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Knowledge, Attitude, and Practice of Antibiotic Use and Resistance among Medical and Science Students of International Islamic University Malaysia

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ABSTRACT

Introduction: Antibiotic resistance is a significant public health concern affecting human and environmental health. Antibiotics in agriculture can contribute to developing antibiotic-resistant bacteria, which can spread to humans through contaminated food or water. Preparing our future healthcare workforce by educating current students on antibiotic resistance threats is crucial, and this can be achieved through well-informed medical and science students.
Objectives: This study aims to evaluate the knowledge, attitudes, and practices regarding antibiotic use and antibiotic resistance among medical and science students. These students are expected to have roles, either directly or indirectly, in working with antibiotics in healthcare and environmental contexts in the future.
Method: The study was conducted in a cross-sectional manner, and the study tool was developed after conducting an extensive literature search. A pilot study assessed the instrument's reliability, measuring data for internal consistency using Cronbach Alpha, which yielded a score of 0.827, indicating good reliability. Data in this study was analysed using SPSS version 26 with descriptive and inferential statistics.
Results: The study included 312 participants, with 154 (49.2%) from the Faculty of Medicine and 159 (50.8%) from the Faculty of Science. Most participants demonstrated sufficient understanding of antibiotics, faculty being factors that influenced their level of knowledge. Meanwhile, faculty affiliation and attendance in training and workshops were associated with their level of practice.
Conclusion: The study revealed that the students had a commendable comprehension of antibiotic resistance, with medical students exhibiting marginally higher levels of knowledge and practice than science students. Based on the findings, future research with an interventional approach is recommended to enhance science students' knowledge and practice concerning antibiotic use and resistance.

Keywords: Antibiotic use, Antibiotic resistance, Medical students, Science students, Malaysia

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INTRODUCTION

Antibiotics are a type of medication that can kill or inhibit the growth of bacteria, which are responsible for causing many kinds of infections, such as strep throat, urinary tract infections, and pneumonia. Antibiotic resistance happens when bacteria evolve with the ability to reduce antibiotic effectiveness and continue to grow, causing infections. The rise in bacterial infections such as carbapenem-resistant Enterobacteriaceae (CRE) and Methicillin-resistant *Staphylococcus aureus* (MRSA) have significantly prolonged hospitalisation and high mortality rates. In Malaysia, CRE cases showed that 95% of the patients have a history of antibiotic exposure, and 50.6% have had a history of antibiotic exposure for more than seven days during hospitalisation (1). In many clinical situations, a variety of infections may lead to overprescribing antibiotics to treat the diseases, eventually leading to increasing rates of antibiotic resistance. Overused antibiotics will result in prolonged hospitalisation, leading to long-term disability and an elevated mortality rate.

Antibiotic resistance is a serious public health issue that can have far-reaching consequences for human and environmental health (2). Furthermore, the impact of antibiotic use on the environment was also perceived in healthcare. For example, the overuse of antibiotics in agriculture can contribute to the development of antibiotic-resistant bacteria that can spread to humans through contaminated food or water (3). Well-informed students in medicine and science can play a crucial role in educating the general public about antibiotic resistance threats by communicating in clear and practical terms. Therefore, the primary aim of this study is to evaluate the knowledge, attitude, and practices concerning antibiotic use and antibiotic resistance among medical and science students at the International Islamic University Malaysia (IIUM). These individuals are expected to play roles, whether directly or indirectly, in working with antibiotics in healthcare and environmental fields.

METHODS

The study used a quantitative cross-sectional study involving 312 undergraduate medical and science students of IIUM. The convenience sampling method has been applied in this study, in which all participants are willing to participate in completing all sections of the questionnaire. The study utilised a closed-ended questionnaire, adapted from previous studies (4,5), sharing the same objectives as the current one. There are four sections in the questionnaire. Section one was regarding the sociodemographic background of participants. The questions relating to demographic characteristics are gender, faculty, year of study, family members and relatives with medical experience, and participation in specific training on antibiotic stewardship. Section two, with 21 questions, was about knowledge of antibiotic use and antibiotic resistance. Next, with ten questions, section three was about the attitude towards antibiotic use. Lastly, section four, with 12 questions on the practice towards antibiotic use.

Before collecting data, the authors received authorisation from the IIUM Research Committee for the ethical and research clearance for the study. Each participant has been provided with an information sheet about the objectives and confidentiality of this study before obtaining consent to participate in this research, and the data obtained from this study is solely for academic purposes. Furthermore, the participants can refuse participation and withdraw consent at any time.

RESULTS

A total of 312 undergraduate medical and science students participated in this study between April and June 2022 (Table I). Out of the 312 participants, 161 (51.8%) were male, while 151 (48.2%) were female. Among the participants, 154 (49.2%) were from the Faculty of Medicine, while 158 (50.8%) were from the Faculty of Science. In terms of the year of study, there were 74 (23.6%) participants in year one, 61 (19.5%) in year two, 55 (17.6%) in year three, 73 (23.6%) in year four, and 49 (15.7%) in year five. Regarding the question, "Do you have any family members or relatives with a healthcare background?", 187 participants (59.7%) answered "yes". In another query, "Have you ever participated in any training or workshop on antibiotics?", 115 participants (36.7%) responded affirm.

Table 1: Demographic Data of Participants (N=312)

Factors	Frequency (*f*)	Percentage (%)
Gender		
Male	161	51.8
Female	151	48.2
Faculty		
Medicine	154	49.2
Science	158	50.8
Have any family members/relatives with a medical background?		
Yes	187	59.7
No	125	40.3
Have you ever attended any training/workshop on antibiotics?		
Yes	115	36.7
No	197	63.3

Table 2 shows the aggregate score of the participants' knowledge, attitude, and practice related to antibiotic use and resistance. Among the medical and science students, a good percentage of 63.3% achieved a good score in the knowledge domain. On the other hand, 40.6% and 44.1% scored moderate in the attitude and practice domains, respectively.

Table 2: Total Score for Knowledge, Attitude, and Practice Domains Among Medical and Science Students of IIUM

Total domain score	Variable (Cut-off value)	Frequency (*f*)	Percentage (%)
Knowledge	Poor (1-12)	115	36.7
	Good (14-20)	197	63.3
Attitude	Poor (1-6)	185	59.4
	Good (7-10)	127	40.6
Practice	Poor (1-8)	174	55.9
	Good (12)	138	44.1

Table 3 shows the frequency and percentage distribution of knowledge regarding antibiotics and antibiotic resistance. The data indicates that all participants acknowledged the common use of antibiotics in treating bacterial infections. However, 28.1% of participants also agreed that antibiotics are commonly used to treat viral infections in humans. Furthermore, over 90% of participants could correctly identify the names of antibiotics in all valid statements in the

questionnaire. Nonetheless, it is noteworthy that only 11% of participants concurred with the statement that "Antibiotics safeguard both humans and animals".

Table 3: The Frequency and Percentage Distribution of Knowledge About Antibiotics and Antibiotic Resistance

Knowledge	**True (n)(%)**	**False (n) (%)**
Antibiotics are common drugs useful in treating bacterial infections.	312 (100)	0 (0)
Antibiotics are common drugs used to treat viral infections in humans.	88 (28.1)	224 (71.9)
Antibiotics should be obtainable without a prescription at pharmacies.	25 (8.0)	287 (92.0)
Antibiotics need to be used according to prescription.	310 (99.4)	2 (0.6)
Amoxicillin is an antibiotic.	292 (93.6)	20 (6.4)
Penicillin is an antibiotic.	296 (94.9)	16 (5.1)
Ibuprofen is antibiotic.	56 (18.2)	256 (81.8)
Aspirin is an antibiotic.	75(24.0)	237 (76.0)
Antibiotics do not cause any side effects.	288 (92.3)	24 (7.7)
Conditions that can be treated with antibiotics:		
Urinary tract infection	288 (92.3)	24 (7.7)
Skin/wound infection	287 (92.0)	25 (8.0)
Sore throat	164 (52.7)	148 (47.3)
Gonorrhoea	237 (76.0)	75 (24.0)
Diarrhoea	198 (63.6)	114 (36.4)
HIV/AIDS	235 (75.4)	77 (24.6)
Antibiotics safeguard both humans and animals.	34 (11)	278 (89)
Vaccination can prevent diseases.	283 (90.7)	29 (9.3)
Antibiotics misused lead to antibiotic resistance.	299 (95.8)	13 (4.2)
Many infections are becoming increasingly resistant to treatment by antibiotics.	301 (96.5)	11 (3.5)
If bacteria are resistant to antibiotics, treating the cause of infections can be complicated.	306 (98.1)	6 (1.9)

Table 4 shows the frequency and percentage distribution of attitudes towards antibiotic use. The results reveal that over 80% of the participants either strongly agree or agree with the valid statements regarding the use of antibiotics.

Table 4*:* The Frequency and Percentage Distribution of the Attitude Toward Antibiotic Use Among the Participants

Attitude	**Strongly Disagree** *f* **(%)**	**Disagree** *f* **(%)**	**Neutral** *f* **(%)**	**Agree** *f* **(%)**	**Strongly Agree** *f* **(%)**
It is necessary to get more information on antibiotics.	0 (0)	0 (0)	0 (0)	54 (17.3)	258 (82.7)
Antibiotic effectiveness is reduced if a full course of antibiotics is not completed.	0 (0)	1 (0.3)	6 (1.9)	56 (17.9)	249 (79.9)
Antibiotic resistance affects you and your family's health.	2 (0.6)	6 (1.9)	0 (0)	89 (28.4)	202 (64.9)
You must take the full course of antibiotics even if your health has improved.	0 (0)	6 (1.9)	7 (2.2)	72 (23.0)	227 (72.8)
Antibiotics are commonly used to treat any disease or infection.	6 (1.9)	23 (7.3)	26 (8.3)	138 (44.4)	119 (38.0)
Poor adherence to hand hygiene practices can cause the spread of antimicrobial resistance among patients.	4 (1.3)	20 (6.4)	32 (10.2)	108 (34.8)	148 (47.3)
Skipping one or two doses could contribute to developing antibiotic resistance.	4 (1.3)	17 (5.4)	40 (12.8)	115 (37.1)	136 (43.5)
It is unacceptable to utilise antibiotics prescribed for a friend or family member, even if the medication was previously used to address the same illness.	5 (1.6)	7 (2.2)	19 (6.1)	84 (26.8)	197 (63.3)
Overprescribing broad-spectrum antimicrobials increases antimicrobial resistance.	1 (0.3)	6 (1.9)	29 (9.3)	103 (32.9)	173 (55.6)
Taking care of my health is my duty, and it is the top priority in my life.	0 (0)	0 (0)	2 (0.6)	19 (6.1)	291 (93.3)

The frequency and percentage distribution of practice regarding antibiotic use are presented in **Table 5**. Most participants (87.8%) either strongly agree or agree that they do not take antibiotics without a prescription, 79.9% strongly agree that antibiotic effectiveness is reduced if a full course of antibiotics is not completed, and 79.6% strongly agree to use the prescribed antibiotic wisely.

Table 5: The Frequencies and Percentages of Practice Levels on Antibiotic Use Among the Participants

Practice	Strongly Disagree *f* (%)	Disagree *f* (%)	Neutral *f* (%)	Agree *f* (%)	Strongly Agree *f* (%)
I do not take antibiotics without a prescription.	8 (2.6)	10 (3.2)	20 (6.4)	68 (21.7)	206 (66.1)
I still complete the full course of antibiotics even when I feel better after two or three doses of antibiotics.	4 (1.3)	26 (8.3)	18 (5.8)	62 (19.8)	202 (64.9)
I usually do not share antibiotics with sick family members and friends.	0 (0)	22 (7.0)	40 (12.8)	72 (23.0)	178 (57.2)
I am not using leftover antibiotics for the same illness.	6 (1.9)	12 (3.8)	30 (9.6)	76 (24.3)	188 (60.4)
I take antibiotics only when getting a prescription from a doctor.	4 (1.3)	0 (0)	12 (3.8)	76 (24.3)	220 (70.6)
I usually check the expiry date of the antibiotics before taking it.	0 (0)	10 (3.2)	20 (6.4)	76 (24.3)	206 (66.1)
I do not keep antibiotic stocks at home.	4 (1.3)	40 (12.8)	38 (12.1)	62 (19.8)	168 (54.0)
When I visit a clinic, I do not expect the doctor to prescribe me antibiotics every time I get sick.	8 (2.6)	24 (7.7)	38 (12.1)	94 (30.0)	148 (47.6)
I cannot continue my previous prescription antibiotics when I get sick again.	4 (1.3)	10 (3.2)	50 (16.0)	86 (27.5)	162 (52.1)
I will not get the antibiotics over the counter (OTC).	4 (1.3)	24 (7.7)	50 (16.0)	74 (23.6)	160 (51.4)
I cannot buy antibiotics that are being sold online.	2 (0.6)	6 (1.9)	12 (3.8)	54 (17.3)	238 (76.4)
I am responsible for using the prescribed antibiotics wisely.	0 (0)	0 (0)	2 (0.6)	62 (19.8)	248 (79.6)

The frequency and percentage distribution of practice regarding antibiotic use are presented in **Table 5**. Most participants (87.8%) either strongly agree or agree that they do not take antibiotics without a prescription, 79.9% strongly agree that antibiotic effectiveness is reduced if a full course of antibiotics is not completed, and 79.6% strongly agree to use the prescribed antibiotic wisely.

The Association Between the Demographic Characteristics and Level of Knowledge on Antibiotics among Medical and Science Students at IIUM.

Table 6 indicates that the level of knowledge among medical students (37.7%) was statistically significantly higher than that among science students (25.6%), with a corresponding p-value of 0.001. For other demographic characteristics, there was no significant difference.

Table 6 : The Association Between Demographic Characteristics and Level of Knowledge on Antibiotics Among Medical and Science Students at IIUM

Demographic characteristics	**Knowledge level**			*p*-value (Chi-square test)
	Poor *f* **(%)**	**Good** *f* **(%)**	**n**	
Gender				
Male	60 (19.2)	101 (32.6)	161	0.910
Female	55 (17.6)	96 (30.7)	151	
Faculty				
Medicine	36 (11.5)	122 (37.7)	158	**0.001***
Science	75 (25.2)	79 (25.6)	154	
Have any family members/relatives with healthcare background?				
Yes	67 (21.4)	118 (38.3)	185	0.683
No	48 (15.3)	78 (24.9)	126	
Have you ever attended any specific training on antibiotic resistance?				
Yes	35 (11.2)	80 (25.6)	115	0.078
No	80 (25.6)	116 (37.7)	196	

*The Chi-square test was used for the analysis, and significance levels were marked as * for p<0.01, signifying the extent of statistical significance.*

The Association Between the Demographic Characteristics and Level of Attitude on Antibiotic Use among Medical and Science Students at IIUM.

Table 7 showed the level of attitude was statistically significantly lower for medical students (15.7%) than for science students (24.9%), which was the p-value= 0.002. For other demographic characteristics, there was no significant difference.

Table 7: The Association Between Demographic Characteristics and Level of Attitude Toward Antibiotic Use Among Medical and Science Students at IIUM

Demographic characteristics	**Attitude level**			***p*-value (Chi-square test)**
	Moderate *f* **(%)**	**Good** *f* **(%)**	**n**	
Gender				
Male	89 (31.0)	73 (23.3)	162	0.094
Female	95 (28.4)	54 (17.3)	150	
Faculty				
Medicine	104 (33.5)	49 (15.7)	153	**0.002***
Science	81 (25.9)	78 (24.9)	159	
Have any family members/relatives with the medical background?				
Yes	114 (36.7)	72 (23.0)	186	0.363
No	71 (22.7)	55 (17.6)	126	
Have you ever attended any training/workshops on antibiotics?				
Yes	66 (21.1)	49 (15.7)	115	0.577
No	119 (38.3)	78 (24.9)	197	

*The Chi-square test was used for the analysis, and significance levels were marked as * for p<0.01, signifying the extent of statistical significance.*

The Association Between the Demographic Characteristics and Level of Practice on Antibiotic Use among Medical and Science Students at IIUM.

Table 8 depicts that the level of practice was notably higher among medical students (26.5%) compared to science students (17.6%), with a p-value of 0.001, indicating statistical significance. Moreover, participants who attended antibiotic training (18.8%) exhibited good practice, significantly lower than those who hadn't participated in specific antibiotic training (25.2%), with a p-value of 0.05, signifying a statistically significant difference. For other demographic characteristics, there was no significant difference.

Table 8: The Demographic Characteristics and Level of Practice on Antibiotic Use Among Medical and Science Students at IIUM

Demographic characteristics	Practice level			p-value (Chi-square test)
	Moderate *f* (%)	Good *f* (%)	n	
Gender				
Male	98 (31.6)	63 (20.1)	161	0.055
Female	76 (24.3)	75 (24.0)	151	
Faculty				
Medicine	71 (22.7)	83 (26.5)	154	**0.001****
Science	103 (33.2)	55 (17.6)	158	
Have any family members/relatives with a healthcare background?				
Yes	98 (31.6)	88 (28.1)	186	0.197
No	76 (24.3)	50 (16.0)	126	
Have you ever attended any training/ workshop on antibiotics?				
Yes	56 (17.9)	59 (18.8)	115	**0.05***
No	118 (38.0)	79 (25.2)	197	

The test was conducted using the Chi-square test, with significance levels denoted as * for p<0.05 and ** for p<0.01, indicating varying degrees of statistical significance.

DISCUSSION

In this study, all participants agreed that antibiotics are exclusive to killing bacteria and cannot be used to treat viral infections. Similar studies also found that the participants mostly acknowledge that antibiotics are used to treat bacterial infections and are ineffective towards viral infections (5). It is important to note that antibiotics are ineffective against viral infections, such as the common cold or flu. The proper use of antibiotics is essential to avoid the development of antibiotic-resistant bacteria, which can be more challenging to treat and can spread to other people (5). Antibiotics should be used as prescribed by a healthcare professional and only for bacterial infections, not viral infections, or other conditions for which they are ineffective.

Most of the students in this study agreed that antibiotics could only be obtained from pharmacies with a prescription from a doctor. Regarding antibiotic side effects, 92.3% of the participants were unaware of antibiotics' side effects, such as disrupting the patient's normal microflora. A study in southern India revealed that only a small group of students realised that antibiotics could cause secondary infections by killing good gut bacteria (6). Other studies reported that around 10% to 15% of the participants could not differentiate between antibiotics and other medications such as aspirin and paracetamol, anti-inflammatory, antipyretic and analgesic drugs (6,7). However, the current study discovered that most participants could distinguish common antibiotics like penicillin and amoxicillin from

other types of medications. Educational initiatives or campaigns aimed at increasing public awareness of antibiotics may have occurred since the previous studies were conducted. This suggests a heightened level of knowledge and understanding among participants regarding antibiotics, in contrast to the findings of earlier studies.

Most participants in the study concurred that conditions such as urinary tract infections, skin and wound infections, sore throats, gonorrhoea, and diarrhoea can be effectively treated with antibiotics. This collective agreement reflects their grasp of bacterial infections and the appropriate use of antibiotics. Furthermore, they expressed disagreement regarding antibiotics for treating HIV/AIDS, demonstrating a clear comprehension of the differentiation between viral and bacterial infections. These findings align with a prior report, highlighting that most medical students in Nigeria (96.7%) knew the potential for ineffective treatment due to the indiscriminate and imprudent use of antimicrobials (9). This understanding highlights the significance of using antibiotics responsibly. Additionally, the participants demonstrated an understanding of the challenges posed by antibiotic resistance. They acknowledged that if bacteria develop antibiotic resistance, it can complicate the treatment of infections, emphasising the need for prudent antibiotic stewardship. Notably, only a small proportion (11%) of the participants believed that antibiotics effectively protect both humans and animals. The study participants may not have been mainly focused on the roles of antibiotics in animal health. However, this finding indicates a potential need for education and awareness campaigns regarding the roles of antibiotics in both human and veterinary medicine. Antibiotics can protect both humans and animals by effectively treating bacterial infections that can cause serious harm if left untreated (9). This can be particularly important in situations where people or animals are at risk of developing severe complications from an infection.

The participant's course of study showed a significant difference in the participants' knowledge (p-value is less than 0.05). In contrast, other factors showed no significant association with the knowledge of antibiotics. Similarly, the student's course of study reflects significantly towards attitude levels in the usage of antibiotics. A survey reported that medical students scored substantially higher than science students in their attitude toward antibiotic use (10). However, in the current study, science students have a better attitude than medical students, consistent with the previous research in China (11). Science students may receive more extensive education on microbiology and the mechanisms of antibiotic resistance, which may lead to a better understanding of the importance of responsible antibiotic use. In recent years, numerous awareness campaigns have been dedicated to promoting responsible antibiotic use across various domains, extending beyond healthcare to encompass areas such as agriculture and wastewater treatment. Science students are frequently exposed to these messages through their academic coursework, research initiatives, and active engagement in scientific conferences. This increased exposure enhances their understanding of ensuring the responsible use of antibiotics, not only for individual patient well-being but also for the broader global health landscape.

The present study revealed a statistically significant correlation between faculty affiliation and participants' antibiotic use practices. Specifically, the findings demonstrated that 83 out of 312 participants (26.5%), primarily medical students, exhibited a commendable level of practice in antibiotic use. This can be attributed to the rigorous training that medical students undergo, which includes antibiotic prescription protocols and the importance of responsible antibiotic use. Furthermore, research conducted in Malaysia supports this observation by indicating that medical students surpass science students in terms of their knowledge and proficiency in the responsible use and management of antibiotics (12). Thus, the response to the practice of antibiotics was much better among medical students. Moreover, the Infection Prevention and Control course and Continuous Medical Education seminars in medical faculty have increased awareness of the correct use of antibiotics (13), thereby facilitating the implementation of antibiotic stewardship and guidelines in healthcare.

This study showed that medical students at the IIUM are more knowledgeable about antibiotics than science students. These outcomes suggested that education and awareness are crucial strategies for educating

about antibiotic resistance. Courses within the Faculty of Science, such as biotechnology, marine science, and plant science, should incorporate discussions on strategies to mitigate antimicrobial resistance in agriculture and the environment. These discussions should emphasise the interconnectedness of antimicrobial resistance with human and animal health. Continual education and awareness efforts should be widely disseminated to highlight that the threat of antibiotic resistance extends beyond healthcare alone. It is important to use antibiotics responsibly and to develop new strategies for preventing and treating infections to help minimise the impact of antibiotic resistance in healthcare and on our environment.

CONCLUSION

In conclusion, medical students have good knowledge and practice but could improve their attitude towards antibiotic use; meanwhile, science students have a good attitude but still lack knowledge and practice. Therefore, the study on knowledge, attitude, and practice can help to affirm that antibiotic and antimicrobial education influences the behavior and compliance of the participants towards reducing the spread of antibiotic resistance.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding this study.

AUTHOR CONTRIBUTION

MHJ: involved in drafting the manuscript, data collection, analysed the data, support with literature content and finalising and editing the manuscript.
ASS: involved in editing the manuscript, support with literature content.
HNMM: involved in drafting the manuscript, data collection, analysed the data, support with literature content

REFERENCES

1. Ministry of Health Malaysia. Malaysian Action Plan on Antimicrobial Resistance (MyAP-AMR) 2017-2021 [Internet]. Ministry of Health, Malaysia and Ministry of Agriculture & Agro-Based Industry Malaysia. 2021 [cited 2023 Apr 2]. Available from: https://www.moh.gov.my/moh/resources/Penerbitan/Garis Panduan/Garis panduan Umum (Awam)/National_Action_Plan_-_FINAL_29_june.pdf

2. Larsson DGJ, Flach CF. Antibiotic resistance in the environment. Nat Rev Microbiol. 2022 May 1;20(5):257–69.

3. Aslam B, Khurshid M, Arshad MI, Muzammil S, Rasool M, Yasmeen N, et al. Antibiotic Resistance: One Health One World Outlook. Front Cell Infect Microbiol. 2021 Nov 25;11:1153.

4. Shatla M, Althobaiti FS, Almqaiti A. Public Knowledge, Attitudes, and Practices Towards Antibiotic Use and Antimicrobial Resistance in the Western Region of Saudi Arabia. Cureus. 2022 Nov 24;14(11).

5. Chinemerem-Nwobodo D, Ugwu MC, Oliseloke Anie C, Al-Ouqaili MTS, Chinedu Ikem J, Victor Chigozie U, et al. Antibiotic resistance: The challenges and some emerging strategies for tackling a global menace. J Clin Lab Anal. 2022 Sep 1;36(9):e24655.

6. Jayabalan N, Selvaraj N, Ganesan S, Rajamohammad MA, Anandan I. A questionnaire based survey on knowledge, attitude and behaviour of antibiotic usage and resistance among undergraduates in South Indian teaching hospital. Int J Basic Clin Pharmacol. 2018 Sep 24;7(10):1991–7.

7. 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. PLoS One. 2015 Apr 1;10(4).

8. 8. Okedo-Alex I, Madubueze UC, Umeokonkwo CD, Oka OU, Adeke AS, Okeke KC. Knowledge of antibiotic use and resistance among students of a medical school in Nigeria. Malawi Med J. 2019 Jun 1;31(2):133.

9. 9. Nayiga S, Kayendeke M, Nabirye C, Willis LD, Chandler CIR, Staedke SG. Use of antibiotics to treat humans and animals in Uganda: a cross-sectional survey of households and farmers in rural, urban and peri-urban settings. JAC-Antimicrobial Resist. 2020 Oct 16;2(4).

10. Ganesh M, Sridevi S, Christina-Mary P. Antibiotic use Among Medical and Para Medical Students: Knowledge, Attitude and its Practice in a Tertiary Health Care Centre in Chennai- a Scientific Insight. Int J Sci Res. 2014 Jun 1;3(7):332–5.

11. Huang Y, Gu J, Zhang M, Ren Z, Yang W, Chen Y, et al. Knowledge, attitude and practice of antibiotics: A questionnaire study among 2500 Chinese students. BMC Med Educ. 2013 Dec 9;13(1):1–9.

12. Haque M, Rahman NAA, McKimm J, Binti Abdullah SL, Islam MZ, Zulkifli Z, et al. A cross-sectional study evaluating the knowledge and beliefs about, and the use of antibiotics amongst Malaysian university students. Expert Rev Anti Infect Ther. 2019 Apr 3;17(4):275–84.

13. Schrier L, Hadjipanayis A, del Torso S, Stiris T, Emonts M, Dornbusch HJ. European Antibiotic Awareness Day 2017: training the next generation of health care professionals in antibiotic stewardship. Eur J Pediatr. 2018 Feb 1;177(2):279–83.