Knowledge, Attitude, and Practice of Antibiotic Use and Antibiotic Resistance During the COVID-19 Pandemic Among Nursing School Students – A Cross-sectional Study

Mohd Hanif Jainlabdin [1]*, Nadilla Daleena Mohd Zainuddin [2] & Siti Afiqah Mohamed Ghazali [2]
[1]*Dept. of Basic Medical Sciences for Nursing, Kulliyyah of Nursing, International Islamic University Malaysia, Pahang, Malaysia.*
[2]*Kulliyyah of Nursing, International Islamic University Malaysia, Pahang, Malaysia.*

ABSTRACT

Background: Antibiotic resistance is a global health concern due to the overuse of antibiotics. The impact of the COVID-19 on the antibiotics used to treat bacterial co-infection during hospitalisation led to the emergence of resistant bacteria. In the light of patient care, nursing students should have good knowledge, attitude and practice in educating the patient on the menace of antibiotic resistance. **Objectives**: This study aims to assess the level of knowledge, attitude, and practice of antibiotic use and antibiotic resistance during the COVID-19 pandemic among the International Islamic University Malaysia nursing students and determine the relationship between the demographic characteristics and level of knowledge, attitude, and practice. **Methods**: A cross-sectional study was conducted in which 206 nursing students were involved in this study. Convenience sampling was applied, and the study was conducted through an online questionnaire. The data were analysed by using the Chi-square test. **Results**: Nursing students of the International Islamic University Malaysia have good knowledge, attitude and practice regarding antibiotic use and antibiotic resistance. There was a significant association between the Infection Prevention and Control program and the nursing students' knowledge and practice, with a p-value ≤ of 0.05. Meanwhile, for the other demographic variables (such as gender, pre-university nursing course and clinical posting experience), there is no significant association ($p \geq 0.05$) with knowledge, attitude and practice among the nursing students. **Conclusions**: The Infection Prevention and Control program shows a significant association with the knowledge and practice, which implies that nursing students who have participated in this program possessed a better understanding and practice of antibiotic use and antibiotic resistance.

Keywords: Antibiotic Resistance, Infection Prevention and Control, nursing students, COVID-19

INTRODUCTION

Antibiotic resistance (ABR) is a serious public health concern even before the COVID-19 outbreak. The COVID-19 is caused by a virus and cannot be treated with antibiotics; however, antibiotic usage has significantly increased throughout the pandemic. In the early stage of the pandemic, patients presenting with pneumonia and flu-like illnesses such as fever, cough, sore throat often were given antibiotics to treat their symptoms (1). Even in the later stage of the pandemic, the usage of the prophylactic drug has become very widespread to prevent hospital-acquired infections during COVID-19 treatment (2). The impact of the COVID-19 on the antibiotics used to treat bacterial co-infection led to the emergence of resistant bacteria to broad-spectrum antibiotics (3). However, the sheer number of hospitalised patients during the COVID-19 pandemic and invasive surgical procedures have drastically increased standard antibiotic therapy.

ABR happens when bacteria develop the ability to escape the drugs that are supposed to kill or inhibit their growth. ABR development mechanisms include drug inactivation or alteration, changing drug binding sites and targets, and changes in cell permeability resulting in reduced intracellular drug accumulation (4). The success of antibiotic therapy depends on the local stewardship plan to prescribe the right antibiotic with the correct dose at the right time to

* Corresponding author:

Dr. Mohd Hanif Jainlabdin
Department of Basic Medical Sciences for Nursing,
Kulliyyah of Nursing,
International Islamic University Malaysia,
Jalan Sultan Ahmad Shah, Bandar Indera Mahkota,
25200 Kuantan, Pahang Darul Makmur, Malaysia.

Email: hanifmj@iium.edu.my
Telephone: +609-5707280

fight the infection (5). However, poor patient compliance in the proper use of systemic antibiotics may reciprocally influence the development of bacterial resistance and clinical outcomes (6).

Training healthcare professionals focusing on antimicrobial stewardship and Infection Prevention and Controls (IPC) is critical during the pandemic (7). Besides physicians and pharmacists, nurses should be educated on the ABR to help in advocating the menace of resistance and prudent use of antibiotics. However, there was mixed understanding of the role of antimicrobial drugs in the treatment of COVID-19 among the healthcare professionals and medical students and in need of concerted action by the hospital and university (2,8). Therefore, the current study aims to assess the knowledge, attitude and practices (KAP) of antibiotic use and ABR during the COVID-19 pandemic among the International Islamic University Malaysia (IIUM) nursing undergraduate students. We also sought to determine the association between students' demographic characteristics (gender, pre-university program, IPC training enrollment and period of clinical posting) and the level of KAP to guide future training in ABR among clinical students and healthcare professionals.

MATERIAL AND METHODS

Study design, sampling and sample size

This is a descriptive cross-sectional study that was conducted between November 2020 and February 2021. The study participants were selected based on convenience sampling within the faculty of nursing of IIUM. The sample size was estimated using the Raosoft online sample size calculator (http://www.raosoft.com/samplesize.html) by allowing a 5% margin of error and a 95% confidence level. Thus, the minimum sample size was computed as 194, after allowance for a 50% non-response rate. The inclusion criteria for this research study are the undergraduate nursing students currently studying at IIUM who voluntarily participated. The postgraduate students and nursing students who refused to participate were excluded from this study. This study obtained ethical approval from the University Research Ethics Committee (IIUM Research Ethics Approval No.: IREC 2020-KON2/9).

Data collection

The participants were informed about the study's objectives and signed informed consent to join this study. The participants solely have the right to withdraw from the study at any time. All the personal information of the participants was private and confidential. The data were collected using a self-administered online questionnaires via Google Forms. The questionnaires were administered with close-ended type of questions and adapted from a previous study (9). Forty-five students were participated in the pilot study to evaluate feasibility, acceptability, and questionnaire assessments. Data collected in this initial study were not included in the final statistical analysis. The Cronbach's Alpha value for the questionnaire was 0.74.

The questionnaire consisted of four sections: the demographics, knowledge of antibiotics resistance; attitude of antibiotics resistance; and participants' practice towards antibiotic use.

The first section of the questionnaire consisted of demographic questions. The first two questions identified the participant as a student. There were questions on gender, prior academic qualification, the length of clinical posting, and participation in IPC.

The second section covered knowledge regarding antibiotics use and its resistance. Participants were asked if they agreed with these statements or not: Antibiotics kill bacteria; Antibiotics treat viral infections; Antibiotics cure all infections; Antibiotics reduce pain and inflammation; Antibiotics used to treat any kind of fever; Antibiotics are medicines that cure stomach aches; Amoxicillin is an antibiotic; Aspirin is an antibiotic; Paracetamol is an antibiotic; Ibuprofen is an antibiotic; Ranitidine is an antibiotic; Antibiotics do not cause side effects; Antibiotics may induce allergic reactions; Antibiotic misuse leads to antibiotic resistance; Many infections are becoming increasingly resistant to treatment by antibiotics; If bacteria are resistant to antibiotics, it can be very difficult to treat the cause of infections. The following statements were added to assess the respondent knowledge on infection control in the hospital setting and its implication towards bacterial co-infections during the COVID-19 pandemic: Correct hand hygiene technique helps to prevent the spread of germs; Minimal time needed to do hand rub with the alcohol-based formulation is 20 – 30 seconds; Bacterial co-infections are a significant impact of COVID-19 treatment.

In the third section, there were 14 statements to assess the participants' attitudes towards antibiotic use. In this section, the 'unsure' answer option was included in this study as a valid response to analysing uncertain attitudes to perceive related to the statement. They were asked

if they 'agree' or 'disagree' or 'unsure' with these statements: I can stop taking the full course of antibiotics if your symptoms improve; Antibiotic effectiveness is reduced if a full course of antibiotics is not completed; Antibiotics are commonly used to treat any diseases or infection; Skipping one or two doses does not contribute to the development of antibiotic resistance; Bacterial antibiotic resistance is a problem in Malaysia; Antibiotic abuse is the main cause of bacterial resistance; Antibiotic resistance may affect you and your family's health; It is necessary to establish a course on rational use of antibiotics at the university level; Prescribing broad-spectrum antimicrobials increases antimicrobial resistance; I can consume antibiotics without prescription in order to prevent infections. Finally, there were four items that asked respondents the extent to which they agreed with the following statements about their attitudes regarding the impacts of COVID-19 on antimicrobial resistance and infection control: Poor adherence to hand hygiene practices can cause the spread of antimicrobial resistance among patients; It is important to know hand-washing techniques in order to reduce the transmission of infection; Antimicrobial resistance needs to be addressed with the same urgency as COVID-19; Antimicrobial resistance might worsen under COVID-19 due to overuse of antibiotics.

Finally, section four included 16 statements to assess participants' practice towards antibiotic use. A 5-point Likert scale, which started from 'strongly disagree' to 'strongly agree', was used to evaluate the participants' responses. Participants were asked if they agreed with these statements or not: I do not take antibiotics without prescription when I get a fever; I am not expecting my doctor to prescribe antibiotics if I have symptoms from the common cold; I still complete the full course of antibiotic treatment even if I feel better after taking two to three doses of antibiotics; I usually do not share antibiotics with sick family members and friends; I am not using leftover antibiotics if I get the same illness again; I take antibiotics only when getting the prescription from a doctor; I usually check the expiry date of the antibiotic before taking it; I do not keep antibiotic stocks at home; Whenever I take an antibiotic, I possibly contribute to the development of antibiotic resistance; When I visit a clinic, I do not expect the doctor to prescribe me antibiotics every time I get sick; I cannot continue my previous prescription antibiotics when I get sick again; I will not get the antibiotics at Over the Counter (OTC); I cannot buy antibiotics that are being sold online; I am responsible to use the prescribed antibiotics wisely. For the other two statements, the respondents were asked to indicate the extent to which they agreed with the statements on the practice of infection control in the hospital setting: I will practice hand hygiene before and after touching the patient to reduce the risk of hospital-acquired infection (HAI); I will wear a mask in order to protect myself from respiratory infection or transmit infection to other people.

The total knowledge was scored 0 for each incorrect answer and 1 for the correct answer. The level of knowledge was considered to be good if they scored 10 or above, while a score below 10 indicated a poor level of knowledge. In the attitude assessment, the scale is as follows: wrong answer = 0, unsure = 1, and true answer = 2. The attitude level was considered good if they scored 17 or above, while a score below 17 indicated poor level attitude. For questions regarding practice, the scoring for each statement was given as follows: 'strongly disagree' = 0, 'disagree' = 1, 'neutral' = 2, 'agree' = 3 and 'strongly agree' = 4. Scores 32 or higher were considered good practice, while those less than 32 were deemed poor.

Statistical analysis

The data were analysed using Statistical Package for Social Sciences (SPSS) software version 23 (SPSS 23, IBM). The association between both independent variables: gender, pre-university course, IPC training enrollment, period of clinical posting, and dependent KAP variables were determined by Chi-square test with a significant value of $p < 0.05$.

RESULTS

Demographic characteristics of the participants

A total of 432 students were reached to participate in the study, and the actual respondents who participated in this study were 206 participants (47.7% response rate). First, most of the participants were female students (86.4%) and mostly had attended the nursing pre-university course (76.7%). Next, 78.6% of the participants had participated in the IPC program during their study, and almost proportionate students experienced clinical posting in the hospital between more and less than 24 weeks. Demographic characteristics of the survey respondent are presented in Table 1.

Table 1. Demographic characteristics of the nursing students in this study.

Demographic characteristics	Frequency (n=206)	Percentage (%)
Gender		
Male	28	13.6
Female	178	86.4
Pre-university program		
Nursing	158	76.7
Non-nursing	48	23.3
IPC training		
Attended	162	78.6
Not attended	44	21.4
Clinical posting Experience		
<24 weeks	105	51.0
>24 weeks	101	49.0

Knowledge regarding antibiotic use and its resistance

The questionnaire revealed that participants had inadequate knowledge about antibiotic use since the percentage of agreement (Yes) on the unacceptable knowledge statements was almost 56.3%. As demonstrated in Table 2, although most participants (97.1%) acknowledged that antibiotics are effective against bacteria, nearly half claimed that antibiotics are effective against viral infections; however, more than half of the respondents agreed that antibiotics could reduce pain and inflammation. It is worth noting that almost all participants (99.5%) reported that hand hygiene could prevent infections, and 72.8% of the participants informed that bacterial co-infections have a significant impact on COVID-19 treatment.

Table 2. Nursing students' knowledge of antibiotic use and its resistance

Correct statements	Yes	No
Antibiotics kill bacteria	200 (97.1)	6 (2.9)
Amoxicillin is an antibiotic	204 (99.0)	2 (1.0)
Antibiotics may induce allergic reactions	182 (88.3)	24 (11.7)
Antibiotic misuse leads to antibiotic resistance	194 (94.2)	12 (5.8)
Many infections are becoming resistant to antibiotics	168 (81.6)	38 (18.4)
If bacteria are resistant to antibiotics, it can be very difficult to treat the infections	203 (98.5)	3 (1.5)
Correct hand hygiene technique helps to prevent the spread of germs	205 (99.5)	3 (0.5)
The time to do entire hand rub with the alcohol-based formulation is 20 – 30 seconds	182 (88.3)	24 (11.7)
Bacterial co-infections are a significant impact on COVID-19 treatment	150 (72.8)	56 (27.2)
Incorrect statements	**Yes**	**No**
Antibiotics treat viral infections	83 (40.3)	123(59.7)
Antibiotics cure all infections	33 (16.0)	174(84.0)
Antibiotics reduce pain and inflammation	116 (56.3)	90 (43.7)
Antibiotics used to treat any kind of fever	75 (36.4)	131(63.6)
Antibiotics are medicines that cure stomach aches	42 (20.4)	164(79.6)
Aspirin is an antibiotic	31 (15.0)	175(85.0)
Paracetamol is an antibiotic	22 (10.7)	184 (89.3)
Ibuprofen is an antibiotic	27 (13.1)	179 (86.9)
Ranitidine is an antibiotic	28 (13.6)	178 (86.4)
Antibiotics do not cause side	19 (9.2)	187 (90.8)

The chi-square test results showed that nursing students who attended the IPC program (p-value ≤0.05) were the only independent variable associated with having appropriate knowledge of antibiotic use and its resistance issues (Table 3). The other independent factors showed no significant association with the nursing students' understanding of antibiotics and antibiotic resistance.

Table 3. The relationship between the demographic characteristics and knowledge score of nursing students towards ABR and antibiotics use

Demographic characteristics	Knowledge level (%)		n	*p*-value
	Poor	Good		
Gender				
Male	0 (0.0)	28 (100.0)	28	1.000
Female				
Pre-university program				
Nursing	3 (1.9)	155 (98.1)	158	0.331
Non-nursing	2 (4.2)	46 (95.8)	48	
IPC training				
Attended	5 (11.4)	39 (88.6)	44	0.000*
Not attended	0 (0.0)	162(100.0)	162	
Clinical posting				
experience	4 (3.8)	101 (96.2)	105	0.369
<24 weeks	1 (2.4)	100 (99.0)	101	
>24 weeks				

* Statistically significant *p*-value

Attitude towards antibiotics and antimicrobial resistance among participants

Regarding the participants' attitude towards antibiotic use, the survey also showed that a significant proportion of respondents had a positive attitude towards antibiotic use. The majority of participants (80.1%) agreed that antibiotic abuse is the leading cause of bacterial resistance. They were also aware that bacterial resistance is a problem in Malaysia (52.9%). Furthermore, most of them agreed that antibiotic resistance affects them and their family's health (68.95), and it is necessary to establish a course on rational use of antibiotics at the university level (88.8%). Interestingly, a total of 58.7% either 'Unsure' or 'Disagreed' that prescribing broad-spectrum antimicrobials increases antimicrobial resistance. About 58% of them also believed that skipping one or two doses does not contribute to the development of ABR. Approximately a quarter of the participants were unsure about the negative impact of antimicrobial resistance during the COVID-19 pandemic and the urgent need to address the overuse of antibiotic prophylaxis in COVID-19 treatment (Table 4).

Table 4. Participants' attitude towards antibiotic use

Positive attitudes	Disagree	Unsure	Agree
Antibiotic effectiveness is reduced if a full course of antibiotics is not completed	25 (12%)	13 (6.3%)	168 (81.6%)
Antibiotic abuse is the main cause of bacterial resistance	11 (5.3%)	30 (14.6%)	165 (80.1%)
Bacterial antibiotic resistance is a problem in Malaysia	6 (3.4%)	90 (43.7%)	109 (52.9%)
Antibiotic resistance affects you and your family's health	28 (13.6%)	36 (17.5%)	142 (68.9%)
It is necessary to establish a course on rational use of antibiotics at university level	5 (2.4%)	18 (8.7%)	183 (88.8%)
Prescribing broad-spectrum antimicrobials increases antimicrobial resistance	22 (10.7%)	99 (48%)	85 (41.3%)
Poor adherence to hand hygiene practices can cause the spread of antimicrobial resistance among patients	11 (5.3%)	27 (13.1%)	168 (81.6%)
It is important to know hand-washing techniques in order to reduce the transmission of infection	3 (1.5%)	1 (0.5%)	202 (98.0%)
Antimicrobial resistance needs to be addressed with the same urgency as COVID-19	20 (9.7%)	62 (30.1%)	124 (60.2%)
Antimicrobial resistance might worsen during the COVID-19 pandemic due to overuse of antibiotics	12 (5.8%)	78 (37.9%)	116 (56.3%)

Negative attitudes	Disagree	Unsure	Agree
You can stop taking the full course of antibiotics if your	179 (86.9%)	9 (4.4%)	18 (8.7%)
Antibiotics are commonly used to treat any disease or infection	81 (39.3%)	35 (17.0%)	90 (43.7%)
Skipping one or two doses does not contribute to the development of antibiotic resistance	120 (58.3%)	50 (24.3%)	36 (17.5%)
I can consume antibiotics without prescription to prevent infections	180 (87.4%)	10 (4.9%)	16 (7.8%)

Chi-square test results showed that participants' attitude towards antibiotic use was not associated to gender (p = 0.356), either attended to pre-university (p = 0.555) or IPC program (p = 0.516) and the length of clinical posting during their study (p = 1.000) (Table 5).

Table 5. The relationship between the demographic characteristics and attitude score of nursing students towards ABR and antibiotics use

Demographic characteristics	Attitude level (%)		n	*p*-value
	Poor	Good		
Gender				
Male	1 (3.6)	27 (96.4)	28	0.356
Female	2 (1.1)	176	178	
Pre-university program				
Nursing	2 (1.3)	156 (98.7)	158	0.555
Non-nursing	1 (2.1)	47 (97.9)	48	
IPC training				
Attended	2 (1.2)	160 (98.8)	162	0.516
Not attended	1 (2.3)	43 (97.7)	44	
Clinical posting experience				
<24 weeks	2 (1.9)	103 (98.1)	105	1.000
>24 weeks	1 (1.0)	100	101	

Participants' practice on antibiotic use and ABR

Most participants have a good practice towards antibiotic use and ABR. As demonstrated in Table 6, 57.3% of surveyed participants 'strongly agreed' that they cannot take antibiotics without prescription, and 64.1% of the participants only take the antibiotics prescribed by a doctor. They also strongly agreed that they still need to complete the full course of antibiotic treatment even if they feel better after taking two to three doses of antibiotics (55.3%), and they usually do not share antibiotics with sick family members and friends (54.9%). Moreover, 68.9% of the participants believed that they are responsible for using the prescribed antibiotics wisely. On the other hand, only 39.3% of the participants will not get antibiotics at Over the Counter (OTC). However, a total of 83.8% of the participants were stated 'strongly agree' and 'agree' for certain that they cannot buy antibiotics that are being sold online. Participants (69.6%) also strongly agreed that they would practise hand hygiene before and after touching the patients in the hospital to reduce the risk of HAIs. Most of them (71.4%) strongly agreed that they would wear a mask to protect themselves from respiratory infection or transmit the infection to other people.

Table 6. Participants' practice towards antibiotic use and ABR

Practices	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I do not take antibiotics without a prescription when I get a fever.	14 (6.8)	10 (4.9)	17 (8.3)	47 (22.8)	118 (57.3)
I am not expecting my doctor to prescribe antibiotics if I have symptoms of the common cold.	18 (8.7)	35 (17.0)	49 (28.6)	49 (23.8)	45 (21.9)
I still complete the full course of antibiotics even when I feel better after two or three doses of antibiotics.	13 (6.3)	14 (6.8)	20 (9.7)	45 (21.8)	114 (55.3)
I usually do not share antibiotics with sick family members and friends.	10 (4.9)	5 (2.4)	30 (14.6)	48 (23.3)	113 (54.9)
I am not using leftover antibiotics for the same illness.	15 (7.3)	13 (6.3)	24 (11.7)	53 (25.7)	101 (49.0)
I take antibiotics only when getting the prescription from a doctor.	161 (7.8)	4 (1.9)	9 (4.4)	45 (21.8)	132 (64.1)
I usually check the expiry date of the antibiotic before taking it.	14 (6.8)	3 (1.5)	17 (8.3)	37 (18.0)	135 (65.5)
I do not keep antibiotic stocks at home.	9 (4.4)	26 (12.6)	33 (16.0)	49 (23.8)	89 (43.2)
Whenever on antibiotics, I possibly contribute to the development of antibiotic resistance.	35 (17.0)	43 (20.9)	86 (41.7)	30 (14.6)	12 (5.8)
When I visit a clinic, I do not expect the doctor to prescribe me antibiotics every time I get sick.	18 (8.7)	27 (13.1)	39 (18.9)	57 (27.7)	65 (31.6)
I cannot continue my previous prescription antibiotics when I get sick again.	9 (4.4)	24 (11.7)	44 (21.4)	44 (21.4)	85 (41.3)
I will not get the antibiotics at OTC.	10 (4.9)	16 (7.8)	50 (24.3)	49 (23.8)	81 (39.3)
I cannot buy antibiotics that are being sold online.	16 (7.8)	6 (2.9)	11 (5.3)	44 (21.4)	129 (62.6)
I will practice hand hygiene before and after touching the patient to reduce the risk of HAI.	14 (6.8)	3 (1.5)	8 (3.9)	37 (18.0)	144 (69.9)
I will wear a mask to protect myself from respiratory infection or transmit the infection to other people.	14 (6.8)	2 (1.0)	7 (3.4)	36 (17.5)	147 (71.4)
I am responsible for using the prescribed antibiotics wisely.	161 (7.8)	1 (0.5)	6 (2.9)	41 (19.9)	142 (68.9)

The IPC program (p=0.002) showed a significant association that support the participants' practices towards antibiotics and ABR. However, the other independent factors showed no significant association with the practice of the nursing students (Table 7).

Table 7. The relationship between the demographic characteristics and practice score of nursing students towards ABR and antibiotics use

Demographic characteristics	Practice level (%) Poor	Good	n	*p*-value
Gender				
Male	4 (14.3)	24 (85.7)	28	0.527
Female	19 (10.7)	159 (89.3)	178	
Pre-university program				
Nursing	18 (11.4)	140 (88.6)	158	0.851
Non-nursing	5 (10.4)	43 (89.6)	48	
IPC training				
Attended	12 (7.4)	150 (92.6)	162	0.002*
Not attended	11 (25.0)	33	44	
Clinical posting experience				
<24 weeks	16 (15.2)	89 (84.8)	105	0.058
>24 weeks	7 (6.9)	94 (93.1)	101	

* Statistically significant *p*-value

DISCUSSION

The rise of antibiotic resistance is of great public health concern, at least for the past decade. With the complexity of COVID-19 treatment, the overuse of antibiotics during hospitalisation is expected to exacerbate the resistance issue. Even though the diagnosis of COVID-19 is far more efficient than at the early stage of the pandemic, antibiotic treatment is often prescribed as a precaution before receiving a test result (10). Early initiation of broad-spectrum antibiotic therapy is a standard of care that is often beneficial in true bacterial infections. However, it is notable to mention that misconceptions regarding antibiotic use have been found among healthcare professionals and clinical students from previous studies (11,12).

This study aimed to assess the level of KAP of antibiotic use and antibiotic resistance among nursing students of the IIUM. Our study revealed that the IIUM nursing students possessed a good KAP of antibiotic use and its resistance. The healthcare educational training on infection control is essential to provide adequate KAP among nurses in preventing the emergence of resistant strains in the hospital settings. In this study, 78.6% of the participants had attended the IPC program and a significant predictor of the knowledge and practice towards the appropriate use of antibiotics and the risk of ABR. This finding is supported by previous observations that IPC training can promote a higher awareness of antimicrobial resistance (13,14). Meanwhile, other factors (gender, pre-university nursing course and clinical posting experience) showed no significant association with nursing students' knowledge, attitude, and practice.

Regarding the appropriate use of antibiotics, 97% of the participants knew that antibiotics kill bacteria which is comparable to 88% in a study conducted by Marzan et al., (2021) and higher than the proportion (73%) reported in Qatar (16). On the other hand, 40% of the respondents did not know that antibiotics were not effective against viruses, which is lower than the proportions (46%) reported among students in Nepal's public universities (17). A possible reason for this finding may be due to the terms 'viral' and 'bacterial' used when referring to infections. Participants may lack adequate knowledge to differentiate between these groups of organisms; hence it may be beneficial to reiterate the students on the biology of viruses and bacteria and the possible infections.

With regards to differentiating antibiotics from other medicines, around 10% to 15% of the respondents confused antibiotics with other medications such as aspirin and paracetamol, anti-inflammatory, antipyretic and analgesic drugs which are higher than the reports from studies conducted in India 6% (18) and Italy 3% (19). The mix-up of these drugs has been attributed to participant's belief regarding the use of antibiotics for fever and other non-bacterial illnesses. The widespread use of antibiotics for the common cold, which is primarily a viral infection, has influenced public perceptions of antibiotic effectiveness in treating this illness (6). Reducing irrational use of antibiotics for common colds and fever can reduce antibiotic resistance and patient safety.

A good number of the participants had adequate knowledge of completing an entire course of antibiotics. Eighty-six per cent of the study population disagreed that the prescribed duration of antibiotics can be stopped when symptoms improve, which is higher than findings among Qatari (55%) (16) and much higher than reports from Emirati university students (55.5%) (20). This concept is vital because early discontinuation of antibiotics puts individuals at risk of infection recurrence and colonisation with antibiotic-resistant bacteria, which is associated with poor outcome (21).

More than half of the participants were aware that antibiotic resistance is a threat and can affect their family's health (68.9%) which is higher than findings among medical students in South America (45%) (22). However, studies conducted among medical students in Nepal and Brunei reported that 75.8% and 97% of the participants, respectively, were highly concerned about the issue of ABR that can affect their family's health (12,17). Such awareness is of great interest in curbing the increasing danger of irrational use of antibiotics.

A third of participants are either neutral or disagree with the statement 'I do not keep antibiotic stocks at home'; however, more participants (54.9%) opined that they do not share antibiotics with sick family members and friends. This report is higher than findings among people in rural areas in Johor, Malaysia, with 35.7% of the respondents keep the leftover antibiotics and share to their family members in an emergency (23). The public can ditch improper antibiotic use by discarding the excess of antibiotics after prescriptions duration and dose.

Regarding the impact of COVID-19 on antimicrobial resistance, 56.3% of the participants informed that the resistance issue might worsen during the pandemic, and around 60% demanded the same urgency as COVID-19 to control the antimicrobial resistance. The awareness of the participants regarding the COVID-19 complicates antimicrobial resistance was impeccable. It is worth emphasising that most participants (95%) understand the benefits of hand hygiene to protect patients from HAI. Almost all (98%) of participants acknowledged the importance of proper hand-washing techniques to break the infection transmission chain. Maintaining good hand hygiene to prevent SARS-CoV-2 transmission could reduce the risk of bacterial infection and limit the use of antibiotics.

This study has some limitations, including a small sample size that could lead to low accuracy and establishing a strong association with the independent factors. A study with a larger sample size by including students from other faculties within and outside the university may be better suited to detect organisation-level correlates.

CONCLUSION

This study showed that demographics and individual's KAP shapes antibiotic use and understanding of ABR. Nursing students trained in infection prevention should apply their knowledge during clinical posting by giving health education to the patients and family regarding the threat of antimicrobial resistance. Other than that, enthusiastic nurses can participate in continuous education training such as the IPC to increase their awareness and get updated information. This effort can enhance the betterment and quality of nursing services and promote good knowledge, practice, and attitude.

ACKNOWLEDGEMENTS

Special thanks to all participants that voluntarily participated in this study. The authors thank Dr. Muhammad Lokman Md. Isa and Dr. Nurasikin Mohamad Shariff, for a critical discussion of the manuscript.

CONFLICT OF INTEREST

The authors have not conflict of interest in this article.

REFERENCES

1. Knight GM, Glover RE, McQuaid CF, Olaru ID, Gallandat K, Leclerc QJ, et al. Antimicrobial resistance and covid-19: Intersections and implications. Vol. 10, eLife. eLife Sciences Publications Ltd; 2021. p. 1–27.
2. Pelfrene E, Botgros R, Cavaleri M. Antimicrobial multidrug resistance in the era of COVID-19: a forgotten plight? Antimicrob Resist Infect Control. 2021 Dec 1;10(1):21.
3. Rodríguez-Baño J, Rossolini GM, Schultsz C, Tacconelli E, Murthy S, Ohmagari N, et al. Key considerations on the potential impacts of the COVID-19 pandemic on antimicrobial resistance research and surveillance. Trans R Soc Trop Med Hyg. 2021 Mar 27;
4. Munita JM, Arias CA. Mechanisms of Antibiotic Resistance. Microbiol Spectr. 2016;4(2):1–37.
5. Majumder MAA, Rahman S, Cohall D, Bharatha A, Singh K, Haque M, et al. Antimicrobial stewardship: Fighting antimicrobial resistance and protecting global public health. Infect Drug Resist. 2020 Dec 29;13:4713–38.
6. Acharya KP, Wilson RT. Antimicrobial

Resistance in Nepal. Front Med. 2019 May 24;6:105.
7. Subramanya SH, Czyż DM, Acharya KP, Humphreys H. The potential impact of the COVID-19 pandemic on antimicrobial resistance and antibiotic stewardship. VirusDisease. 2021 May 25;1–8.
8. Arshad M, Mahmood SF, Khan M, Hasan R. Covid -19, misinformation, and antimicrobial resistance. Vol. 371, The BMJ. BMJ Publishing Group; 2020.
9. Nepal A, Hendrie D, Robinson S, Selvey LA. Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal. BMC Public Health. 2019 Nov 26;19(1):1–12.
10. Ashiru-Oredope D, Kerr F, Hughes S, Urch J, Lanzman M, Yau T, et al. Assessing the impact of covid-19 on antimicrobial stewardship activities/programs in the United Kingdom. Antibiotics. 2021 Feb 1;10(2):1–13.
11. Wang W, Wang X, Hu YJ, Wu D, Lu J, Xu Y, et al. The misconception of antibiotic equal to an anti-inflammatory drug promoting antibiotic misuse among chinese university students. Int J Environ Res Public Health. 2019 Feb 1;16(3).
12. Shahpawee NS, Chaw LL, Muharram SH, Goh HP, Hussain Z, Ming LC. University students' antibiotic use and knowledge of antimicrobial resistance: What are the common myths? Antibiotics. 2020 Jun 1;9(6):1–12.
13. Collignon P, Beggs JJ. CON: COVID-19 will not result in increased antimicrobial resistance prevalence. JAC-Antimicrobial Resist. 2020 Sep 1;2(3).
14. Lucien MAB, Canarie MF, Kilgore PE, Jean-Denis G, Fénélon N, Pierre M, et al. Antibiotics and antimicrobial resistance in the COVID-19 era: Perspective from resource-limited settings. Int J Infect Dis. 2021 Mar 1;104:250–4.
15. Marzan M, Islam DZ, Lugova H, Krishnapillai A, Haque M, Islam S. Knowledge, attitudes, and practices of antimicrobial uses and resistance among public university students in Bangladesh. Infect Drug Resist. 2021 Feb 11;14:519–33.
16. Aljayyousi GF, Abdel-Rahman ME, El-Heneidy A, Kurdi R, Faisal E. Public practices on antibiotic use: A cross-sectional study among Qatar University students and their family members. PLoS One. 2019;14(11).
17. Shah P, Shrestha R, Mao Z, Chen Y, Chen Y, Koju P, et al. Knowledge, attitude, and practice associated with antibiotic use among university students: A survey in Nepal. Int J Environ Res Public Health. 2019 Oct 2;16(20).
18. Gupta M, Vohra C, Raghav P. Assessment of knowledge, attitudes, and practices about antibiotic resistance among medical students in India. J Fam Med Prim Care. 2019;8(9):2864.
19. Scaioli G, Gualano MR, Gili R, Masucci S, Bert F, Siliquini R. Antibiotic Use: A cross-sectional survey assessing the knowledge, attitudes and practices amongst students of a school of medicine in Italy. Vol. 10, PLoS ONE. Public Library of Science; 2015. p. e0122476.
20. Jairoun A, Hassan N, Ali A, Jairoun O, Shahwan M. Knowledge, attitude and practice of antibiotic use among university students: A cross sectional study in UAE. BMC Public Health. 2019 May 6;19(1).
21. Cotton JL, Ali-Dinar T, Navas-Nazario A. Cavitary Pneumonia: A Complication of Antibiotic Noncompliance. Case Rep Pulmonol. 2020 Mar 16;2020:1–5.
22. Higuita-Gutiérrez LF, Roncancio Villamil GE, Jiménez Quiceno JN. Knowledge, attitude, and practice regarding antibiotic use and resistance among medical students in Colombia: a cross-sectional descriptive study. BMC Public Health. 2020 Dec 1;20(1):1–12.
23. Chow CQ, Nor Liana CY. Knowledge and attitude on antibiotic use among public in rural area Batu Pahat, Johor. Malaysian J Public Heal Med. 2020;20(1):220–8.