness or fatigue (1.76%), cold (1.76%), wound (4.27%), rapid recovery from any distress or diseases (20.35%), and for multiple reasons (35.68%) (Figure 1). In addition, no significant correlation was observed related to the educational background, age and education level of the participant with their self-medication behavior. participants who were aware of antimicrobial drugs were significantly to use antibiotics without any doctor's prescription (26%, p=0.001). In contrast, 41.27% and 28.10% of participants knew about antibiotics (p=0.179) and antimicrobial or antibiotic resistance (p= 0.268), respectively, and they were also taking antibiotics without any doctor's prescription.

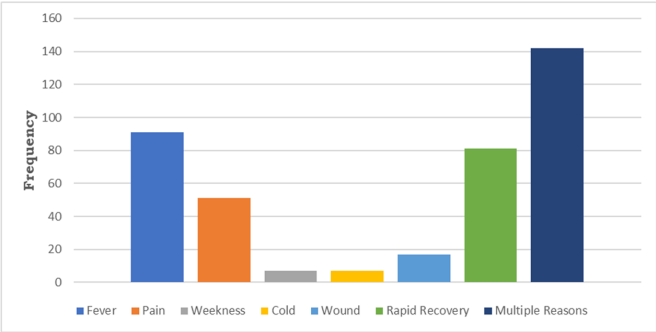

Figure 1: Illustrates the aims of antibiotics used among the participants (n= 396)

Attitude and Behaviour Towards the Usage of Antimicrobials and Antibiotics:

When antibiotics seemed ineffective, the participant's behavior varied significantly depending on their academic background (Table 3). Most of the participants (52.66%) reported that they would discontinuing the antibiotic and visit the physician again. A smaller group (14.7%) reported stopping treatment and consulting another physician, while 32.6% reported continuing the antibiotics for the full given period even if they seemed ineffective. Science students were more likely to follow through with the prescribed period (21.8%) compared to those from arts (6.8%) or commerce (4.1%) (p<0.001). However, there was no significant correlation between the participants' gender, age, education level, knowledge regarding antibiotics, antimicrobial drugs, or AMR, and their behavior when antibiotics did not work properly.

Figure 2 shows that 29.87% of students used antibiotics in order not to get ill. Among the participants, 28.71% in biological science, 31.19% in arts, 30.34% in commerce, and 29.17% in pure science or engineering took antibiotics aiming not to get ill as a preventive medicine (p= 0.98).

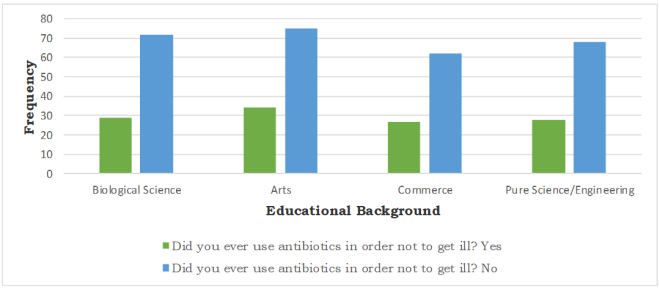

Figure 2: Illustrates the frequency distributions of participants with different disciplines: They used antibiotics in order not to get ill (n=395) (p=0.98).

As shown in Figure 3, 23.54%, 7.85%, 2.03%, 22.28%, and 44.30% of participants obtained antibiotics for their last infections by consulting with a local pharmacy or self-decision, family members, friend, followed last prescription and doctors' advice, respectively. Among them, 66.97% of participants in the arts discipline took antibiotics without a doctor's recommendation during their last infection. At the same time, participants who were in biological science, commerce, and pure science or engineering discipline obtained antibiotics without a doctor's prescription were 49.5%, 55.06%, and 50% respectively (p=0.161).

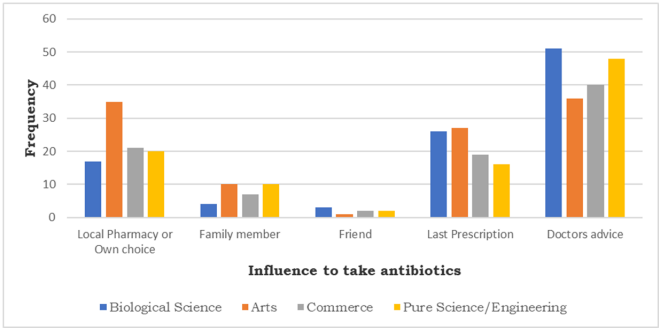

Figure 3: Frequency distribution of medication style of antibiotics used among the participants during their last infection with different education backgrounds (n=395) (p=0.161).

Figure 4 illustrates the behavior of participants when they stop taking antibiotics during their antibiotic course, and we found that 45.57% of participants discontinued antibiotics once they felt better without completing the full course of antibiotics. Among the participants, 31.68% of biological science, 58.72% of arts, and 38.54% of pure science or engineering discontinued antibiotics when they felt better with significant difference (p=0.001). On the other hand, Fig-

Table 3: $\chi 2$ test for assessing several sociodemographic and irrational use of antibiotics related potential factors associated with antibiotic resistance (Antibiotic seem ineffective) among antibiotic users (N=395).

		When Antibiotics Seem Ineffective						
		Stop & Visit Doctor		Stop & Change Doctor		Continue Until Period		
Variable	**Category**	**N**	**%**	**N**	**%**	**N**	**%**	**p-value**
Gender	Male	101	25.57	30	7.59	68	17.22	0.741
	Female	107	27.09	28	7.09	61	15.44	
Discipline	Science	85	21.52	26	6.58	86	21.77	**<0.001**
	Arts	69	17.47	13	3.29	27	6.84	
	Commerce	54	13.67	19	4.81	16	4.05	
Age (yrs)	16-20	1	0.25	1	0.25	0	0	0.468
	21-25	192	48.61	55	13.92	119	30.13	
	26-30	15	3.80	2	0.51	10	2.53	
Education Level	Honors	176	44.56	51	12.91	111	28.10	0.803
	Masters	32	8.10	7	1.77	18	4.56	
Heard of Antimicrob.	Yes	132	33.42	33	8.35	90	22.79	0.209
	No	76	19.24	25	6.33	39	9.87	
Heard of Antibiotics	Yes	188	47.60	54	13.67	118	29.87	0.802
	No	20	5.06	4	1.01	11	2.79	
Heard of Resistance	Yes	126	31.90	38	9.62	87	22.03	0.420
	No	82	20.76	20	5.06	42	10.63	

Bold values are statistically significant

ure 5 illustrates participants' responses to the question, "Did you ever use antibiotics prescribed by a doctor irregularly?" Overall, 40.25% of participants reported taking antibiotics irregularly at least once during a prescribed course. No significant differences were observed across disciplines (p = 0.128). Additionally, 21.27% of participants preferred to start using antibiotics based on advice from local pharmacists without significant disciplinary differences (p= 0.247) (Figure-6). In addition, the biological background students were more likely to follow timely use of antibiotics compared to the other disciplines. Figure 7 shows that 56.44% of biological science, 36.70% of arts, 35.96% of commerce, and 51.04% of pure science or engineering background students strictly followed 12 hours interval period of antibiotic (p=0.005). Finally, figure 8 demonstrates that 70.24% of students made people aware of AMR and those who were aware of AMR (p= <0.001). Over the total students (398), 146 students (36.68%) had not heard about AMR.

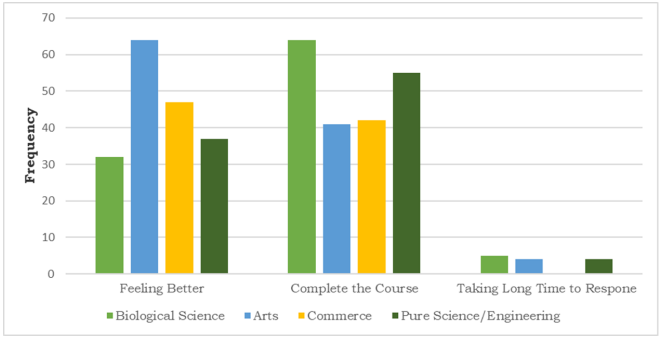

Figure 4: Frequency distribution of the participants' behavior towards stopping taking antibiotics when they feel better without completing the antibiotic course with different education backgrounds (n=395) (p=0.001).

4. DISCUSSION

This study highlights the antibiotic misuse and antimicrobial resistance knowledge among university students in Bangladesh. Hence, reports of antimicrobial or antibiotic misuse are a common problem in developing or underdeveloped countries (Salam *et al*. 2023).

The major findings of this study were 64.07%, 90.70%, and 63.32% of the participants heard about antimicrobial drugs, antibiotics, and AMR respectively. Disciplined-based knowledge of antibiotics, antimicrobial drugs, and AMR showed statistically significant (p<0.001). Arts and commerce students had less knowledge of antibiotics, antimicrobial drugs, or AMR than science (Buke *et al*., 2005; Marzan *et al*., 2021) which is non-satisfactory and a serious public health crisis in developing and under-developing countries including Bangladesh.

The attitudes towards the use of antimicrobials or antibiotics showed that the majority of the participants (74.94%) obtained antibiotics based on a doctor's recommendation. It was very surprising that about 3.80% of participants obtained antibiotics at home without consulting with doctors, and 21.26% took suggestions from local pharmacists. Thus, it is alarming that antibiotics are available and people can buy without prescriptions (Buke *et al*., 2005).

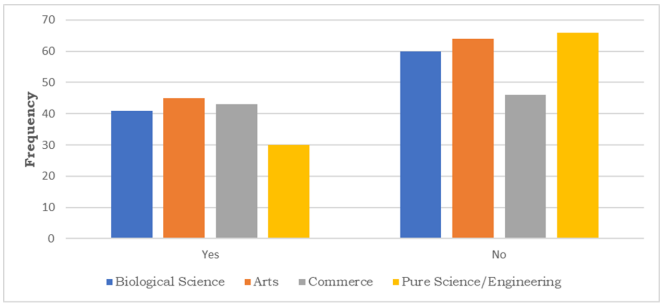

Figure 5: Frequency distribution of the participants' attitude towards irregular use of antibiotics prescribed by doctors with different education backgrounds (n=395) (p=0.128).

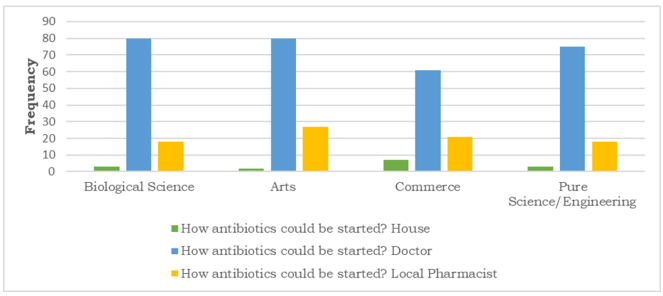

Figure 6: Frequency distribution of the participants' attitude towards "How antibiotics could be started?" with different education backgrounds (n=395) (p=0.247).

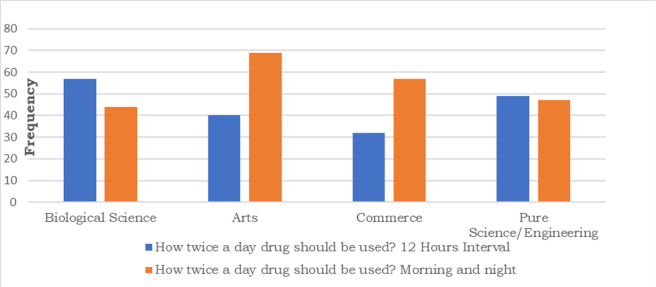

Figure 7: Frequency distribution of the participants' practice towards "How twice a day drugs should be used twice a day when antibiotics need to be taken twice a day?" with different education backgrounds (n=395) (p=0.005).

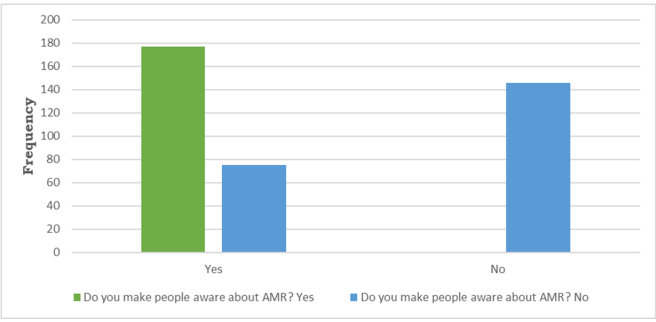

Figure 8: Frequency distribution of participants' attitudes towards their knowledge of AMR and their awareness of AMR (n=398) (p=<0.001).

In addition, participants reported using antibiotics aiming to relieve symptoms such as fever, pain, weakness or fatigue, cold, wound, and rapid recovery from any distress or diseases (Almeshal *et al*., 2024; Buke *et al*., 2005; Hossain *et al*., 2023). About 45.2% of the participants reported using antibiotics for fever, cold, or rapid recovery from any distress or diseases. A previous study reported that 27.4% of people used antibiotics to treat the cold (Vanden Eng *et al*., 2003) and around 26% of people misused as an antipyretic (Buke *et al*., 2005). Even many people discontinued antibiotics course when they felt better (Borek *et al*., 2023; Marzan *et al*., 2021).

Furthermore, awareness of the dangers associated with using antibiotics or antimicrobials was acknowledged by most participants, with 88.70% (353/398) agreeing, 10.55% (42/398) disagreeing, and 0.75% (3/398) providing no response. Misuse or inappropriate administration of antibiotics accelerates antimicrobial resistance, leading to severe infections, higher treatment costs, and even death (Llor & Bjerrum, 2014). Regarding the self-medication of antibiotics or antimicrobials attitude and practices, 46.33% of the participants experienced self-medication. At the same time, males (27.34%) were more prone to self-medicate than females (18.99%) (p=0.001). However, self-medication may cause therapeutic failures, medication toxicity, complications, and increased antimicrobial resistance (Morgan *et al*., 2011).

The knowledge of antimicrobial drugs was closely associated with disciplines (p<0.001). This study showed that students from science backgrounds had significantly higher awareness than those from other backgrounds.

A previous study demonstrated that students from biological backgrounds have a better understanding and attitude toward antibiotics and usages compared with students from arts and business backgrounds (Siam *et al*., 2021). Therefore, education programs should focus on students with a non-science background. Additionally, it should promote the proper use of antibiotics to reduce self-medication attitudes and practice among students and AMR burden (Buke *et al*., 2005).

5. CONCLUSION

Irrational use of antimicrobial drugs is a widespread problem that increases treatment costs, threatens both human and animal health, and promotes antimicrobial-resistant microbes in the environment. Therefore, coordinated actions by healthcare regulators, academic institutions, and public health stakeholders are needed to enforce stricter antibiotic sales policies and integrate antimicrobial-resistance education across all academic disciplines.

Acknowledgment:

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Ethical Statment:

This study received ethical clearance from the Institutional Animal, Medical Ethics, Biosafety and Biosecurity Committee (IAMEBBC), University of Rajshahi, Bangladesh (Memo No: 244/320(41)/IAMEBBC/IBSc).

Conflict of Interests:

The authors declare no competing interests.

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Author Contributions:

M.R.B., N.S.H., A.K., S.B.S., S.S.A.S.: data collection, data curation; M.N.A., M.M.F.: data analysis; M.R.B., N.S.H., A.K., S.B.S.: visualization; M.R.B., M.N.A.: writing- original draft; I.H.: writing-review and editing, supervision. All authors have read and agreed to the published version of the manuscript.

Data Availability:

Data are available from the corresponding author upon request.

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