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Knowledge attitude and practice of antibiotic use among medical students in Bangladesh: A cross-sectional study

Atia Sharmin Bonna[1,2] | Sinthia Mazumder[1] | Ridwana Maher Manna[1,2] | Shahed Rafi Pavel[3] | Sabrina Nahin[4] | Istiak Ahmad[5] | Nujhat Nabilah[1] | Mohammad Ali[6] | Mohammad Ashraful Amin[1,2,7]

[1]Department of Public Health, North South University, Dhaka, Bangladesh

[2]Division of Public Health, Public Health Promotion and Development Society (PPDS), Dhaka, Bangladesh

[3]Department of Community Dentistry, Bangladesh University of Health Science, Dhaka, Bangladesh

[4]Department of Physiology, Green Life Medical College Hospital, Dhaka, Bangladesh

[5]Department of Internal Medicine, Bangladesh Institute of Tropical and Infectious Diseases (BITID), Chittagong, Bangladesh

[6]Department of Physiotherapy and Rehabilitation, Uttara Adhunik Medical College and Hospital, Uttara Model Town, Dhaka, Bangladesh

[7]Department of Clinical Trials, London School of Hygiene and Tropical Medicine, London, UK

Correspondence

Mohammad Ashraful Amin, Department of Public Health, North South University Bashundhara, Plot# 15, Block# B, Bashundhara R/A, Dhaka – 1229, Bangladesh.
Email: mohammad.amin02@northsouth.edu

Abstract

Background and Aims: Antibiotic misuse represent a significant global health challenge, with medical students positioned as key figures in promoting responsible antibiotic usage. This study investigates the knowledge, attitudes, and practices (KAP) regarding antibiotic use among medical students in Bangladesh, aiming to identify areas for targeted educational and policy interventions.

Methods: This cross-sectional survey was conducted among 501 medical students across various years of study in Bangladesh, collecting data over a 3-month period. The survey assessed antibiotic knowledge, usage practices, and attitudes towards misuse, employing descriptive statistics and multiple logistic regression analyses to explore associations between students' demographic characteristics and their KAP towards antibiotics. Significance was assigned at p-value < 0.05.

Results: In our study involving 501 medical students from four medical colleges in Bangladesh, we achieved a 76% response rate. Among the participants, 78.24% correctly identified antibiotics' effectiveness against bacterial infections, but 45.71% were uncertain about their efficacy against viral infections. Notably, 21.20% reported self-prescribing antibiotics, predominantly sourced from physician prescriptions (54.89%). The most common reason for antibiotic use was fever (19.02%). Senior students were less likely to have good knowledge compared to junior students, and urban students demonstrated a higher likelihood of good knowledge and positive attitude towards antibiotic resistance.

Conclusion: This study highlights the critical need for educational reforms and antimicrobial stewardship among medical students in Bangladesh to combat antibiotic misuse and mitigate antimicrobial resistance.

KEYWORDS

antibiotic, attitude, Bangladesh, knowledge, medical students, practice

1 | INTRODUCTION

Antimicrobial resistance[1] is at the top of the World Health Organization's (WHO) list of global hazards to public health,[2] which is a major cause of morbidity and mortality. In Bangladesh, the misuse of antibiotics is widespread due to high consumption rates, over-the-counter availability without prescription, and cultural expectations for quick cures, leading to a significant challenge in healthcare management. This unrestricted use has contributed to an alarming rise in antibiotic resistance,[1] notably against common pathogens responsible for urinary tract infections, respiratory infections, and gastrointestinal infections. The consequences of AMR extend to public health, manifesting in longer hospitalizations, escalated medical costs, and increased mortality, particularly as resistant infections necessitate the use of costlier or less accessible treatments. This scenario is further aggravated in a setting with limited resources, where newer and more effective antibiotics are scarce, thus posing a threat to advancements in healthcare and life-saving interventions like surgery and chemotherapy. The economic burden on Bangladesh's healthcare system due to AMR is significant, with the costs of managing resistant infections far surpassing those associated with non-resistant ones. This not only imposes a financial strain on families but also diverts essential resources away from other critical health services, underscoring the urgent need for a comprehensive strategy to tackle antibiotic misuse and resistance.[1,3,4] Although antimicrobial resistance[1] is an inevitable occurrence, anthropogenic factors including overuse and misuse of antimicrobials are contributing significantly to this crisis. Patients as well as the general population have insufficient knowledge of rational medication use, regardless of their level of education or location.[5–7] More alarmingly, physicians' irrational use of antibiotics poses an important risk to public health. Studies have shown that a substantial portion of antibiotic prescriptions in county hospitals deviate from standard recommendations, with a high percentage of patient visits involving unnecessary antibiotic use.[8] Over 77% of patient visits in rural China in 2019 were unnecessary antibiotic use, according to a study.[9] Additionally, research in hospital settings has highlighted a knowledge deficit among physicians as a critical factor contributing to the spread of AMR.[10] Studies have shown that both healthcare providers and patients often lack sufficient knowledge for rational medication use, leading to behaviors that significantly contribute to the crisis of AMR.[11,12] The role of medical students in this context is particularly noteworthy, as they acquire theoretical knowledge on antibiotic prescribing while observing the prevailing practices in healthcare settings. Despite not having the legal authority to prescribe antibiotics, medical students' future practices are likely to be influenced by their education and observations. This influence underscores the need for targeted educational interventions to address knowledge gaps and misconceptions about antibiotic use and resistance in the early stages of medical education.

Regarding the rationale for our study participants, we focused on first- to fourth-year medical students from four distinct medical colleges. This decision was predicated on the understanding that early medical education is a critical period for shaping future prescribing habits. By targeting students at varying levels of their medical education, we aimed to capture a broad spectrum of knowledge and attitudes towards antibiotic use, thus providing insights into the effectiveness of current educational strategies and identifying potential areas for intervention. In this study, our objective was to investigate the knowledge, attitude, and practices of antibiotic misuse among medical students at selected medical colleges at the Dhaka, Chattogram, Rajshahi, and Rangpur division in Bangladesh. Our aim was to identify the primary drivers behind these attributes, with the ultimate goal of pinpointing specific areas that could benefit from sustainable interventions or further evaluation.

2 | METHODS AND MATERIAL

2.1 | Study design and setting

A cross-sectional study was conducted to assess the knowledge, attitudes, and practices (KAP) regarding antibiotic use and resistance among first- to fourth-year medical students at various medical colleges in Bangladesh. Data collection occurred from November 2022 over a 3-month period, incorporating students across different years of study from the entry cohorts of 2014/15 to 2019/20.

2.2 | Participants

Participants were eligible if they were enrolled in the first 4 years of their medical education in Bangladesh at the time of data collection. Students in their fifth year or beyond were excluded to focus on those in the earlier stages of their medical education. The selection of participants was voluntary, with recruitment occurring during lectures and following exams to ensure a diverse sample. Face-to-face interviews were conducted during lectures and post-exams, utilizing a questionnaire with sections on antibiotic knowledge and resistance, antibiotic use practices, and attitudes toward antibiotic misuse and resistance as a health issue.

2.3 | Validation of the questionnaire

Previous use in a similar study [Marzan, Mahfuza, et al (2021)] conducted among university students in Bangladesh. The referenced study, utilized a comparable scale to assess knowledge, attitudes, and practices regarding antibiotic, so we used the same scale was informed by the documented evidence of its effectiveness in the Bangladeshi context, ensuring that the instrument is culturally and contextually appropriate. Moreover, the questionnaire underwent a rigorous process of expert validation by an independent microbiologist and a medical education expert to ensure its relevance and comprehensiveness for our study population. Additionally, a pilot test was conducted with a sample of 10 medical students, which provided

preliminary evidence of the questionnaire's clarity, understandability, and ability to elicit meaningful responses. While we acknowledge that a direct analysis of internal and external consistency, such as calculating Cronbach's alpha for internal consistency reliability, was not explicitly reported, the questionnaire's previous application in a peer-reviewed study provides a foundation for its reliability. The external consistency, or the questionnaire's ability to produce stable results across different populations within the same context, is supported by its effective use in the referenced study.

2.4 | Data measurement

Data were collected using a structured questionnaire, which was divided into three sections: knowledge of antibiotics and resistance, antibiotic use practices, and attitudes towards antibiotic misuse and resistance. The questionnaire included a mix of true/false, multiple-choice, and 3-point Likert scale questions, alongside open-ended questions for thematic analysis. The instrument was validated by an independent microbiologist and a medical education expert and pilot-tested with a sample of 10 students to ensure clarity, objectivity, and sensitivity.

2.5 | Bias

Efforts to minimize bias included the anonymization of responses, voluntary participation, and the validation process for the questionnaire to ensure it accurately measured the intended variables without leading questions.

2.6 | Study size

The study size was determined based on the availability of participants during the data collection period, aiming to capture a wide range of responses from students across different years of study to ensure representative sampling of the population.

2.7 | Quantitative variables

The study's independent variables included demographic factors such as gender, age, year of study, religion, residence, parent's education level, monthly family income, and parents' occupations. Dependent variables were the participants' antibiotic use practices, knowledge about antibiotics, and attitudes towards antibiotic misuse and resistance. The diagnostic criteria for assessing knowledge and attitudes were based on responses to the survey questions and also previous study-based design for this study.

The analysis of quantitative variables involved the use of descriptive statistics, which included calculations of frequencies, percentages, means, and standard deviations. Outcomes were categorized based on scores derived from the knowledge section of the questionnaire, and logistic regression models were used to identify associations between demographic variables and knowledge/attitude outcomes.

2.8 | Statistical methods

Data were analyzed using R statistical software. Descriptive statistics were employed to characterize the study population and response distribution. To explore associations between independent variables and binary outcome measures (knowledge and attitudes), multiple logistic regression analyses were conducted. A backward stepwise method was applied to control for potential confounders, retaining covariates with $p < 0.05$. Odds ratios (ORs) with 95% confidence intervals were calculated from the logistic regression models. Bartlett's test of sphericity was conducted to check the certain redundancy among the variables for summarizing them with knowledge and attitude factors. The approach to missing data involved complete case analysis, where only records with complete data were included in the final analysis to ensure accuracy. The analysis took into account the cross-sectional design of the study without requiring adjustments for sampling strategy, given the voluntary and comprehensive nature of participant recruitment.

2.9 | Ethical approval

Ethical approval was obtained from the Ethics Review Committee of the Institute of Physiotherapy, Rehabilitation & Research (IPRR), Bangladesh (Protocol no. BPA-IPRR/IRB/19/01/2023/65). Written informed consent was secured from all participants before study enrollment.

3 | RESULTS

Our study successfully surveyed 501 medical students across four medical colleges in Bangladesh, achieving a response rate of 76%. This high level of participation indicates robust engagement from the target demographic, providing a comprehensive insight into the current state of antibiotic knowledge, attitudes, and practices among future healthcare providers.

3.1 | Demographic characteristics

The study included 501 participants, with the majority falling in the age group of 23–25 years (43.91%) and 21–23 years (23.35%). Male students constituted 31.34% of the sample, while female students comprised 68.66%. A significant portion of the participants identified as Muslim (74.05%). Parental educational backgrounds varied, with 85.83% having a higher than college degree and 14.17% having only

High School Certificate (HSC) or lower qualification. In terms of monthly income, 65.27% reported incomes greater than 50,000 taka (around 460$), and 28.94% reported incomes between 30,000 and 50,000 (around 280–460$) takas. The majority of fathers (88.22%) and mothers (94.41%) were engaged in Nonmedical professions. Additionally, 14.17% of participants had supplementary exams during their academic year (Table 1).

3.2 | Knowledge about antibiotics

Participants were evaluated on their knowledge of antibiotics. A majority demonstrated awareness that antibiotics are effective for treating bacterial infections (78.24%) and understood that antibiotic resistance refers to the loss of efficacy of an antibiotic (56.09%). Furthermore, 56.49% recognized that missing an antibiotic dose could contribute to antibiotic resistance, while 53.29% acknowledged that overuse of antibiotics could also lead to resistance. Additionally, 42.51% were aware that consuming antibiotics without a physician's prescription could contribute to resistance. A significant proportion (64.47%) correctly identified that antibiotics are ineffective against viral infections. However, a notable portion of participants (45.71%) were uncertain whether antibiotics are effective for treating both bacterial and viral infections. (Table 2). From the Bartllet's test of sphericity we have found a significant ($p < 0.001$) correlations among the knowledge related questions or variables. Therefore, we may use these variables to summarize the knowledge level.

3.3 | Attitude regarding rational use of antibiotic

A substantial majority of participants (68.46%) concurred that antibiotic resistance is escalating. There was a strong consensus (68.86%) that antibiotic consumption should be a primary concern, and a similar proportion (69.26%) advocated for heightened public awareness of antibiotic resistance through government initiatives. The need for robust research to prevent antibiotic resistance was underscored by 66.47% of participants, while 58.88% emphasized the importance of stringent monitoring of antibiotic use in the poultry and dairy industries. However, most of the students were uncertain about if they think physicians often prescribe antibiotics unnecessarily (42.91%) (Table 3). From the Bartllet's test of sphericity we have found a significant ($p < 0.001$) correlations among the attitude related questions or variables. Therefore, we may use these variables to summarize the attitude level.

3.4 | Antibiotic consumption patterns

Participants reported various sources for obtaining antibiotics, including physician prescriptions (54.89%), previous prescriptions (12.38%), self-prescription (5.19%), suggestions from friends or relatives (9.38%), and recommendations from pharmacists (18.16%).

TABLE 1 Socio-demographic characteristics of the participants ($N = 501$).

Factor	Labels	Frequency	Percentage
Year of Study	1st	114	22.75
	2nd	43	8.58
	3rd	73	14.57
	4th	194	38.72
	5th	77	15.37
Age (in Years)	Below 20	41	8.18
	20	88	17.56
	21-23	117	23.35
	23-25	220	43.91
	Above 25	35	6.99
Gender	Female	344	68.66
	Male	157	31.34
Religion	Muslim	371	74.05
	Non-Muslim	130	25.95
Permanent Residence	Rural	169	33.73
	Urban	332	66.27
Result in HSC	GPA 4–4.99	66	13.17
	GPA 5	435	86.83
Medical in Which division	Chittagong	320	63.87
	Dhaka	177	35.33
	Rajshahi	3	0.60
	Rangpur	1	0.20
Medical College in which area	Rural	91	18.16
	Urban	410	81.84
Type of Medical	Government	387	77.25
	Private	114	22.75
Parent's education	Above college (HSC)	430	85.83
	Under college (Equal or below HSC)	71	14.17
Monthly family income	Below 10k	6	1.20
	10k–20k	3	0.60
	20k–30k	20	3.99
	30k–50k	145	28.94
	Above 50k	327	65.27
Father's occupation	Medical	59	11.78
	Nonmedical	442	88.22
Mother's occupation	Medical	28	5.59
	Nonmedical	473	94.41
Did you get any supplementary exam?	No	430	85.83
	Yes	71	14.17

TABLE 2 Knowledge level of rational use of antibiotic (*N* = 501).

Factor	labels	Frequency	Percentage
Antibiotics are effective for the treatment of bacterial infections	False	9	1.80
	True	392	78.24
	Uncertain	100	19.96
Antibiotics are effective for the treatment of viral infections	False	323	64.47
	True	65	12.97
	Uncertain	113	22.55
Antibiotics are effective for the treatment of both bacterial and viral infections	False	202	40.32
	True	70	13.97
	Uncertain	229	45.71
Antibiotic resistance is the loss of activity of an antibiotic	False	95	18.96
	True	281	56.09
	Uncertain	125	24.95
Missing an antibiotic dose contributes to antibiotic resistance	False	91	18.16
	True	283	56.49
	Uncertain	127	25.35
Antibiotic resistance can be caused by the overuse of antibiotics	False	75	14.97
	True	267	53.29
	Uncertain	159	31.74
Consumption of antibiotics without physician's prescription can contribute to antibiotic resistance	False	98	19.56
	True	213	42.51
	Uncertain	190	37.92

TABLE 3 Attitude regarding rational use of antibiotic (*N* = 501).

Factor	Labels	Frequency	Percentage
Do you think antibiotic resistance is increasing?	Agree	343	68.46
	Disagree	26	5.19
	Uncertain	132	26.35
Do you think we should be more concerned regarding antibiotic consumption?	Agree	345	68.86
	Disagree	43	8.58
	Uncertain	113	22.55
Government should create more awareness of antibiotic resistance	Agree	347	69.26
	Disagree	47	9.38
	Uncertain	107	21.36
Enough knowledge should be generated to prevent antibiotic resistance	Agree	333	66.47
	Disagree	64	12.77
	Uncertain	104	20.76
The uses of antibiotics in poultry and dairy industries should be strictly monitored	Agree	295	58.88
	Disagree	73	14.57
	Uncertain	133	26.55
Do you think physicians often prescribe antibiotics unnecessarily?	Agree	109	21.76
	Disagree	177	35.33
	Uncertain	215	42.91

Common reasons for taking antibiotics included fever (19.02%), cough (3.80%), and cold (3.26%) with other infections (13.59%), as well as various ailments such as pain (2.72%), gastroenteritis (9.24%), skin lesions (2.17%), and ear infections (11.41%). Alarmingly, 47.70% of respondents failed to complete their antibiotic courses, and 21.20% took antibiotics without a doctor's advice or prescription. The study also identified common side effects of antibiotic use, including diarrhea (23.37%), weakness (21.74%), dizziness (11.41%), loss of appetite (10.33%), and allergic reactions (3.80%). Furthermore, 14.97% of participants reported experiencing antibiotic resistance in their lives (Table 4).

3.5 | Association of socio-demographic variables with knowledge level regarding rational use of antibiotic

From the analysis the association of socio-demographic variables with knowledge levels regarding antibiotic use. In comparison to female participants, male individuals were shown to be more than three times as likely to have high knowledge (AOR 3.01, CI: 1.00–9.08). Similarly, Muslim participants exhibited a higher likelihood of good knowledge (AOR 2.30, CI: 1.10–4.78) compared to Non-Muslim participants. Urban students also demonstrated a higher likelihood of good knowledge (AOR 2.75, CI: 1.33–5.71) compared to their rural counterparts. Senior students (≥3rd Year) had lower knowledge (AOR 0.30, CI: 0.13–0.72) compared to junior students. Middle- to high-income students were less likely to be knowledgeable (AOR 0.23, CI: 0.09–0.64) than low- to lower-middle-income students (Table 5).

3.6 | Association of socio-demographic variables with attitude level regarding rational use of antibiotic

From the outlines the association of socio-demographic variables with attitude levels regarding antibiotic use. Muslims were more than three times more likely to have a good attitude (AOR 3.41, CI: 1.97–5.92). Urban students also exhibited a higher likelihood of good attitude (AOR 2.29, CI: 1.22–4.31). Students with parents in a medical occupation were more than seven times more likely to have a good attitude (AOR 7.39, CI: 1.71–31.94). Supplementary examinations increased students' good attitude by more than twofold (AOR 2.76, CI: 1.03–7.45). On the other hand, senior students (AOR 0.44, CI: 0.25–0.79), students from urban area medical colleges (AOR 0.31, CI: 0.14–0.71), and students from middle to high income families (AOR 0.24, CI: 0.12–0.50) were less likely to have a good attitude compared to their counterparts (Table 6).

TABLE 4 Practice of rational use of antibiotic ($N = 501$).

Factor	Labels	Frequency	Percentage
How do you generally take antibiotics?	According to previous prescription	62	12.38
	Physician's prescription	275	54.89
	Self-medication	26	5.19
	Suggested by friends/relatives	47	9.38
	Suggested by pharmacists	91	18.16
Do you fail to complete the doses of antibiotic?	No	262	52.30
	Yes	239	47.70
Have you taken any antibiotics within the last 6 months?	No	317	63.27
	Yes	184	36.73
If yes, what was the name of antibiotic	Amoxicillin	14	7.61
	Azithromycin	78	42.39
	Cephalosporin	9	4.89
	Ciprofloxacin	49	26.63
	Flucloxacillin	34	18.48
Why did you take the antibiotic (name of the disease)?	Any Kind of Pain	5	2.72
	Cold	6	3.26
	Cough	7	3.80
	Cough And Common Cold	37	20.11
	Ear Infection	21	11.41
	Fever	35	19.02
	Gastroenteritis	17	9.24
	Other	25	13.59
	Pustules	4	2.17
	Surgery	6	3.26
	Urine Infection	21	11.41
Was it prescribed by an authorized doctor?	No	39	21.20
	Yes	145	78.80
For how long did you take the antibiotics (days/months)?	<5 days	19	10.33
	<7 days	40	21.74
	>14 days	6	3.26
	7-14 days	56	30.43
	7 days	61	33.15
	Other	2	1.09
Did the antibiotics work successfully?	No	33	17.93
	Yes	151	82.07
Did you complete the course of antibiotic?	No	46	25.00
	Yes	138	75.00
If no, why didn't complete the course of antibiotic?	As feel better	55	29.89
	No reason	129	70.11
If no, did you take another antibiotic?	No	143	77.72
	Yes	41	22.28
Did you face any side effect?	No	136	73.91
	Yes	48	26.09
If yes, what were the side effects?	Allergic Reaction	7	3.80
	Diarrhea	43	23.37
	Did not face any side effects	1	0.54
	Dizziness	21	11.41
	Loss of Appetite	19	10.33
	no	2	1.09
	No	15	8.15
	No effect	6	3.26
	No problem	1	0.54
	no side effect	1	0.54
	No side effect	1	0.54
	No side effects	3	1.63
	Now	1	0.54
	Vomiting	23	12.50
	Weakness	40	21.74
Have you ever faced antibiotic resistance?	No	426	85.03
	Yes	75	14.97

4 | DISCUSSION

The most striking finding of our study was the high level of awareness among medical students in Bangladesh regarding the effectiveness of antibiotics for bacterial infections, yet a notable proportion exhibited gaps in understanding the appropriate use of antibiotics for viral infections. This paradox highlights a critical area for intervention, suggesting that while medical students are well-informed about the basics of antibiotics, their practical application of this knowledge is flawed. Particularly alarming was the discovery that a significant number of students engaged in self-prescription of antibiotics, a practice that can contribute to the development of antibiotic resistance. This behavior underscores the urgent need for educational reforms that emphasize the consequences of antibiotic misuse. Our analysis revealed that both crude and adjusted odds ratios indicate

TABLE 5 Association of socio-demographic variables with kKnowledge level regarding rational use of antibiotic (*N* = 501) (Crude OR).

Factor	Level	Crude OR (95% CI)	*p* value	Adj. OR (95% CI)	*p* value
Gender	Female	Ref.	-	Ref.	-
	Male	4.2 (1.46, 12.04)	0.008	3.01 (1, 9.08)	0.050
Study Year	≤3rd Year	Ref.	-	Ref.	-
	>3rd Year	0.24 (0.1, 0.56)	0.001	0.3 (0.13, 0.72)	0.007
Religion	Non-Muslim	Ref.	-	Ref.	-
	Muslim	3.57 (1.82, 6.98)	0.000	2.3 (1.1, 4.78)	0.027
Residence	Rural	Ref.	-	Ref.	-
	Urban	2.34 (1.2, 4.56)	0.012	2.75 (1.33, 5.71)	0.006
HSC Result	GPA 4.0-4.99	Ref.	-		
	GPA 5	0.76 (0.26, 2.22)	0.617		
Medical College in which area	Rural	Ref.	-		
	Urban	0.83 (0.34, 2.06)	0.693		
Medical College Type	Nongovernment	Ref.	-		
	Government	0 (0, Inf)	0.986		
Parents Education	Under college (Equal or below HSC)	Ref.	-		
	Above college (HSC)	0.91 (0.34, 2.42)	0.852		
Family Income Class	Low to Lower middle Income Class	Ref.	-	Ref.	-
	Middle to High Income Class	0.26 (0.1, 0.69)	0.006	0.23 (0.09, 0.64)	0.005
Parent's Occupation	Nonmedical	Ref.	-		
	Medical	6.48 (0.88, 47.96)	0.067		
Get any supplementary exam	No	Ref.	-		
	Yes	6.59 (0.89, 48.77)	0.065		

significant associations between demographic variables and knowledge/attitude towards antibiotic use and resistance. However, given the cross-sectional nature of our study, these associations must be interpreted with caution. Cross-sectional studies can identify associations but not causal relationships. Therefore, while our findings contribute valuable insights into the current state of knowledge, attitudes, and practices among medical students, they cannot ascertain the directionality of these relationships.

This study confirms previous findings on medical students' antibiotic knowledge, attitudes, and practices.[13–15] The study found that the majority of participants had strong knowledge about antibiotics, which is consistent with other studies.[13,14] However, less than half of the participants had inadequate knowledge, which is a cause for concern. The study also found that a significant proportion of participants agreed that antibiotic resistance is increasing, and that the government should create more awareness. This is consistent with other studies that have found that increasing awareness is an important factor in reducing antibiotic resistance.[16,17] A research examined the level of understanding, inclination, and implementation of self-medication with antibiotics among undergraduate nursing students in their final year at Lahore, Pakistan, which revealed a positive attitude towards self-medication accompanied a moderate understanding of antibiotic usage and antimicrobial resistance.[14]

The study found that physician prescriptions were the most common source of obtaining antibiotics, followed by previous prescriptions, self-prescription, suggestions from friends or relatives, and recommendations from pharmacists. This is consistent with other studies that have found that physician prescriptions are the most common source of obtaining antibiotics.[13–15] The study also found that common reasons for taking antibiotics included fever, cough, cold, pain, gastroenteritis, skin lesions, and ear infections. This is consistent with other studies that have found that respiratory tract infections are the most common reason for antibiotic use,[18,19] which indicates that there has been no significant change in the conduct of patients in Bangladesh over the past 7 years. Due to diagnostic and prognostic uncertainty, antibiotics may be prescribed by physicians as a precaution to reduce the perceived threat of complications (such as hospitalization).[20]

The study found that a significant proportion of participants failed to complete their antibiotic courses, and that a substantial proportion took antibiotics without a doctor's advice or prescription. This is consistent with other studies that have found that non-adherence to

TABLE 6 A: Association of socio-demographic variables with attitude level regarding rational use of antibiotic ($N = 501$) (Crude OR).

Factor	Level	Crude OR (95% CI)	*p* value	Adj. OR (95% CI)	*p* value
Gender	Female	Ref.	-		
	Male	1.96 (1.13, 3.37)	0.016		
Study Year	≤3rd Year	Ref.	-	Ref.	-
	>3rd Year	0.33 (0.2, 0.54)	0.000	0.44 (0.25, 0.78)	0.005
Religion	Non-Muslim	Ref.	-	Ref.	-
	Muslim	4.61 (2.87, 7.43)	0.000	3.62 (2.13, 6.15)	0.000
Residence	Rural	Ref.	-	Ref.	-
	Urban	2.08 (1.31, 3.3)	0.002	2.30 (1.23, 4.31)	0.009
HSC Result	GPA 4.0-4.99	Ref.	-		
	GPA 5	0.49 (0.22, 1.11)	0.086		
Medical College in which area	Rural	Ref.	-	Ref.	-
	Urban	0.49 (0.25, 0.99)	0.048	0.32 (0.14, 0.71)	0.006
Medical College Type	Nongovernment	Ref.	-		
	Government	0 (0, Inf)	0.977		
Parents Education	Under college (Equal or below HSC)	Ref.	-	Ref.	-
	Above college (HSC)	2.12 (1.2, 3.75)	0.010	2.22 (0.96, 5.12)	0.061
Family Income Class	Low to Lower middle Income Class	Ref.	-	Ref.	-
	Middle to High Income Class	0.46 (0.27, 0.78)	0.004	0.24 (0.12, 0.50)	0.000
Parent's Occupation	Nonmedical	Ref.	-	Ref.	-
	Medical	8.97 (2.16, 37.32)	0.003	7.24 (1.68, 31.28)	0.008
Get any supplementary exam	No	Ref.	-	Ref.	-
	Yes	3.35 (1.31, 8.56)	0.012	2.87 (1.07, 7.70)	0.036

antibiotic courses is a common problem.[3,21] It is a common practice to obtain antibiotics without proper indication, particularly in urban areas. Patients/caregivers and clinicians use antibiotics as a 'quick and economical' option, including self-medication.[22] The study also identified common side effects of antibiotic use, including diarrhea, weakness, dizziness, loss of appetite, and allergic reactions. This is consistent with other studies that have found that side effects are a common problem associated with antibiotic use.[23] Antibiotics are unlikely to be beneficial for the majority of self-limiting infections, and therapy with antimicrobial agents has been linked to significant risks and adverse effects. Bangladesh's antibiotic consumption patterns are concerning due to excessive prescribing, inadequate diagnostic facilities, aggressive marketing strategies, poor consumer awareness, unregulated drug shops,[24] and inadequate knowledge and practices among healthcare providers. These factors contribute to misuse and overuse of antibiotics, highlighting the need for effective monitoring and control measures, improved diagnostic facilities, increased consumer awareness, and regulation of drug shops. Addressing these issues is crucial for a healthier and safer healthcare system.[25]

In our study, senior students (≥3rd Year) were less likely to have good knowledge compared to junior students (≤3rd Year). Bangladesh's senior students may have reduced antimicrobial resistance knowledge due to excessive antibiotic usage and misuse, insufficient clean water, sanitation, and hygiene, restricted access to quality, inexpensive treatment, vaccinations, and testing, and absence of antibiotic awareness.,[25] poor knowledge among healthcare professionals,[26] and inadequate training for pharmacists.[24] To address these issues, targeted educational programs, training sessions, and awareness campaigns can be implemented to improve knowledge and understanding of AMR among senior students, healthcare professionals, and the general population.[24]

Urban students not only demonstrated a higher likelihood of good knowledge compared to their rural counterparts but also exhibited a greater likelihood of having a positive attitude in this study. Urban students in Bangladesh have better AMR knowledge and attitudes due to factors such as access to education, healthcare facilities, media, and socioeconomic factors. These factors contribute to better knowledge and attitudes towards AMR, and further research is needed to understand the specific reasons behind these differences. However, a comprehensive understanding of the issue is still needed.

The outcomes of this study underscore the significance of implementing targeted interventions to address the escalating issue of antibiotic resistance. One crucial aspect involves incorporating relevant

content into the academic curriculum and medical training programs. To effectively combat antibiotic resistance, it is imperative to enhance awareness among medical students and the broader public regarding the consequences of antibiotic misuse. Medical students' knowledge about antibiotic use and AMR varies based on school type, major, and clinical experience, with positive associations observed between enhanced knowledge and classroom instruction as well as the time dedicated to learning about these issues.[27] To identify the factors that influence the prescribing behavior of medical physicians, evidence-based decision- knowledge, attitude, and practice (KAP) assessments can be implemented.[28] Research has demonstrated that educational programs can enhance healthcare professionals' awareness and understanding of antimicrobial resistance (AMR) while also promoting appropriate prescription behavior.[29] The academic curriculum is the primary source of information about antibiotics for both health science and non-health science students, according to a study conducted at Walailak University in Thailand.[30] Health science students exhibited superior levels of knowledge, and a notable association was observed between academic curriculum and practical applications.[30] Therefore, medical schools should provide education about Antimicrobial use (AMU) and Antibiotic Resistance[1] throughout antimicrobial resistance (AMR) and antimicrobial stewardship (AMS) awareness campaigns, as well as brief, complimentary presentations and workshops.[31] In addition to performing a wide variety of tasks in both the clinic and the community, medical students can form groups to coordinate their efforts, such as outreach into schools, lecture series, or journal clubs.[32] Additionally, there is a pressing need to emphasize the significance of completing prescribed antibiotic courses to ensure the efficacy of treatment. The intervention strategy should extend to reducing unnecessary antibiotic prescriptions and refining overall prescribing practices. Integrating antimicrobial stewardship programs into medical training can serve as a pivotal measure to instill responsible antibiotic use and prescribing habits, contributing significantly to the overall mitigation of antibiotic resistance.[33,34] Ensuring adherence to antibiotic guidelines, including dosage, treatment duration, and diagnostic test utilization, and implementing antimicrobial stewardship programs that educate healthcare workers on alternative treatments, infection transmission, and prevention of resistant bacteria spread are crucial in healthcare.[35] Improved patient care, less antibiotic use, and efficient healthcare spending are the aims of antimicrobial stewardship.[36]

4.1 | Strengths and limitations

One of the strengths of this study is its contribution to the scant literature on antibiotic use and resistance knowledge among medical students in Bangladesh. By focusing on this group, the study provides targeted insights that can inform educational interventions. Furthermore, the use of a validated questionnaire adapted from previous research adds to the reliability of our findings.

However, our study has limitations. Cross-sectional designs limit causal inferences from observed connections. Self-reported data may also create bias since participants may give socially desirable answers, especially on sensitive areas like self-prescription. Another limitation is the study's focus on medical students from only certain years of study, which may not fully represent the entire medical student population in Bangladesh.

5 | CONCLUSION

The study emphasizes the critical need for improved education and policy reforms to address antibiotic misuse among Bangladesh's medical students. Enhanced curricula focusing on antimicrobial stewardship and awareness campaigns are essential for combating antibiotic resistance and safeguarding public health.at could have appeared to influence the work reported in this paper.

AUTHOR CONTRIBUTIONS

Atia Sharmin Bonna: Conceptualization; methodology; software; investigation; validation; formal analysis; project administration; writing—original draft; writing—review and editing. **Sinthia Mazumder**: Methodology; investigation; visualization; project administration; supervision; writing—review and editing. **Ridwana Maher Manna**: Methodology; software; data curation; supervision; visualization; writing—original draft; writing—review and editing. **Shahed Rafi Pavel**: Writing—review and editing; writing—original draft; visualization. **Sabrina Nahin**: Writing—review and editing; writing—original draft; visualization. **Istiak Ahmad**: Writing—original draft; writing—review and editing. **Mohammad Ashraful Amin**: Methodology; writing—original draft; writing—review and editing; supervision; investigation; visualization.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request. Data from this article are available with the corresponding author and first author. Any researcher is interested, for a valid reason, they may contact the corresponding author (author Atia Sharmin Bonna- atiasharmin72@gmail.com).

ETHICS STATEMENT

Ethical approval for this study was granted by the Ethics Review Committee of the Institute of Physiotherapy, Rehabilitation &

Research (IPRR), Bangladesh (Protocol no. BPA-IPRR/IRB/19/01/2023/65). Informed consent was obtained from all participants before their involvement in the study. All authors have read and approved the final version of the manuscript. Atia Sharmin Bonna had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

TRANSPARENCY STATEMENT

The lead author Mohammad Ashraful Amin affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Atia Sharmin Bonna http://orcid.org/0000-0002-6119-1213
Mohammad Ali http://orcid.org/0000-0002-4685-5050
Mohammad Ashraful Amin http://orcid.org/0000-0001-9142-9176

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