

Original Article

Understanding antibiotic use and resistance: knowledge, attitudes, practices, and training needs of paramedical students

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Abstract

The inappropriate and overuse of antibiotics is considered the main source of antimicrobial resistance (AMR). Therefore, this study aimed to assess the knowledge, attitudes, and practices of antibiotic use and resistance among paramedical students. In addition, the study also assessed the perceptions, knowledge gaps, and educational needs of paramedical students regarding antibiotic use, resistance and related training. This descriptive cross-sectional study was conducted at Khyber Medical University by recruiting 500 students from twelve different paramedic disciplines. The self-administered questionnaire was distributed online through email and WhatsApp, resulting in 364 completed responses and a response rate of 72.8%. The study revealed that 41.21% of paramedic students were using antibiotics without a prescription, 23.63% admitted that they discontinued their prescribed antibiotic course once they felt better, 95.88% recognized the term 'antibiotics', and 79.67% acknowledged that inappropriate use contributed to resistance. A sex comparison revealed that male students (81.32%) were significantly more likely to complete their prescribed antibiotic courses than their female counterparts were (67.29%) ($p = 0.002$). This study identifies gaps in paramedical students' knowledge, attitudes, and practices related to antibiotic use and resistance. Despite a general awareness of key concepts, misconceptions and improper practices were also common. Therefore, there is a dire need to upgrade the curriculum and implement integrated modules on antibiotic stewardship, infection control, and responsible antibiotic use, which could enhance students' knowledge, enable them to make informed decisions, and contribute significantly to combating antibiotic resistance.

Keywords

Paramedics; Health knowledge, attitudes, practices; Antibiotic resistance; Students

1. Introduction

Antibiotic resistance has emerged as a crucial issue over the last two decades, posing a significant challenge to healthcare systems worldwide [1]. In May 2015, a global action plan was endorsed by the World Health Organization (WHO) to provide safer antibiotics for the prevention and treatment of infectious diseases [2]. However, the spread of antimicrobial resistance (AMR) continues in several parts of the world, including developing countries such as Pakistan [3,4,5,6]. Some strains of bacteria become resistant to all the prescribed antibiotics and are known as panresistant organisms or superbugs. This can lead to increased hospitalization, increased hospital costs, poor clinical outcomes and increased mortality rates. Every year, an estimated seven million deaths occur due to drug resistance globally. If it continues at the current rate, by 2050, it is estimated to cost

a hundred trillion United States dollars (USD) in losses as well as more than ten million deaths per year globally [7].

The spread and involvement of multiresistant bacteria in infectious diseases worldwide are considered public health threats [8]. A direct relationship between AMR has been reported in many epidemiological studies, with the irrational use of antibiotics such as self-medication, multiple antibiotic prescriptions to a single patient, antibiotic use in nonbacterial infections, low doses, overdose, diversion from clinical guidelines, and preference for injection when oral formulations are more effective [9,10]. According to the WHO, antibiotics have prevented millions of deaths, but their effectiveness is diminishing because of their irrational use [11]. There is significantly more irrational use of antibiotics in developing countries than in developed nations. Studies from Europe reported a prevalence of 19% and 30%, whereas in developing countries, the prevalence ranged from 75% to 100% [9,10,12,13,14,15,16,17]. This ineffectiveness of antimicrobial agents may lead to an era where antibiotics are no longer available for the treatment of infections, and consequently, a minor bacterial infection will lead to death.

A holistic approach to overcoming AMR is promoting the reasonable utilization of antibiotics through antimicrobial stewardship (AMS) [18]. Preprescription and postprescription are the two major approaches. The first approach requires prior authorization from the restrictive prescriptive authority for the use of antibiotics, whereas the postprescriptive approach is based on reviews and feedback of the recent antibiotic used, allowing the physician with the ability to change, adjust, continue, or halt antibiotics depending on the patient's clinical signs and symptoms and available results [19]. Excessive antibiotic use due to prescription is not restricted, whereas in the postprescription approach, rationalization of the prescription results in improved physician satisfaction and a decrease in antibiotic use [18,20].

Among low-resource countries, Pakistan ranks third in the consumption of antibiotics, and antibiotic resistance is a serious problem for healthcare. It is estimated that approximately 35,000 patients in Pakistan use antibiotics daily [21]. While self-medication is more prevalent in Pakistan, the majority of patients obtain antibiotics without a physician's prescription and do not complete antibiotic doses. Furthermore, antibiotics can easily be obtained from both medical stores and pharmacies without a prescription from a qualified physician, similar to over-the-counter medicines, contributing to a lack of awareness and misuse among consumers [22,23,24,25,26,27]. As future healthcare professionals, paramedical students play a crucial role in addressing this issue not only at healthcare facilities but also in the community [28,29]. Considering their direct involvement in patient care and medication administration, their knowledge and practices significantly influence antibiotic prescribing, use, and stewardship. Educating paramedical students about the risks of self-medication and the principles of antimicrobial use and antimicrobial stewardship is essential for reducing AMR [30]. However, the curriculum at the undergraduate level does not fully equip students with practical challenges related to antibiotic use in their professional lives [31,32,33].

To address this gap, it is crucial to evaluate the knowledge and perceptions of students, particularly those in paramedical sciences, as they represent the future of the healthcare system as specialized technologists. Therefore, this study aimed to assess the knowledge, attitudes, and practices of antibiotic use and resistance among paramedical students. In addition, the study also assessed the perceptions, knowledge gaps, and educational needs of paramedical students regarding antibiotic use, resistance and related training. Furthermore, a sexwise comparison was conducted to assess differences in practices related to antibiotic use.

2. Methods

2.1 Study design, duration, and setting

This descriptive cross-sectional study was conducted from August to September 2023 at the Institute of Paramedical Sciences, Khyber Medical University (KMU), Peshawar, Pakistan, which is the largest and only medical university in Khyber Pakhtunkhwa (KP) Province [34]. The institute offers a BS four-year program in twelve various technologies, i.e., medical lab technology, dialysis technology, dental technology, radiology, neurophysiology, cardiology, cardiac perfusion, respiratory therapy/intensive care, emergency, health, and anesthesia. It is a provincial-level institute and provides equal opportunity to all the residents of KP Province.

2.2 Selection criteria

The students who were enrolled in various paramedic programs irrespective of sex, who were 18 years or older and who voluntarily agreed to participate were included in the study. However, students with prior professional experience in pharmacology-related fields and those suffering from conditions such as chronic infections requiring frequent antibiotic use were excluded from the study.

2.3 Sampling technique and sample size

The participants were selected using purposive sampling to include paramedical students from KMU to ensure relevance, as it offers disciplines beyond paramedical programs while enabling targeted selection for efficient data collection.

The sample size for the study was calculated via an online epidemiological calculator, which assumes an expected overall knowledge score of 74% with a 95% confidence interval and a 5% margin of error [35,36]. The required sample size was determined to be 291 but was increased to 500 to account for an anticipated reduced response rate, maintain analytical strength and address potential nonresponse owing to electronic survey distribution challenges in Pakistan [37]. Given the overall digital divide in Pakistan, where internet access and digital literacy remain limited, particularly in certain regions and socioeconomic groups, missing or incomplete responses were expected, which could lead to data exclusion [38]. Therefore, a significant increase in sample size helped mitigate this issue to ensure valid responses for the study.

2.4 Questionnaire development

Following a thorough literature review, a self-administered questionnaire was adapted for this study [20,21,26]. The questionnaire consisted of five sections. The demographic and medication history section of the questionnaire collected information on age, sex, marital status, discipline of study, current program of study, plans for higher education, current academic year of enrollment, antibiotic use within the past month and the past six months, and the types of antibiotics most recently used. All other sections of the questionnaire assessed participants' knowledge (11 questions), attitudes (8 questions), and practices (4 questions) related to antibiotic usage and resistance. Additionally, these sections assessed perceptions (7 questions) and knowledge gaps (4 questions) concerning antibiotic education, training needs, and related suggestions. The pilot study included ten paramedic students to assess the questionnaire for clarity, unambiguity, and ease of response, which aligns with previous methodological recommendations, suggesting that small sample sizes (10–30) are adequate for pilot studies [39]. Moreover, the questionnaire was sent to two field experts for review to ensure content validity, relevance, and clarity before its final use. The pilot study data were excluded from the final results.

2.5 Data collection

Google Forms was used to develop the questionnaire, and an electronic link to the questionnaire was distributed among potential participants via email or WhatsApp.

2.6 Ethical approval

The study was conducted after the approval of the Ethical Review Committee of the KMU, Peshawar (No. 2091-26143-5). The participants were briefed about the procedures and objectives of the study. Informed consent was obtained from the students, with participation being entirely voluntary. The participants had the option to decline participation or exit the survey at any time without any obligation. Furthermore, data confidentiality was maintained according to the Helsinki Declaration and Data Protection Act (Organic Law 3/2018). After ensuring that all the aforementioned parameters were fulfilled, the email addresses or WhatsApp numbers of potential participants were added to the list for questionnaire distribution.

2.7 Statistical analysis

IBM SPSS Statistics (version 24) was used to analyze the data as frequencies and percentages. Moreover, the chi-square test was employed for a sexwise comparison to assess differences in practices related to antibiotic use. A p value < 0.05 was considered significant.

3. Results

3.1 Demographic information

Among the 500 questionnaires distributed, 364 paramedical students submitted their responses online, resulting in a response rate of 72.8%. Table 1 shows that most of the respondents were male (70.6%), and a significant portion of the students reported being single (89%). A total of 79.9% of the participants were aged between 18 and 23 years. Most of the participants were from radiology technology (15.11%), followed by medical lab technology (12.64%) and anesthesia technology (12.36%), along with students from other disciplines. Moreover, 98.4% of the students were currently studying undergraduate, whereas 1.65% had completed their undergraduate program but were awaiting a degree. Moreover, 37.6% and 29.12% of the students were in their third and fourth academic years of the program, respectively, and 90.1% were planning to pursue further higher education. Among the 364 respondents, 32.7% used antibiotics in the past month, whereas 69.3% used antibiotics in the last six months. Moreover, most of the participants identified commonly used antibiotics from the provided list. Among the reported antibiotics, ciprofloxacin (35.16%) was the most commonly used, followed by azithromycin (26.92%) and Augmentin (22.53%).

Table 1. Demographic profile and medication history of the study participants (n = 364).

Variables		Frequency (%)
<i>Sociodemographic Indicators</i>		
Age	18 – 23 years	290 (79.67)
	> 23 years	74 (20.33)
Sex	Male	257 (70.60)
	Female	107 (29.40)
Marital status	Married	40 (10.99)
	Unmarried	324 (89.01)

Table 1. *Cont.*

Variables		Frequency (%)
Discipline of study	Medical lab technology	46 (12.64)
	Radiology technology	55 (15.11)
	Anesthesia technology	45 (12.36)
	Emergency technology	33 (9.07)
	Respiratory therapy/ICU	32 (8.79)
	Dialysis technology	30 (8.24)
	Surgical technology	27 (7.42)
	Neurophysiology	27 (7.42)
	Cardiology technology	25 (6.87)
	Dental technology	22 (6.04)
	Health technology	16 (4.40)
	Cardiac perfusion	6 (1.65)
Current program of study	Undergraduate	358 (98.35)
	Under graduation completed	6 (1.65)
Students planning to pursue postgraduate studies	Yes	328 (90.11)
	No	36 (9.89)
Current academic year of the program in which the student is enrolled	First	56 (15.38)
	Second	59 (16.21)
	Third	137 (37.64)
	Fourth	106 (29.12)
	Completed but degree awaiting	6 (1.64)
<i>Medication History</i>		
Antibiotic use in the past month	Yes	119 (32.69)
	No	236 (64.84)
	Maybe	9 (2.47)
Antibiotic use in the past six months	Yes	252 (69.23)
	No	101 (27.75)
	Maybe	11 (3.02)
Types of antibiotics most recently used	Ciprofloxacin	128 (35.16)
	Azithromycin	98 (26.92)
	Augmentin	82 (22.53)
	Amoxicillin	78 (21.43)
	Vibramycin	66 (18.13)
	Metronidazole	56 (15.38)
	Erythromycin	49 (13.46)
	Streptomycin	11 (3.02)
	Sulfamethoxazole/Trimethoprim	8 (2.20)

3.2 Participants' knowledge, attitudes, and practices regarding antibiotic use

Table 2 shows the participants' knowledge, attitudes and practices related to antibiotic use and resistance; 95.88% of the participants recognized the term 'antibiotics', whereas 89.56% were aware of the term 'antibiotic resistance'. Approximately four-fifths of the participants (79.67%) acknowledged that the inappropriate use of antibiotics contributes to antibiotic resistance. Moreover, 79.12% of the students accurately recognized that antibiotics cannot kill viruses, 15.11% incorrectly stated that they could kill viruses, and 5.77% were unsure. In response to the knowledge regarding the proper course of antibiotics, 71.98% of the participants responded correctly, whereas 20.33% did not know, and 7.69% were uncertain. Most of the participants (85.71%) stated that bacteria

can develop resistance to antibiotics; however, 6.04% disagreed, while 8.24% were unsure. The identification rates of amoxicillin and ciprofloxacin as antibiotics were high, with 97.53% and 97.80% of the participants correctly identified them, respectively. However, only 15.66% knew that aspirin is not an antibiotic, with a majority (79.67%) incorrectly identified as one.

Table 2 further shows that half of the participants (51.65%) correctly believed that antibiotics should not be used for fever, and 63.19% correctly rejected their use for allergies. Most participants (64.29%) disagreed with the prevention of the use of antibiotics as soon as patients feel better. While 88.19% agreed that antibiotics should be used only when they are prescribed by a physician, 82.42% acknowledged that inappropriate use is a major cause of bacterial resistance, and 74.73% recognized antibiotic resistance as a significant problem in Pakistan, with 67.58% identifying it as a global issue.

In terms of practices, 76.37% of the participants reported that they completed their prescribed antibiotic course, whereas 23.63% admitted that they quit once they felt better. Most of the participants (60.16%) stated that they consulted a doctor when ill, but 41.21% mentioned that they used antibiotics without a prescription. For leftover antibiotics, 51.92% saved them for future use, and only 30.77% discarded them.

Table 2. Participants' knowledge, attitudes, and practices related to antibiotic use and resistance.

Variables		Frequency (%)
<i>Knowledge</i>		
Do you know what antibiotics are?	Yes	349 (95.88)
	No	2 (0.55)
	Maybe	13 (3.57)
Are you familiar with the term 'antibiotic resistance'?	Yes	326 (89.56)
	No	23 (6.32)
	Maybe	15 (4.12)
Do you know that inappropriate use of antibiotics can lead to antibiotic resistance?	Yes	290 (79.67)
	No	35 (9.62)
	Maybe	39 (10.71)
Do you know that antibiotics can kill bacteria?	Yes	345 (94.78)
	No	3 (0.82)
	Maybe	7 (1.92)
Do you know that antibiotics can kill viruses?	Yes	55 (15.11)
	No	288 (79.12)
	Maybe	21 (5.77)
Are you aware of the proper course of antibiotics?	Yes	262 (71.98)
	No	74 (20.33)
	Maybe	28 (7.69)
Do you know that bacteria can develop resistance to antibiotics?	Yes	312 (85.71)
	No	22 (6.04)
	Maybe	30 (8.24)
Do you know that Amoxicillin is an antibiotic?	Yes	355 (97.53)
	No	2 (0.55)
	Maybe	7 (1.92)
Do you know that Ciprofloxacin is an antibiotic?	Yes	356 (97.80)
	No	3 (0.82)
	Maybe	5 (1.37)

Table 2. Cont.

Variables	Frequency (%)
Do you know that Aspirin is not an antibiotic?	Yes
	57 (15.66)
	No
Do you know that inappropriate use of antibiotics exists?	290 (79.67)
	Maybe
	17 (4.67)
	Yes
	283 (77.75)
	No
	45 (12.36)
	Maybe
	32 (8.79)
<i>Attitudes</i>	
Do you believe antibiotics can be used for the treatment of fever?	Yes
	136 (37.36)
	No
	188 (51.65)
	Maybe
	40 (10.99)
Do you believe antibiotics can be used for the treatment of allergies?	Yes
	96 (26.37)
	No
	230 (63.19)
	Maybe
	38 (10.44)
Do you believe patients may stop antibiotics as soon as they start feeling better?	Yes
	91 (25.00)
	No
	234 (64.29)
	Maybe
	39 (10.71)
Do you think colds/coughs should always be treated with antibiotics for quick recovery?	Yes
	152 (41.76)
	No
	157 (43.13)
	Maybe
	55 (15.11)
Do you believe that antibiotic resistance is the biggest problem the world faces?	Yes
	246 (67.58)
	No
	35 (9.62)
	Maybe
	83 (22.80)
Do you agree that antibiotics should only be used when prescribed by a physician?	Yes
	321 (88.19)
	No
	18 (4.95)
	Maybe
	25 (6.87)
Do you think antibiotic resistance is a significant problem in Pakistan?	Yes
	272 (74.73)
	No
	31 (8.52)
	Maybe
	61 (16.76)
Do you agree that inappropriate use of antibiotics is the main cause of bacterial resistance?	Yes
	300 (82.42)
	No
	18 (4.95)
	Maybe
	46 (12.64)
<i>Practices</i>	
Do you complete the prescribed course of antibiotics?	Yes
	278 (76.37)
	No, I quit the course when I feel better
	86 (23.63)
Do you use antibiotics without a prescription?	Yes
	150 (41.21)
	No
	196 (53.85)
	Maybe
	8 (2.20)
How do you respond to illness or disease?	Allow it to recover naturally
	55 (15.11)
	Consult a doctor
	219 (60.16)
	Use self-medication
	69 (18.96)
	Take medicines based on random suggestions
	21 (5.77)
What do you do with leftover antibiotics?	Save for future use
	189 (51.92)
	Return to the pharmacy
	25 (6.87)
	Discard
	112 (30.77)
	Give to others
	38 (10.44)

3.3 Perception of training on antibiotics in different paramedical specialties

Table 3 shows that 53.02% of the participants felt that they had enough education to select the best antibiotic for infections, whereas 45.05% believed that they could decide on the right antibiotic regimen. However, a notable proportion remained uncertain or unaware in both cases. Most of the participants (87.64%) were interested in more education on antibiotic use and resistance, and 90.66% considered microbiology and infection control knowledge important for their careers. Most participants (47.53%) suggested teaching antibiotics during their second year of study, and 92.58% believed that awareness sessions on antibiotics would be helpful.

Table 3 further shows the self-reported knowledge gaps among paramedical students; 96.70% stated that they needed more knowledge about antibiotics, and 65.38% admitted that they lacked sufficient information to answer specific questions. A vast majority (90.66%) of the participants emphasized the need for thorough microbiology and infectious disease knowledge, and 93.41% highlighted the importance of drug knowledge before starting practicums.

Table 3. Perceptions and knowledge gaps in antibiotic education and training needs.

Variables		Frequency (%)
<i>Perceptions</i>		
Do you have enough education to select the best antibiotic for infections?	Agree	193 (53.02)
	Disagree	24 (6.59)
	Not sure	117 (32.14)
	Don't know	30 (8.24)
Do you have enough education to decide on the right antibiotic regimen?	Agree	164 (45.05)
	Disagree	38 (10.44)
	Not sure	115 (31.59)
	Don't know	47 (12.91)
Would you like more education on antibiotic use and resistance?	Agree	319 (87.64)
	Disagree	7 (1.92)
	Not sure	29 (7.97)
	Don't know	9 (2.47)
Is microbiology and infection control knowledge important for your career?	Agree	330 (90.66)
	Disagree	7 (1.92)
	Not sure	24 (6.59)
	Don't know	3 (0.82)
When should institutes spend more time teaching antibiotics?	First year	97 (26.65)
	Second year	173 (47.53)
	Third year	59 (16.21)
	Fourth year	24 (6.59)
	No required	11 (3.02)
Should the use of antibiotics be reduced?	Yes	235 (64.56)
	No	62 (17.03)
	Maybe	67 (18.41)
Would awareness sessions on antibiotics be helpful?	Yes	337 (92.58)
	No	7 (1.92)
	Maybe	20 (5.49)
<i>Knowledge Gaps</i>		
Do you need more knowledge about antibiotics?	Yes	352 (96.70)
	No	2 (0.55)
	Maybe	10 (2.75)

Table 3. *Cont.*

Variables	Frequency (%)
Do you lack information to answer certain questions?	Yes
	238 (65.38)
	No
Is detailed microbiology and infectious diseases knowledge necessary?	63 (17.31)
	Maybe
	63 (17.31)
Is drug knowledge essential before starting practicum?	Yes
	330 (90.66)
	No
	11 (3.02)
	Maybe
	23 (6.32)
	Yes
	340 (93.41)
	No
	7 (1.92)
	Maybe
	17 (4.67)

3.4 Sexwise comparison of practices related to antibiotic use among paramedical students

Table 4 shows a sexwise comparison of practices related to completing prescribed antibiotic courses. A greater proportion of males (81.32%) reported completing their antibiotic courses than females did (67.29%) ($X^2 = 9.220$, $df = 1$, $p = 0.002$). However, there were no significant differences observed between males and females in the use of antibiotics without a prescription, with similar proportions reported ($X^2 = 0.130$, $df = 2$, $p = 0.937$).

Table 4. Sexwise comparison of practices related to antibiotic use among paramedical students.

Practices		Gender		<i>p</i> value *
		Male	Female	
		N = 257	N = 107	
		Frequency (%)	Frequency (%)	
Do you complete the prescribed course of antibiotics?	Yes	209 (81.32)	72 (67.29)	0.002 *
	No	48 (18.68)	35 (32.71)	
Do you use antibiotics without a prescription?	Yes	105 (40.86)	44 (41.12)	0.937
	No	140 (54.47)	58 (54.21)	
	Maybe	12 (4.67)	5 (4.67)	

* Variables were compared using the chi-square test. ** Significant value ($p \leq 0.05$).

4. Discussion

Our study revealed that most of the study participants were male, single, aged between 18 and 23 years, and studying in the third and fourth professional years of undergraduate programs. Most of the participants were aware of antibiotics and antibiotic resistance and had used antibiotics in the past six months. Four-fifths of the participants agreed that inappropriate use of antibiotics can cause resistance. More than half of the participants agreed that antibiotics should not be used in fever and prophylaxis and should be used as per prescription from a physician. Fewer than half of the participants believed that they were able to choose the right antibiotic regimen. The vast majority agreed that they require more knowledge and training for microbiology, infectious diseases and antibiotic use. Furthermore, male participants were more likely to complete the antibiotic course than their female counterparts were, whereas there was no significant difference among the sexes in the use of antibiotics without a prescription.

Our study results regarding knowledge of antibiotic resistance among study participants were supported by a Nigerian study that included healthcare students and reported that 88.3% of the students had a better understanding of AMR [40]. Similarly, an African study revealed that 96% of healthcare students were familiar with the term AMR; how-

ever, a significant proportion were not aware of the concept of antibiotic stewardship [41]. A study conducted at the University of Zambia reported that 87.3% of medical students had good knowledge about antibiotic use and resistance, and 75% had good practices toward antibiotic use [42]. Another Saudi Arabian study revealed that 78.2% of medical students believed that unnecessary use of antibiotics reduces their effectiveness, reflecting awareness of the potential consequences of antibiotic misuse [43].

A study conducted in Cairo reported that 79.7% of university students had poor knowledge of antibiotics, 92.2% lacked awareness of antibiotic resistance, and only 30.6% were familiar with the term AMR [44]. Moreover, a study conducted among pharmacy students in Punjab, Pakistan, reported that 59.8% of the students had an average understanding of antibiotic use, 42.6% were aware of antibiotic resistance, and 48% were aware of the mechanics of antibiotic resistance. Furthermore, only 21.6% of the students were familiar with the antibiotic stewardship program [4]. Another Pakistani study reported that only 43% of university students were aware of AMR, and 30% were aware that the irregular use of antibiotics would lead to resistance [45]. A Saudi Arabian study that targeted pharmacy and nursing students reported above-average knowledge of the students toward antibiotics and AMR [46]. A study targeting pharmacy and medical students in East Africa reported that only 36.6% of all the students had overall knowledge about antibiotics [47]. The same finding was reported in an Indian study, which reported a poor level of knowledge about antibiotics and AMR [48].

The lack of guidance among educators impedes the inclusion of important topics in courses for paramedic students at the national level. Moreover, the unavailability of elective courses on crucial topics such as AMS and antibiotic prescription taught by experts to undergraduate students also affects their practical behavior [49]. These courses can play a crucial role in enhancing students' knowledge and raising awareness about the importance of the responsible and effective use of antibiotics, thereby helping to reduce the risk of resistance [50,51].

A Bangladeshi study reported a better attitude of students toward antibiotic use, and 90% of the students consumed antibiotics as per the prescription of a registered medical practitioner; however, their adherence to the therapy was not satisfactory [52]. A study conducted among pharmacy students in three Asian countries reported that students had moderate knowledge about antibiotic use, resistance, and stewardship; however, they had poor knowledge about antibiotic therapy [53]. Moreover, a Malaysian study reported that a large proportion of medical students believed that antibiotics could treat viral infection, and half of the respondents completed an antibiotic course. Furthermore, gender, race, family income, and nationality were significantly associated with antibiotic knowledge and use among students [54]. The undergraduate curriculum for healthcare students may not be sufficiently updated and often fails to address practical problems effectively. A possible reason for this could be inadequate training provided to students at universities on the appropriate use of antibiotics in infections, which may influence their confidence in selecting and using antibiotics correctly [55,56]. Additionally, the marketing strategies of pharmaceutical companies potentially glamorize antibiotic use as a cure for all types of infections. Poorly monitored drug stores by regulatory authorities, allowing easy access to antibiotics without prescriptions, and limited consumer awareness could also contribute to the misuse of antibiotics [57].

Our study focused exclusively on paramedical students from various disciplines at one of the largest institutions in the province, providing an in-depth understanding of their knowledge and practices regarding antibiotic use and resistance. The study employed a tool developed after a comprehensive literature review, incorporating key aspects of the topic, and included a substantial number of participants. However, this study

does not explore qualitative dimensions or include open-ended questions to identify potential reasons, which may be considered a limitation. Additionally, cultural beliefs, healthcare accessibility, and systemic issues such as over-the-counter antibiotic availability may influence knowledge, attitudes, and practices (KAP) in Pakistan, highlighting the need for further qualitative investigation. Moreover, the generalizability of the findings is limited because of the use of purposive sampling, which may introduce potential selection bias. Additionally, there is a likelihood of response bias stemming from the self-reported nature of the data used to assess participants' attitudes and practices. Finally, this study did not use a scoring method to assess knowledge, attitudes, and practices; future studies can address this gap for a more detailed evaluation. The study was carried out in constrained healthcare environments with limited resources, a small sample size, and a restricted set of variables. These limitations hinder the ability to perform advanced analytical techniques that can clarify the complex relationships among the variables involved.

5. Conclusions

This study highlights gaps in the knowledge, attitudes, and practices of paramedical students regarding antibiotic use and resistance. Although there was a general awareness of key concepts, misconceptions and improper practices were also common. To increase students' knowledge and decision-making in combating antibiotic resistance, the curriculum should be upgraded with integrated modules on antibiotic stewardship, infection control, and responsible antibiotic use. Additionally, the study recommends incorporating detailed antibiotic and chemotherapeutic content into undergraduate curricula and introducing mandatory short courses and hands-on workshops as part of educational policy reforms.

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