Janaki Medical College Journal of Medical Sciences (2023); Vol.11 (2):74-84

JMCJMS

Original Article

Knowledge and Beliefs about Antimicrobial drug resistance and its Implications in Future Prescribers

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ABSTRACT

Background & Objective: Antimicrobial drug resistance is the ability of microorganisms to persist or grow in the presence of antimicrobial drugs designed to inhibit or kill them. Since, Bachelor of Medicine and Bachelor of Surgery (MBBS) students will be the future prescribers of antimicrobial drugs, this study aims to observe the existing knowledge and beliefs about antimicrobial drug resistance and its impact on the future use of antimicrobial drugs.

Material and Methods: This cross-sectional study was conducted at Janaki Medical College, Janakpurdham, Nepal, among 223 students of Bachelor of Medicine and Bachelor of Surgery (MBBS) program. Data was collected through a structured and customized self administered questionnaire as a tool from the respondents of MBBS first year to MBBS final Year. Chi square test was applied to test the association between different academic years of MBBS and their knowledge on antimicrobial drugs, antimicrobial drug resistance, beliefs about antimicrobial drugs, and implications of the knowledge of antimicrobial drugs and antimicrobial drug resistance. $p<0.05$ was considered statistically significant.

Results: Out of the total participants (n=223), the majority participants were male (n=150) and the mean age of study participants was 22.93±2.15 years. There was no statistically significant difference ($p>0.05$) in the knowledge on antimicrobial drugs among the different academic years of MBBS. However, there was statistically significant difference ($p<0.05$) between different academic years of MBBS, in most of the responses related to the knowledge on antimicrobial drug resistance and beliefs on antimicrobial drugs. Most of the students from all the academic years agreed that, their current knowledge of antimicrobial drugs and antimicrobial drug resistance was inadequate, and that they would

like to have more education on antimicrobial drugs and antimicrobial drug resistance, for their future career as a doctor.

Conclusion: There is a need for more rigorous academic and clinical intervention so that only specific antimicrobial drugs are prescribed with an overall reduction in further development of antimicrobial drug resistance to the existing as well as to the antimicrobial drugs that are still in their clinical trial phases.

Keywords: Antimicrobial drugs, antimicrobial drug resistance, knowledge, beliefs, MBBS.

INTRODUCTION

Antimicrobial drugs are chemical substances of natural or synthetic origin that suppress the growth of or destroy, micro-organisms including bacteria, fungi, helminths, protozoa and viruses [1]. Antimicrobials include antibiotics, antivirals, antifungals and antiparasitics which are used to prevent and treat infections in humans, animals and plants. World Health Organization (WHO) defines antimicrobial resistance as a microorganism's resistance to an antimicrobial drug that was once able to treat an infection by that microorganism [2].

Antimicrobial drug resistance is an urgent global public health threat, killing at least 1.27 million people worldwide and is associated with nearly 5 million deaths in 2019. In the U.S., more than 2.8 million antimicrobial-resistant infections occur each year. More than 35,000 people die as a result, according to Centers for Disease Control and Prevention (CDC) 2019 Antibiotic Resistance (AR) Threats Report [3]. When microorganisms become resistant to antimicrobial drugs, standard treatments are often ineffective, and in some cases, no drugs provide effective therapy, leading to treatment failure [4]. Antimicrobial drug resistance has the potential to affect people at any stage of life, as well as the healthcare, veterinary, and agriculture industries. This makes it one of the world's most urgent public health problems [3].

Current medical students are future doctors who will be prescribing antimicrobial drugs independently throughout their careers. Many medical students do not adequately learn prescribing skills for rational prescription of drugs during their undergraduate programs [5]. The World Health Organization (WHO) also reports that the prescribing of at least 50% of medicines is inappropriate [6]. Increasing antimicrobial drug resistance with decreased incentives to develop new antimicrobial drugs has been failing to address a major global threat of antimicrobial drug resistance. In many studies, it has been shown that, future prescribers are not well aware of antibiotic resistance and are also not fully trained for safer antibiotic prescription [7].

Most of the studies done are related to the antibiotic resistance which is only a major subset of antimicrobial resistance, so this study was conducted on the broader aspect of antimicrobial resistance including the knowledge, beliefs on antimicrobial drugs and antimicrobial drug resistance as well as the implication of this knowledge and beliefs on antimicrobial drugs and antimicrobial drug resistance in their future carrier as a doctor, who would be prescribing antimicrobial drugs.

MATERIAL AND METHODS

This cross-sectional study was conducted at Janaki Medical College, Janakpurdham, Nepal, among 223 students (both males and females) of Bachelor of Medicine and

Bachelor of Surgery (MBBS) program, out of the total 290 students enrolled in various academic years. Data was collected in the month of April 2023, through a structured and customized self-administered questionnaire [8,9,10] as a tool , from the respondents of MBBS first year to MBBS final Year. The questionnaire comprised of 5 sections: section A included questions on demographic features, section B included 5 questions about the knowledge of antimicrobial drugs, section C included 13 questions related to the knowledge about antimicrobial resistance, section D included 6 questions about the beliefs about antimicrobial drugs and section E included 9 questions related to the implications of the knowledge of antimicrobial drugs and antimicrobial resistance as future medical doctors. The questionnaire was pretested by using google form sent through email to 30 students of MBBS program of Janaki Medical College, Janakpurdham, Nepal, however, they were not included in data analysis for this study. Convenience sampling technique was used, where in the students available in their respective lecture halls at the time of data collection were included. The nature and purpose of the study was explained to the students and written consent was taken from the students before distributing the questionnaire for collection of data. The questionnaire was distributed as well as collected by the principal investigator. 30 minutes time, was allotted for filling up the questionnaire and its submission. Data was entered into IBM SPSS software (Version 20) and both descriptive and inferential statistics were carried out for the presentation of data.

Chi square test was applied to test the association between the different academic years of MBBS and the knowledge on antimicrobial drugs, antimicrobial resistance, beliefs about antimicrobial drugs, and implications of the knowledge of antimicrobial drugs and antimicrobial resistance. $p<0.05$ was considered statistically significant.

Ethical approval was taken before conducting the study from the Institutional Review Committee (Ref No. 19/2079-080) of Janaki Medical College, Janakpurdham, Nepal.

RESULTS

The demographic details of the study participants (n=223) based on academic year of MBBS and gender has been projected in table 1. Majority of the participants were male (n=150) and the mean age of the study participants was 22.93±2.15 years.

Based on the responses from the study participants to the statements related to the knowledge on antimicrobial drugs, there was no statistically significant difference ($p>0.05$) in the knowledge on antimicrobial drugs among the different academic years of MBBS students, as shown in table 2.

As depicted in table 3, there was no statistical difference ($p>0.05$) in the knowledge on antimicrobial drug resistance on most of the responses to the statements, however there was statistically significant difference in the responses between different academic years of MBBS to the statements like, it is not necessary to use the correct dose of an antimicrobial drug to reduce the chances of the occurrence of microbial resistance to drug ($p=0.015$), improper self-medication can cause antimicrobial resistance ($p=0.030$), antibiotics will improve the outcome of the treatment of viral infections ($p=0.008$), antimicrobial drug resistance increases the cost of treatment ($p=0.023$),

Table 1: Demographic characteristics of study participants (n=223)

Characteristics	Gender		Total number (%)	Mean age± SD
	Male	Female		
MBBS academic year				
First	31	18	49(22)	21.08 ± 1.79
Second	29	17	46(20.6)	21.74 ± 1.16
Third	40	10	50(22.4)	23.38 ± 1.39
Fourth	23	14	37(16.6)	23.70 ± 1.05
Final	27	14	41(18.4)	25.22 ± 2.19
Total	150	73	223 (100)	22.93 ± 2.15

Table 2: Knowledge on antimicrobial drugs (n=223)

Statement	Response	MBBS academic year					Total n (%)
		First n (%)	Second n (%)	Third n (%)	Fourth n (%)	Final n (%)	
Antimicrobial drugs are medicines used to prevent and treat infections in humans, animals and plants	Yes	42(85.7)	44(95.7)	44(88)	36(97.3)	40(97.6)	206(92.4)
	No	7(14.3)	2(4.3)	5(10)	1(2.7)	0(0)	15(6.7)
	Don't Know	0(0)	0(0)	1(2)	0(0)	1(2.4)	2(0.9)
	p-value	0.128					
Antimicrobial drugs are used to treat infections caused by bacteria, virus, fungi, parasites	Yes	38(77.6)	42(91.3)	38(76)	30(81.1)	38(92.7)	186(83.4)
	No	11(22.4)	3(6.5)	12()	7(18.9)	3(7.3)	36(16.1)
	Don't Know	0(0)	1(2.2)	0(0)	0(0)	0(0)	1(0.4)
	p-value	0.109					
Antimicrobial drugs can be obtained from Pharmacy after prescription	Yes	46(93.9)	43(93.5)	47(94)	36(97.3)	41(100)	213(95.5)
	No	2(4.1)	3(6.5)	3(6)	1(2.7)	0(0)	9(4)
	Don't Know	1(2)	0(0)	0(0)	0(0)	0(0)	1(0.4)
	p-value	0.570					
Antimicrobial drugs should be used only when needed	Yes	46(93.9)	45(97.8)	50(100)	36(97.3)	41(100)	218(97.8)
	No	3(6.1)	1(2.2)	0(0)	1(2.7)	0(0)	5(2.2)
	Don't Know	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	p-value	0.241					
Family, friends, internet and social media are all reliable sources of antimicrobial drug information	Yes	14(28.6)	19(41.3)	18(36)	15(40.5)	10(24.4)	76(34.1)
	No	34(69.4)	26(56.5)	31(62)	20(54.1)	30(73.2)	141(63.2)
	Don't Know	1(2)	1(2.2)	1(2)	2(5.4)	1(2.4)	6(2.7)
	p-value	0.672					

antimicrobial drug resistance can cause imbalance in normal flora of human body (p=0.023). Overall, the final year MBBS students had better knowledge on antimicrobial drug resistance compared to the other year students.

Table 3: Knowledge on antimicrobial drug resistance (n=223)

Statement	Response	MBBS academic year					Total n (%)
		First n (%)	Second n (%)	Third n (%)	Fourth n (%)	Final n (%)	
Antimicrobial drug resistance is the ability of microbes to grow in the presence of a chemical (drug) that would normally kill them or limit their growth	Yes	46(93.9)	45(97.8)	45(90)	37(100)	41(100)	214(96)
	No	2(4.1)	0(0)	5(10)	0(0)	0(0)	7(3.1)
	Don't Know	1(2)	1(2.2)	0(0)	0(0)	0(0)	2(0.9)
	p-value	0.068					
It is not necessary to complete the regimen of an antimicrobial drug to reduce the chances of the occurrence of microbial resistance to drug	Yes	15(30.6)	6(13)	15(30)	6(16.2)	7(17.1)	49(22)
	No	31(63.3)	39(84.8)	35(70)	30(81.1)	33(80.5)	168(75.3)
	Don't Know	3(6.1)	1(2.2)	0(0)	1(2.7)	1(2.4)	6(2.7)
	p-value	0.183					
It is not necessary to use the correct dose of an antimicrobial drug to reduce the chances of the occurrence of microbial resistance to drug	Yes	13(26.5)	1(2.2)	7(14)	3(8.1)	4(9.8)	28(12.6)
	No	35(71.4)	45(97.8)	43(86)	32(86.5)	36(87.8)	191(85.7)
	Don't Know	1(2)	0(0)	0(0)	2(5.4)	1(2.4)	4(1.8)
	p-value	0.015					
Antimicrobial drug resistance can cause treatment failure	Yes	41(83.7)	42(91.3)	48(96)	36(97.3)	39(95.1)	206(92.4)
	No	8(16.3)	3(6.5)	2(4)	1(2.7)	2(7.9)	16(7.2)
	Don't Know	0(0)	1(2.2)	0(0)	0(0)	0(0)	1(0.4)
	p-value	0.141					
Improper self-medication can cause antimicrobial drug resistance	Yes	41(83.7)	42(91.3)	48(96)	37(100)	40(97.6)	208(93.3)
	No	8(16.3)	3(6.5)	1(2)	0(0)	1(2.4)	13(5.8)
	Don't Know	0(0)	1(2.2)	1(2)	0(0)	0(0)	2(0.9)
	p-value	0.030					
Antimicrobial drug resistance affects all age groups	Yes	46(93.9)	43(93.5)	49(98)	36(97.3)	40(97.6)	214(96)
	No	2(4.1)	1(2.2)	1(2)	0(0)	0(0)	4(1.8)
	Don't Know	1(2)	2(4.3)	0(0)	1(2.7)	1(2.4)	5(2.2)
	p-value	0.752					
Antimicrobial drug resistance makes it harder to eliminate infections from the body as existing drugs become less effective	Yes	49(100)	43(93.5)	48(96)	36(97.3)	40(97.6)	216(96.9)
	No	0(0)	1(2.2)	2(4)	0(0)	0(0)	3(1.3)
	Don't Know	0(0)	2(4.3)	0(0)	1(2.7)	1(2.4)	4(1.8)
	p-value	0.397					
Antimicrobial drug resistance can lead to spread of infections due to ineffectiveness of standard treatment	Yes	42(85.7)	41(89.1)	50(100)	36(97.3)	38(92.7)	207(92.8)
	No	3(6.1)	2(4.3)	0(0)	0(0)	1(2.4)	6(2.7)
	Don't Know	4(8.2)	3(6.5)	0(0)	1(2.7)	2(4.9)	10(4.5)
	p-value	0.259					
Antibiotics will improve the outcome of the treatment of viral infections	Yes	26(53.1)	20(43.5)	10(20)	10(27)	11(26.8)	77(34.5)
	No	23(46.9)	23(50)	38(76)	27(73)	28(68.3)	139(62.3)
	Don't Know	0(0)	3(6.5)	2(4)	0(0)	2(4.9)	7(3.1)
	p-value	0.008					

Antimicrobial drug resistance increases the cost of treatment	Yes	40(81.6)	38(82.6)	44(88)	34(91.9)	39(95.1)	195(87.4)
	No	9(18.4)	4(8.7)	6(12)	2(5.4)	2(4.9)	23(10.3)
	Don't Know	0(0)	4(8.7)	0(0)	1(2.7)	0(0)	5(2.2)
	p-value	0.023					
Antimicrobial drug resistance is a worldwide problem	Yes	45(91.8)	41(89.1)	41(82)	36(97.3)	40(97.6)	203(91)
	No	2(4.1)	1(2.2)	4(8)	0(0)	1(2.4)	8(3.6)
	Don't Know	2(4.1)	4(8.7)	5(10)	1(2.7)	0(0)	12(5.4)
	p-value	0.197					
Antimicrobial drug resistance can cause imbalance in normal flora of human body	Yes	47(95.9)	44(95.7)	45(90)	32(86.5)	37(90.2)	205(91.9)
	No	0(0)	0(0)	5(10)	3(8.1)	0(0)	8(3.6)
	Don't Know	2(4.1)	2(4.3)	0(0)	2(5.4)	4(9.8)	10(4.5)
	p-value	0.022					
Antimicrobial drug resistance is not really as it seems because new antimicrobial drugs are developed yearly by scientists	Yes	25(51)	16(34.8)	16(32)	12(32.4)	13(31.7)	82(36.8)
	No	19(38.8)	23(50)	24(48)	18(48.6)	23(56.1)	107(48)
	Don't Know	5(10.2)	7(15.2)	10(20)	7(18.9)	5(12.2)	34(15.2)
	p-value	0.521					

Table 4: Beliefs about antimicrobial drugs

Statement	**Response**	**MBBS academic year**					**Total n (%)**
		First n (%)	**Second n (%)**	**Third n (%)**	**Fourth n (%)**	**Final n (%)**	
Keep antimicrobial drugs at home in case of need later	Agree	7(14.3)	16(34.8)	19(38)	16(43.2)	13(31.7)	71(31.8)
	Disagree	26(53.1)	15(32.6)	18(36)	11(29.7)	19(46.3)	89(39.9)
	Neutral	16(32.7)	15(32.6)	13(26)	10(27)	9(22)	63(28.3)
	p-value	0.126					
Get antimicrobial drug from others without seeing a doctor	Agree	1(2)	1(2.2)	2(4)	0(0)	1(2.4)	5(2.2)
	Disagree	45(91.8)	40(87)	48(96)	35(94.6)	39(95.1)	207(92.8)
	Neutral	3(6.1)	5(10.9)	0(0)	2(5.4)	1(2.4)	11(4.9)
	p-value	0.411					
Buy antimicrobial drugs from pharmacy without a prescription	Agree	1(2)	2(4.3)	5(10)	3(8.1)	3(7.3)	14(6.3)
	Disagree	45(91.8)	35(76.1)	42(84)	32(86.5)	37(90.2)	191(85.7)
	Neutral	3(6.1)	9(19.6)	3(6)	2(5.4)	1(2.4)	18(8.1)
	p-value	0.086					
Always take complete antimicrobial drugs dose even if you feel better	Agree	40(81.6)	42(91.3)	48(96)	36(97.3)	40(97.6)	206(92.4)
	Disagree	6(12.2)	1(2.2)	2(4)	0(0)	1(2.4)	10(4.5)
	Neutral	3(6.1)	3(6.5)	0(0)	1(2.7)	0(0)	7(3.1)
	p-value	0.042					
Stop taking antimicrobial drugs when you feel better	Agree	9(18.4)	4(8.7)	1(2)	2(5.4)	2(4.9)	18(8.1)
	Disagree	38(77.6)	35(76.1)	46(92)	33(89.2)	37(90.2)	189(84.8)
	Neutral	2(4.1)	7(15.2)	3(6)	2(5.4)	2(4.9)	16(7.2)
	p-value	0.040					
Antimicrobial drugs should be used in treatment of all diseases	Agree	6(12.2)	4(8.7)	0(0)	0(0)	1(2.4)	11(4.9)
	Disagree	36(73.5)	40(87)	46(92)	32(86.5)	37(90.2)	191(85.7)
	Neutral	7(14.3)	2(4.3)	4(8)	5(13.5)	3(7.3)	21(9.4)
	p-value	0.041					

In the above table 4, there was statistically significant difference in the responses between different academic years of MBBS to the statements related to the beliefs about antimicrobial drugs like, always take complete antimicrobial drugs dose even if you feel better (p=0.042), stop taking antimicrobial drugs when you feel better (p=0.040),

Table 5: Implications of knowledge on antimicrobial drugs and antimicrobial resistance (n=223)

Statement	Response	MBBS academic year					Total n (%)
		First n (%)	Second n (%)	Third n (%)	Fourth n (%)	Final n (%)	
I feel prepared to know whether to recommend an antimicrobial drug or not	Agree	23(46.9)	21(45.7)	23(46)	26(70.3)	32(78)	125(56.1)
	Disagree	7(14.3)	8(17.4)	8(16)	5(13.5)	2(4.9)	30(13.5)
	Neutral	19(38.8)	17(37)	19(38)	6(16.2)	7(17.1)	68(30.5)
	p-value	0.021					
I feel prepared to know when to recommend that a patient starts a antimicrobial drug therapy	Agree	26(53.1)	25(54.3)	32(64)	29(78.4)	32(78)	144(64.6)
	Disagree	8(16.3)	11(23.9)	8(16)	5(13.5)	2(4.9)	34(15.2)
	Neutral	15(30.6)	10(21.7)	10(20)	3(8.1)	7(17.1)	45(20.2)
	p-value	0.062					
I feel prepared to know, how to select the best antimicrobial drug for a patient	Agree	27(55.1)	24(52.2)	28(56)	28(75.7)	31(75.6)	138(61.9)
	Disagree	6(12.2)	12(26.1)	8(16)	5(13.5)	2(4.9)	33(14.8)
	Neutral	16(32.7)	10(21.7)	14(28)	4(10.8)	8(19.5)	52(23.3)
	p-value	0.045					
I feel prepared to know which route of administration is best for a patients antimicrobial drug therapy	Agree	29(59.2)	31(67.4)	27(54)	29(78.4)	33(80.5)	149(66.8)
	Disagree	4(8.2)	3(6.5)	8(16)	3(8.1)	2(4.9)	20(9)
	Neutral	16(32.7)	12(26.1)	15(30)	5(13.5)	6(14.6)	54(24.2)
	p-value	0.114					
I know the current and relevant specimens to be collected from patients that can be used to identify various infections	Agree	30(61.2)	26(56.5)	34(68)	28(75.7)	36(87.8)	154(69.1)
	Disagree	8(16.3)	5(10.9)	4(8)	2(5.4)	1(2.4)	20(9)
	Neutral	11(22.4)	15(32.6)	12(24)	7(18.9)	4(9.8)	49(22)
	p-value	0.061					
My current knowledge of antimicrobial drugs is adequate for my future career as a doctor	Agree	16(32.7)	9(19.6)	14(28)	6(16.2)	6(14.6)	51(22.9)
	Disagree	21(42.9)	29(63)	24(48)	15(40.5)	23(56.1)	112(50.2)
	Neutral	12(24.5)	8(17.4)	12(24)	16(43.2)	12(29.3)	60(26.9)
	p-value	0.099					
My current knowledge of antimicrobial drug resistance is adequate for my future career as a doctor	Agree	14(28.6)	10(21.7)	15(30)	4(10.8)	6(14.6)	49(22)
	Disagree	20(40.8)	29(63)	19(38)	18(48.6)	20(48.8)	106(47.5)
	Neutral	15(30.6)	7(15.2)	16(32)	15(40.5)	15(36.6)	68(30.5)
	p-value	0.068					
I would like to have more education on the appropriate use of antimicrobial drugs	Agree	44(89.8)	44(95.7)	49(98)	36(97.3)	37(90.2)	210(94.2)
	Disagree	1(2)	0(0)	0(0)	0(0)	0(0)	1(0.4)
	Neutral	4(8.2)	2(4.3)	1(2)	1(2.7)	4(9.8)	12(5.4)
	p-value	0.468					
I would like to have more education on antimicrobial resistance	Agree	41(83.7)	45(97.8)	50(100)	37(100)	38(92.7)	211(94.6)
	Disagree	3(6.1)	0(0)	0(0)	0(0)	0(0)	3(1.3)
	Neutral	5(10.2)	1(2.2)	0(0)	0(0)	3(7.3)	9(4)
	p-value	0.007					

antimicrobial drugs should be used in treatment of all diseases (p=0.041).

The above table 5 highlights the detailed responses on the implications of their knowledge on antimicrobial drugs and antimicrobial resistance. There was statistically significant difference in the responses between different academic years of MBBS to the statements related to the implications of knowledge on antimicrobial drugs and antimicrobial resistance. Most of the students from all the academic years agreed that, their current knowledge of antimicrobial drugs and antimicrobial resistance was inadequate for their future career as a doctor, and that they would like to have more education on antimicrobial drugs and antimicrobial resistance.

DISCUSSION

Antimicrobial drug resistance has been increasing at an alarming rate and the reasons for its development are multi-factorial with the most common being self medication and irrational prescribing of antimicrobial drugs. In this study, MBBS first year to final year students of Janaki Medical College, Janakpurdham, Nepal, who would be the future prescribers of antimicrobial drugs, were enrolled to assess their existing knowledge and beliefs on antimicrobial drugs and antimicrobial drug resistance along with the implication of their knowledge and beliefs on antimicrobial drug and antimicrobial drug resistance.

In this study, the majority of the participants were male (n=150) which is probably due to the greater number of male students enrollment in the MBBS program at Janaki Medical College. The mean age of the study participants was 22.93±2.15 years, which is in accordance with the study conducted by Haque et al. in Malaysia [9].

The findings of this study regarding knowledge of antimicrobial drugs showed that most of the students (>80%) of all the academic years, had adequate knowledge about antimicrobial drugs and there was no statistically significant difference (p> 0.05) in the knowledge on antimicrobial drugs among the different academic years of MBBS students, probably because the students were being made aware about antimicrobial drugs in their academic activities and clinical postings. Most of the studies have been conducted on knowledge on antibiotics alone, hence there was no comparative study findings to this study. Majority of the respondents agreed that antimicrobial drugs were medicines used to prevent and treat infections in humans, animals and plants (92.4%), and that antimicrobial drugs were used to treat infections caused by bacteria, virus, fungi, parasites (83.4%) which is in accordance to the definition of WHO [2]. Final year students (100%) had agreed that antimicrobial drugs should be used only when needed, as well as antimicrobial drugs can be obtained from Pharmacy after prescription, as they might have recalled to what was taught to them in theory or practical classes and clinical postings in earlier years. Most of the respondents (63.2%) agreed that family, friends, internet and social media were not reliable sources of antimicrobial drug information, as they might have compared the information in their textbooks and the information related to antimicrobial drugs in other sources, finding them incorrectly placed.

In this study, the results related to the knowledge on antimicrobial drug resistance demonstrated that, there was good

knowledge among the respondents about antimicrobial drug resistance as they significantly (≥90%) agreed that antimicrobial resistance is the ability of microbes to grow in the presence of a chemical (drug) that would normally kill them or limit their growth, which is also consistent with the findings of Sholabi et al.[10] and as defined by WHO [2]. Various studies conducted by Hyat K et al. in Pakistan [11], Sakeena et al. in Sri Lanka [12] and Lubwama et al. in East Africa [13], have revealed the potential reasons for development of antimicrobial drug resistance, and in this study also, the respondents have mostly agreed upon similar reasons like not consuming the complete antimicrobial drug regimen (75.3%), consuming inappropriate dose of antimicrobial drug, and self-medication of antimicrobial drugs (93.3%) for the development of antimicrobial drug resistance.

In this study, it was found that most of the respondents were aware that, antimicrobial drug resistance affects all age groups (96%), can cause treatment failure (92.4%), can cause imbalance in normal flora of human body (91.9%), can lead to spread of infections due to ineffectiveness of standard treatment (92.8%), and makes it harder to eliminate infections from the body as existing drugs become less effective (96.9%) which is in line with the findings of study conducted by Sholabi et al. in Nigeria [10]. Mostly respondents also agreed to the statement that antimicrobial resistance increases the cost of treatment (87.4%), and also was a worldwide problem (91%), similar to the CDC's 2019 Antibiotic Resistance (AR) Threats Report [3]. The response to the statement, antibiotics will improve the outcome of the treatment of viral infections was poor , probably due to confusion with the words "antibiotic" and "antimicrobials" which are used as synonyms most of the times, which is similar to the findings of Chaurasia et al. [14], and Azevedo et al. [15]. There was mixed response to the statement that antimicrobial drug resistance is not really as it seems because new antimicrobial drugs are developed yearly by scientists (Yes- 36.8%, No- 48% and Don't Know- 15.2%), which could be due to their unawareness about the declaration done by WHO [16]. These findings are similar to the findings of study done by Ogunnigbo et al. in African countries [17].

Most of the respondents has good belief on antimicrobial drugs for the statements related to the beliefs about antimicrobial drugs, as they disagreed for, keeping antimicrobial drugs at home in case of need later (39.9%), getting antimicrobial drugs from others without seeing a doctor (92.8%), buying antimicrobial drugs from pharmacy without a prescription (85.7%), stop taking antimicrobial drugs when felt better (84.8%) and antimicrobial drugs should be used in treatment of all diseases (85.7%). These findings are similar to the findings of study done by Maroof et al. in Kumaon region [8], and Suaifan et al. in Jordan [18], where in the term antibiotics has been synonymously used for antimicrobial drugs. It was also found that 92.4% of the respondents agreed for taking complete antimicrobial drug dose, even if they felt better, however, this finding could be mainly based on their theoretical knowledge as the findings are contradictory to the finding of study done by Maroof et al. [8].

The finding of this study revealed that, very few agreed to have adequate knowledge on antimicrobial drugs and antimicrobial drug resistance, while many respondents were neutral. The findings are in contradiction to

the results of Abdu-Aguye et al. [19]. Similarly, most of the students from all the academic years agreed that, their current knowledge of antimicrobial drugs (50.2%) and antimicrobial drug resistance (47.5) was inadequate for their future career as a doctor, and that they would like to have more education on antimicrobial drugs (94.2%) and antimicrobial drug resistance (94.6%), which is similar to the findings of the study done by Abdu-Aguye et al. [19] in Northern Nigeria, and Ahmed et al. [20]. The study had a small sample size, a single study site, and a single stream of health sciences were selected for data collection, so the results of this study cannot be generalized to all medical and health science students.

CONCLUSION

The findings can be used as a supporting tool for amending changes in the teaching learning activities of students including more relevant clinical settings wherein antimicrobial drugs are indicated or even for designing techniques of demonstration to future prescribers in order to enhance their knowledge of antimicrobial drugs and antimicrobial drug resistance with an emphasis on rational prescribing of antimicrobial drugs. There is a need of more rigorous academic and clinical intervention so that only specific antimicrobial drugs are prescribed with an overall reduction in further development of antimicrobial drug resistance to the existing as well as to the antimicrobial drugs which are still in their clinical trial phases.

ACKNOWLEDGEMENT

Researchers would like to appreciate the contribution of all the participants of the study for their support to this study.

Conflict of interest

None

Funding

None

Author's Contribution:

*Concept, design, supervision, funding, materials, data collection and processing, analysis and interpretation, literature review, writing-**LC;** analysis, interpretation, literature review, writing-**RS;** analysis, interpretation, literature review, writing, review-**SD;** analysis, interpretation, literature review, writing, review-**RCS;** Analysis, interpretation, literature review, writing, review-**GP.** The finalized version of the manuscript was reviewed and approved by all authors.*

REFERENCES

1. Waller DG, Sampson AP. Chemotherapy of infections. In Medical Pharmacology and Therapeutics. 5th edn. Dutch: Elsevier. 2018; pp581-629.
2. WHO. Antimicrobial resistance: Fact sheet. 2014. Available online: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance [Retrieved 7 March 2015].
3. www.cdc.gov/DrugResistance/Biggest-Threats.html
4. https://www.fao.org/antimicrobial-resistance/background/what-is-it/en/
5. McLellan L, Yardley S, Norris B et al. Preparing to prescribe: how do clerkship students learn in the midst of complexity? Adv Health Sci Educ Theory Pract 2015; 20(5):1339-54.
6. World Health Organization. The pursuit of responsible use of medicines: sharing and learning from country experiences. Technical Report prepared for the Ministers Summit on the benefits of responsible use of medicines: Setting policies for better and cost effective health care. 20 Avenue Appia, 1211 Geneva 27, Switzerland: WHO Press, World Health Organization 2012 [cited 2018 Aug 14].
7. Gupta MK, Vohra C and Raghav P. Assessment of knowledge, attitudes, and practices about antibiotic resistance among medical students in India. J Family Med Prim Care 2019; 8(9): 2864.

8. Maroof M, Khan MNA, Ansari ZM et al. Antimicrobial resistance - are future prescribers aware? A study among undergraduate medical students in Kumaon region. Asian Journal of Medical Sciences 2023; 14(4):137-42.
9. Haque M, Rahman NAA, McKimm J et al. A cross-sectional study evaluating the knowledge and beliefs about, and the use of antibiotics amongst Malaysian university students. Expert Review of Anti-infective Therapy 2019; 17(4):275-84.
10. Akande-Sholabi W, Ajamu AT. Antimicrobial stewardship: Assessment of knowledge, awareness of antimicrobial resistance and appropriate antibiotic use among healthcare students in a Nigerian University. BMC Med Educ 2021; 21(1):488.
11. Hayat K, Fatima N, Umer MF, Khan FU, Khan FU, Najeeb ZUR et al. Understanding of Future Prescribers About Antimicrobial Resistance and Their Preparedness Towards Antimicrobial Stewardship Activities in Pakistan: Findings and Implications. Front. Pharmacol 2022; 13:771083.
12. Sakeena MHF, Bennett AA, Jamshed S et al. Investigating knowledge regarding antibiotics and antimicrobial resistance among pharmacy students in Sri Lankan universities. BMC Infect Dis 2018; 18(1):209.
13. Lubwama M, Onyuka J, Ayazika KT et al. Knowledge, attitudes, and perceptions about antibiotic use and antimicrobial resistance among final year undergraduate medical and pharmacy students at three universities in East Africa. PLoS One 2021; 16(5):e0251301.
14. Chaurasia L, Chaudhary S, Paudel G, Singh JK. Knowledge, Attitude and Practice on Antibiotic Use among Medical Students. Janaki Medical College Journal of Medical Science 2020; 8(1):23-33.
15. Azevedo MM, Pinheiro C, Yaphe J and Baltazar F. Portuguese students' knowledge of antibiotics: A cross-sectional study of secondary school and university students in Braga. BMC Public Health 2009; 9:359.
16. World Health Organization. Antimicrobial Resistance: Key Facts. 2020. Available online: https://www.who.int/news-room/ fact-sheets/detail/antimicrobial-resistance (accessed on 21 June 2021).
17. Ogunnigbo O, Nabiryo M, Atteh et al. Exploring the Antimicrobial Stewardship Educational Needs of Healthcare Students and the Potential of an Antimicrobial Prescribing App as an Educational Tool in Selected African Countries. Antibiotics 2022; 11:691.
18. Abdu-Aguye SN, Barde KG, Yusuf H, Lawal BK, Shehu A, Mohammed E. Investigating Knowledge of Antibiotics, Antimicrobial Resistance and Antimicrobial Stewardship Concepts Among Final Year Undergraduate Pharmacy Students in Northern Nigeria. Integr Pharm Res Pract 2022; 23(11):187-95.
19. Suaifan GARY, Shehadeh M, Darwish DA, Al-Ijel H, Yousef AM, Darwish RM. A cross-sectional study on knowledge, attitude and behavior related to antibiotic use and resistance among medical and non-medical university students in Jordan. African Journal of Pharmacy and Pharmacology 2012; 6(10):763-70.
20. Ahmed N, Abujheisha K, Balaha M. Pharmacy students' knowledge and perceptions about antimicrobial stewardship. J Pharm Res Int 2019; 31(1):1-8.