Original Article

Understanding the use of Antibiotics and Antibiotic Resistance among Science Stream and Non-Science Stream Undergraduate Students in a Malaysian University

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ABSTRACT

OBJECTIVE: To assess the knowledge and attitude of science and non-science students in a tertiary institution in Malaysia towards antibiotics and antibiotic resistance.

METHODOLOGY: A cross-sectional study was conducted from January to March 2020 among Science and non-science undergraduates. A random sample of 284 students from Biotechnology, Engineering, Business, and Mass Communication courses, were recruited into the study. An arbitrary scoring system was implemented for the assessment of the knowledge and attitude level of students based on the answer provided. The data was analyzed using Statistical Package for the Social Science (SPSS) version 26.0

RESULTS: In this study, science students have significantly higher knowledge (52.8%, n=75) and attitude level (76.1%, n=108) than non-science students (32.4%, n=46) and (61.3%, n=87) respectively. Although 78% of the students, in general, acknowledged that antibiotics needed to be completed in time, there was still a lack of knowledge regarding ABR among the non-science students.

CONCLUSION: An individual's knowledge of antibiotic use is significant because personal decisions are made based on their knowledge and attitude. A higher knowledge level indicates a more positive attitude on antibiotic use and ABR. Hence, subsequent antibiotic awareness campaigns should be restructured to involve more non-science students to enhance their knowledge and correct the misconceptions of current students.

KEY WORDS: Antibiotics, antibiotic resistance, Science and non-Science students, Malaysia

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INTRODUCTION

Antibiotic Resistance (ABR) is a natural phenomenon defined by the process of bacterial adaptation in the presence of antibiotics. The persistence of antibiotics in the environment puts selective pressure that kills or inhibits susceptible bacteria, allowing resistant bacteria to thrive[1]. Furthermore, antibiotics are rendered ineffective with the increasing prevalence of antibiotic-resistant bacteria such as Methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant enterococci (VRE). ABR has been highlighted as one of the major public health threats in the 21st century by the World Health Organization[2].

ABR is a multifactorial problem that encompasses human health, animal health, and the environment sector. Therefore, a unified approach and inter-sectoral collaboration intervention are needed. One of the major factors leading to ABR is the irrational use of antibiotics over the years which includes inappropriate drugs selection, inadequate dosing, and non-adherence to National Antimicrobial Guidelines[3,4]. If ABR spreads unchecked, many infectious diseases due to resistant bacteria will become untreatable leading to higher morbidity and mortality[5]. Given the escalating incidence of antimicrobial resistance globally, the World Health Assembly endorsed an action plan in 2015 to address this issue with five action plans including raising better awareness and understanding of antimicrobial resistance[6]. Following this initiative, one of the strategies under the action plan in Malaysia has been to implement the Antibiotic Stewardship Program[7].

Antibiotic resistance awareness surveys in Malaysia are mostly limited to pharmacy students or the general public in certain states in Malaysia. Thus, this study aimed to explore the current knowledge and attitudes of science and non-science undergraduates towards antibiotic use and antibiotic resistance in a tertiary

institute in Malaysia. In addition, results of a similar study by King LC 2019[8] in the same institute served as data for comparison with the current knowledge and attitudes of students in 2020 after being exposed to three consecutive antibiotic-resistant awareness campaigns to determine the effectiveness of these campaigns in raising awareness among undergraduate students.

METHODOLOGY

Study design

The total estimated student population enrolled in the tertiary institution was 5000. The required sample size was calculated using the Raosoft sample size calculator providing a confidence level of 95% with a margin of error of 5%, which indicated the need to approach at least 357 students[9]. The undergraduate students were categorized as science (Biotechnology and Engineering), and non-science students (Accounting and Business). The researchers assured that confidentiality would be maintained following strict ethical principles. An introduction explaining the intention and background of the survey was included and students were encouraged to participate voluntarily. The completed survey which was returned indicated consent on the part of the participants.

Ethical approval was obtained from the INTI IU Ethics Committee (INTI/UEC/2018/001) prior to the commencement of this survey.

Survey tool development

A cross-sectional survey was carried out in a tertiary institution in Malaysia. A 23-point questionnaire was developed based on previous perception studies of Jamshed SK et al.[10] and Oh AL 2011[11]. The questionnaire consisted of 5 categories on the following: (A) socio-demographics of the student participants including age, gender, degree enrolled in and any previous exposure to antibiotic resistance awareness campaigns (4 questions), (B) understanding antibiotics and antibiotic resistance (10 questions), (C) Understanding antibiotics and antibiotic-resistance (2 questions), (D) Understanding roles and ways to minimize antibiotic resistance (4 questions), (E) attitudes towards the use of antibiotics (7 questions).

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 26.0 was used to analyze the collected data in the survey. The level of significance applied was 5% and 95% for the confidence level. The demographic characteristics such as gender, age, nationality, program, total knowledge, and attitude score of participants were presented as percentages. The Chi-Square test was used to assess the influence of socio-demographic characteristics and campaign exposure factors on their knowledge and attitude level towards antibiotic resistance. The Spearman's rank-order correlation coefficient, r_s was used to describe the strength and direction of the association between ranked values for knowledge score and attitude score[11].

RESULTS

Demographic characteristics

The completed survey forms returned totalled 284 out of the 357 surveys that were initially distributed, resulting in an effective response rate of 78.5%. As shown in **Table I**, there were an equal number of science (50.0%, n= 142) and non-science participants (50.0%, n= 142). The participants comprised a higher number of female participants (52.1%, n= 148) compared to the male participants (47.9%, n= 136). Of the 284 participants, most participants (68.3%, n= 194) were aged between 18 and 22 years with a mean age of 21.94. The majority of the participants (81.3%, n= 231) were Malaysian students and the remaining participants (18.7%, n= 53) were international students from countries including Pakistan, Brunei, and China.

TABLE I: SUMMARY OF DEMOGRAPHIC CHARACTERISTICS OF SURVEY PARTICIPANTS

Characteristics	Number (n= 284)	Percentage (%)
Gender		
Male	136	47.9
Female	148	52.1
Age		
18-22	194	68.3
23-26	85	29.9
25-30	3	1.1
>30	2	0.7
Nationality		
Malaysian	231	81.3
International	53	18.7
Antibiotic Awareness Campaign		
Attended Before	61	21.5
Never Attended	223	78.5
Program		
(a) Science	142	50.0
(b) Non-science	142	50.0
Total	**284**	

Knowledge level on antibiotic usage

According to **Table II**, the most correctly answered knowledge-based question (80.6%, n= 229) was the acknowledgment of proper use of antibiotics according to instructions on the label and that they needed to complete the prescribed antibiotic course to help in limiting the spread of antibiotic resistance regardless of program of study. Of the respondents, 83.8% (n= 119) were science students and the other half (77.5%, n= 110) were non-science students. Encouragingly, 71.1% of the non-science students also provided the

TABLE II: ASSOCIATION OF S AND NS UNDERGRADUATES WITH KNOWLEDGE-BASED QUESTIONS

Questions	Correct Answer		Incorrect Answer		P value (χ2 test)
	Science	Non-science	Science	Non-science	
Antibiotics are medicines that you need to complete within a specific period of time	121 (85.2%)	101 (71.1%)	21 (14.8%)	41 (28.9%)	0.004
Is an antibiotic designed to kill bacteria?	103 (72.5%)	81 (57.0%)	39 (27.5%)	61 (43.0%)	0.006
Can viral infections be treated with antibiotics?	89 (62.7%)	40 (28.2%)	53 (37.3%)	102 (71.8%)	< 0.001
Can common cold or flu be treated with antibiotics?	54 (38.0%)	23 (16.2%)	88 (62.0%)	119 (83.8%)	< 0.001
Have you ever heard of antibiotic resistant bacteria or superbugs?	79 (55.6%)	51 (35.9%)	63 (44.4%)	91 (64.1%)	0.001
Do you think that is a relationship between the incorrect/ indiscrete use of antibiotics and the high occurrence of antibiotic resistant bacteria.	88 (62.0%)	54 (38.0%)	54 (38.0%)	88 (62.0%)	< 0.001
Antibiotic resistance has been called as one of the world's most pressing public health problems.	73 (51.4%)	55 (38.7%)	69 (48.6%)	87 (61.3%)	0.032
Do you know that the effectiveness of the treatment reduces when antibiotics is not completed according to the instruction?	111 (78.2%)	88 (62.0%)	31 (21.8%)	54 (38.0%)	0.003
Does the ministry of health (any country) play the ultimate role in controlling the spread of antibiotic resistant bacteria?	68 (47.9%)	81 (57.0%)	74 (52.1%)	61 (43.0%)	0.122
Do you know you have a role in limiting the spread of antibiotic resistant bacteria?	92 (64.8%)	67 (47.2%)	50 (35.2%)	75 (52.8%)	0.003
Proper use of antibiotics (taking antibiotics according to instruction on the label and finishing the course as Prescribed) help in limiting the spread of antibiotic resistance.	119 (83.8%)	110 (77.5%)	23 (16.2%)	32 (22.5%)	0.177

S- Science undergraduates; NS – Non-science undergraduates

correct definition of antibiotics. A total of 184 (64.8%) students agreed that antibiotic was designed to kill bacteria. Most of the science students (62.7%) realized the fact that viral infections cannot be treated by using antibiotics compared to only around a quarter (28.2%) of non-science students. Based on the survey, it was found out that more than half (64.1%) of the non-science students had never heard of antibiotic -resistant bacteria or superbugs while more science students (55.6%, n= 79) were familiar with these terms.

Around 62% (n= 88) of non-science students wrongly claimed that there is no relationship between the incorrect or indiscrete use of antibiotics and the high occurrence of antibiotic-resistant bacteria. On the contrary, more than half of the science students (62.0%, n= 88) correctly correlated the relationship between them. Furthermore, 128 (45.1%) of the students stated that antibiotic resistance has been called one of the world's most pressing public health problems while the remaining students, almost half of them disagreed with the statement. Almost 50% (n= 68) of the science students agreed that the Ministry of Health plays an important role in controlling the spread of antibiotic-resistant bacteria and even more non-science students (57.0%, n= 81) agreed to that statement. The majority of science students (64.8%, n= 92) and about half the non-science students (52.8%, n= 75) realized that they could make an impact in limiting the spread of antibiotic resistance.

Attitude level

Table III summarizes the attitude of the science and non-science students towards antibiotics and ABR. In this study, it was found that there were still several students (41.2%, n= 117) who had the misconception of taking antibiotics when they get common cold of which, 69 were non-science students. 37.0% of the students had the misunderstanding that they should discontinue taking antibiotics if the symptoms of illness had improved. A high percentage of students, both in science (82.4%, n= 117) and non-science (76.1%, n= 108), said in the survey that they would follow instructions and complete the course of oral antibiotics. A similar percentage of science (78.2%, n= 111) and non-science students (79.6%, n= 113) stated that they would not purchase antibiotics without a medical prescription or without visiting the doctor first. Furthermore, it was encouraging to find that more than half of the students (82.2%, n= 231) stated that they would not pass their leftover antibiotics prescribed for them to their friends who suffered from similar symptoms.

TABLE III: ASSOCIATION OF PROGRAM STUDY WITH ATTITUDE-BASED QUESTIONS

Questions	Correct Answer		Incorrect Answer		P value (χ2 test)
	Science	Non-science	Science	Non-science	
I will take antibiotics when I get common cold (runny or stuffy nose, sneezing, cough, fever, mild fatigue).	94 (66.2%)	73 (51.4%)	48 (33.8%)	69 (48.6%)	0.011
I insist antibiotics to be prescribed by the doctor when I have a common cold.	89 (62.7%)	89 (62.7%)	53 (37.3%)	53 (37.3%)	1.000
I will stop taking the prescribed antibiotics when the symptoms of an illness have improved.	109 (76.8%)	70 (49.3%)	33 (23.2%)	72 (50.7%)	<0.001
I will complete the course of oral antibiotics as indicated in the instruction (on the label).	117 (82.4%)	108 (76.1%)	25 (17.6%)	34 (23.9%)	0.188
I can purchase antibiotics without a medical prescription (without visiting the doctor).	111 (78.2%)	113 (79.6%)	31 (21.8%)	29 (20.4%)	0.771
I give the leftover antibiotics prescribed for me to my friends when they are ill with the same symptoms e.g. like a common cold.	119 (83.8%)	112 (78.9%)	23 (16.2%)	30 (21.1%)	0.286
I will use the same, leftover antibiotics of mine to treat other illnesses without medical consultation.	123 (87.3%)	115 (81.0%)	19 (12.7%)	27 (19.0%)	0.198

Association of Antibiotic Resistance Awareness campaign with knowledge and attitude-based questions

Based on **Figures I and II**, it was noted that there were higher average knowledge and attitude scores obtained by students if they attended any of the Antibiotic Resistance Awareness Campaigns held in the institution. Science students who attended these campaigns generally had an average score of 11.1, roughly two times higher in score than science students who never attended the campaign (5.6).

Figure I: Average knowledge score obtained by students who attended Antibiotic Resistance Awareness Campaign and who never attended. A higher average knowledge score in science and non-science students attended Antibiotic Awareness Campaign than those did not attend the campaign.

FIGURE I: AVERAGE KNOWLEDGE SCORE

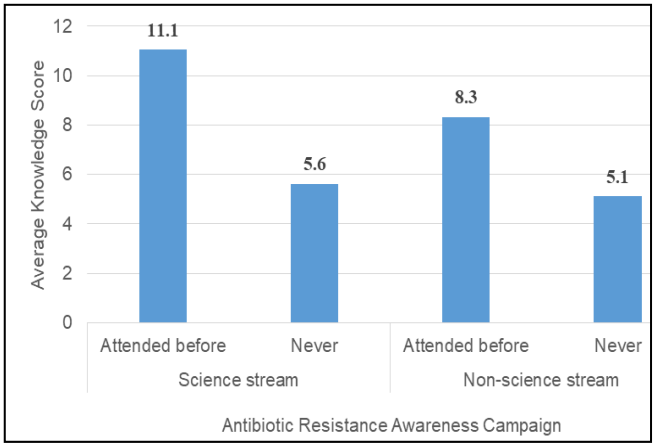
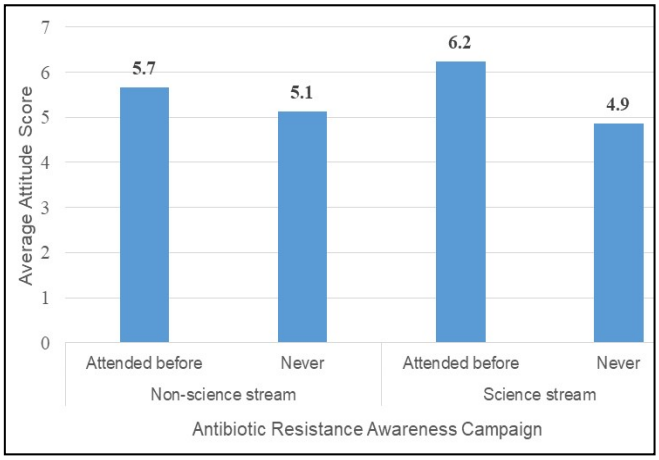


Figure II: Average attitude score obtained by students who attended Antibiotic Resistance Awareness Campaign and who never attended. A higher average attitude score in science and non-science students attended Antibiotic Awareness Campaign than those did not attend the campaign.

FIGURE II: AVERAGE ATTITUDE SCORE



Participants' knowledge and attitude towards antibiotics and antibiotic resistance presented a strong correlation of r_s = 0.828 when Spearman's rank-order correlation analysis was performed at a 5% significance level. The difference in scores between Science and non-Science undergraduates was statistically significant (p-values were < 0.05), where the average scores were higher in the Science students compared to the non-Science students (**Table IV**).

TABLE IV: ASSOCIATION OF PROGRAM STUDY WITH LEVEL OF ATTITUDE

Programme	Level of Attitude			P value (χ2 test)
	Poor (0-2)	Average (3-4)	Good (5-7)	
Science	16 (11.2%)	18 (12.7%)	108 (76.1%)	< 0.001
Non-science	27 (19.0%)	28 (19.7%)	87 (61.3%)	
Total	43 (15.1%)	46 (16.2 %)	195 (68.7%)	

DISCUSSION

ABR remains a global threat to public health and increased knowledge and understanding among university students regarding this issue could have a positive impact on ABR. This study illustrates the knowledge and attitudes of science and non-science students in a tertiary institution in Malaysia. In general, the science students had better knowledge and understanding of antibiotic use and ABR compared to non-science students. A similar finding was reported in a study by Sakr S 2020[12] who noted that students in health-related majors were more knowledgeable about antibiotics and ABR compared to those who were in other fields of study. It was encouraging to note that most of the participants in this study had a good attitude towards the use of antibiotics regardless of their program of study as a high proportion of participants knew the importance of completing the full course of antibiotics acknowledging that the effectiveness of treatment reduces when the antibiotic regime is not completed. Furthermore, more than three-quarters of the participants claimed that they would complete the antibiotics as indicated in the instructions. However, half of the non-science students stated that they would stop taking the prescribed antibiotics when the symptoms of an illness had improved. This finding was concurrent to a study conducted in the United Arab Emirates in which about 44.5% of university students indicated that they stopped taking antibiotics once symptoms improved Jairoun A 2019[13]. This poor adherence to the full antibiotic course could potentially contribute to the rising threat of ABR.

There have been other surveys conducted with medical and pharmacy students who generally had better knowledge of antibiotic use and ABR[13-16]. This could be due to the inclusion of information regarding ABR and antibiotics in the curriculum. A study in China, however, recently reported that although medical students were aware of antibiotics and ABR, they also noted that there were incidences of antibiotic self-medication for and stocking of antibiotics among these students which is a worrying factor Hu Y et al.[17]. This was also seen in medical students in another university in Pakistan and Malaysia who were self-medicating with antibiotics[16,18]. A study by Topor G 2017[19] attributed self-medication of antibiotics with inadequate awareness about ABR along with inappropriate practices, attitudes, and knowledge about antibiotic use. However, this issue could also be a direct repercussion of the availability of "over-the-counter" antibiotics in pharmacies despite the strict legislation in various countries against such practices[20].

It was encouraging to note that a majority of the participants seemed to know that antibiotics were effective against bacteria. Similar results were observed in studies conducted in the United Arab Emirates (UAE) and Gujarat[13,21]. It was important to note that there was a huge gap between the science and non-science students in determining the use of antibiotics to treat viral infections with more than half of the science students recognizing antibiotics' ineffectiveness in treating viral infections whereas most of the non-science students believed that the common cold or flu could be treated with antibiotics which coincided with the findings by Hayat K 2021[16]. One possible reason that contributed to this inadequacy of knowledge could be due to the frequent usage of the term 'germ' when giving medical advice to patients without using proper microbiological terms such as 'bacteria' or 'virus', presuming that the general term 'germ' was easier to understand[11].

It was encouraging to observe that more than half of both science and non-science students correctly acknowledged that bacteria could develop resistance towards antibiotics with more than half of the science students acknowledging that there was a relationship between the indiscrete and incorrect use of antibiotics with the high occurrence of antibiotic-resistant bacteria which was reported, in other studies as well [13,22,23].

A majority of science students agreed that antibiotic resistance has been called one of the world's most pressing public health problems, whereas only one-third of the non-science students recognized this issue as such. This could be because only fewer non-science students had received any information related to antibiotic resistance. These findings suggested that the external sources of information regarding antibiotic resistance provided were crucial and effectively exposed the non-science students to the ABR issue[24]. In this vein of thought, a majority of the science student participants stated that knowledge concerning antibiotic resistance could be increased by attending an ABR awareness campaign. The reason could be that science students had a higher chance to become involved with the campaign and found out firsthand that the information provided during these campaigns helped enhance their knowledge on antibiotic resistance. This was consistent with our finding that students who attended antibiotic awareness campaigns had a higher knowledge level than those

who did not attend the campaign before regardless of the course they studied.

A similar observation was made in Poland where survey respondents admitted that their knowledge and attitude towards antibiotics and ABR had changed after being exposed to the European Antibiotic Awareness Campaign[25]. The better exposure of the Science students to the institution's ABR awareness campaign, coupled with the inclusion of antibiotics and ABR in teaching modules such as Microbiology and Medical Biotechnology, could also be a contributing factor to the improved awareness of these students toward this global issue.

The effectiveness of this intervention measure of the ABR awareness campaigns could be seen when comparing the data from this study with that of a similar study conducted in the same institution[8]. Overall, it was found that participants generally had shown an improvement in their knowledge regarding antibiotics and ABR whereby eight out of the eleven knowledge statements had an increase in several students who provided the correct answers regardless of the program of study. From this, it was interpreted that students had the correct concept which could have been obtained through the course of study or from external sources of information including the ABR awareness campaigns conducted in the institution. The higher percentage of correct answers were provided by science students who had a better exposure to the ABR awareness campaigns indicated the success of these events organized annually by the institution.

In line with the advice from WHO, National Antimicrobial Resistance Committee (NARC) drafted the Malaysian Action Plan on Antimicrobial Resistance (MyAP-AMR) that outlined strategies to tackle AMR in Malaysia in which one of them was to promote educational activities such as antibiotic awareness campaign at institutions of higher education annually[25]. Therefore, there should be more intensive measures to create awareness such as carrying out these ABR awareness campaigns and introducing novel ways of spreading information regarding ABR and antibiotic usage through gamification[26].

The present study has a few limitations. To start with, these results are not generalized to the population of university students in Malaysia since this cross-sectional study was conducted in only one university. Hence, the results may not be a true representation for all of the university students in Malaysia. Furthermore, there were possibilities for selection bias due to the convenient sampling method used. Lastly, the accuracy of the results was heavily dependent on the honesty and understanding of the respondents. The plans are to conduct a similar study in a few more tertiary institutions in different states in Malaysia to enable a more accurate representation of antibiotic resistance awareness among undergraduate students in Malaysia.

CONCLUSION

The study aimed to assess the knowledge and attitude level of current science and non-science students in a tertiary institution concerning antibiotic use and antibiotic resistance. Only 32.4% of the non-science students had a good level of knowledge. Science students had a better knowledge level than non-science. A majority of the students reported that they knew that they needed to complete the antibiotic treatment given. However, a majority of the participants were still under the misapprehension that antibiotics could be used to treat the common cold or flu. In terms of attitude, the percentage of non-science students that failed to complete the prescribed antibiotic course had improved. There was a statistically significant correlation between knowledge and attitude towards antibiotic use and antibiotic resistance as a larger number of participants had a higher level of knowledge and a more positive attitude towards the use of antibiotics compared to the participants in the 2016 survey.

The reason for the improvement in knowledge and attitude level in students may be partly due to the exposure of the antibiotic awareness campaign in the university. The goal of the educational campaign focuses on promoting the judicious use of antibiotics to prevent the spreading of antibiotic resistance. From the data obtained in this study, and the comparison of data with the previous study, the antibiotic resistance awareness campaign in this institution was beneficial to students in dimensions of knowledge and attitude level. However, this seemed limited mainly to the science program students who were involved with the campaign. Therefore, the recommendations of this study are to continue with the annual antibiotic resistance awareness campaigns in the tertiary institute but to find ways of involving more students from non-science programs to increase the spread the ABR awareness. This could be done by having related competitions online, videos, and posters on antibiotic resistance to be displayed throughout the year instead of just once a year for a brief period.

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