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Assessment of Knowledge, Attitude, and Behavior (KAB) Associated With the Use of Antibiotics and Presence of Antibiotic Resistance Among STEM Students in the Philippines: A Cross-sectional Study

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ABSTRACT

Background and Aim: Misuse and overuse of antibiotics fuel the development of antibiotic resistance. Therefore, these drugs have become ineffective and antimicrobial resistance has emerged. The study aimed to assess the current knowledge, attitude, and behavior (KAB) of the Science, Technology, Engineering, and Mathematics (STEM) students in one of the selected private universities in Malolos, Bulacan, Philippines, concerning antibiotic resistance and usage.

Materials and Methods: This cross-sectional study surveyed 245 Grade 12 STEM students in Malolos, Bulacan, Philippines using KAB survey questionnaires to assess the antibiotic use and resistance in society. This group was selected as they will be future deciding authorities to educate people. The survey assessed students' KAB regarding the use of antimicrobial drugs in clinical settings.

Results: The study revealed low level of students' knowledge about antibiotic usage and the presence of antibiotic resistance. They incorrectly believed that antibiotics can be used as prophylaxis and can be bought without prescription. Additionally, they believed that antibiotics can speed up the recovery of colds and coughs. On the attitude level, less than 60% agreed that antibiotic resistance is a global public health concern. Additionally, 3 out of 7 statements in the behavior section were incorrectly answered, indicating low level of behavior.

Conclusion: The findings indicate a need to promote awareness about proper antibiotic usage that may provide helpful additional evidence to develop a successful framework for improving antibiotic information dissemination, particularly in academic institutions.

Keywords: Antibiotics, Antibiotic resistance, Antimicrobial stewardship, Cross-sectional study, Medical Microbiology

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1. Introduction

The discovery of antibiotics in 1928 by Sir Alexander Fleming was a turning point in human history. Following its discovery, many lives were saved from infectious diseases. In addition, contemporary medical procedures such as cancer treatment, organ transplantation, and open-heart surgery have become possible **(1, 2)**. However, due to the irrational use of antibiotics by humans, these drugs called "miracle drugs" have become ineffective, creating havoc on the rise of antimicrobial resistance (AMR).

Today, AMR is reported for many bacterial strains and is recognized by the World Health Organization

(WHO) as a health concern worldwide **(3)**. AMR is mainly due to the misuse and overuse of antibiotics in humans and animals, poor hygiene and sanitation, and inefficient infection control plans in healthcare settings **(4-7)**. Several studies have indicated that using excessive amounts of antibiotics can contribute to emergence of resistant bacteria and decrease in ability of the oral flora to combat invasion of pathogenic bacteria thereby resulting in infections caused by multidrug-resistant (MDR) bacteria **(3)**.

According to the Centers for Disease Control and Prevention (CDC), at least 2.8 million people are reported to have infection caused by MDR, and more than 35,000 people die annually in the United States **(8)**. By 2030, case projections may increase to 24 million people worldwide in extreme poverty. In 2050, drug-resistant infections might lead to high mortality, with approximately 10 million people each year worldwide **(9)**.

At present, antibiotic awareness campaigns are one of the most effective ways to reduce the magnitude of antibiotic resistance **(10)**. Available information about the KAB concerning the usage of antibiotics might help control the rate of AMR **(11)**. A KAB-based survey on antibiotic usage has already been conducted to assess KAB. Based on the literature, the general public **(12-14)**, teachers **(14)**, healthcare professionals **(15, 16)**, and students **(17, 18, 11)** have already been surveyed from various countries. According to Sunusi et al. **(19)**, among 306 African students, 34% and 15% had poor knowledge and attitudes toward antibiotic use and resistance, respectively. Moreover, another study conducted by Marzan et al. **(10)** revealed that Biology and non-Biology students have poor knowledge associated with antibiotic use. Furthermore, according to Crucis et al. **(20)**, the majority of respondents in Manila, Philippines, had inadequate knowledge and poor practices regarding antibiotic usage. Poor knowledge and behavior are regarded as drivers of the development of AMR **(21)**. The development of innovative alternative drugs is significantly outpaced by the rate at which AMR arises and spreads; therefore, public education regarding prudent antibiotic use is essential to decrease the magnitude of this public health concern **(22)**. In line with this, the spread of MDR bacteria can be slowed and eventually mitigated.

In Philippines, there is no report on KAB regarding antibiotic use and resistance, specifically among senior high school students. It is crucial to examine their perspective since the success of antibiotic therapy and the subsequent development of resistance are impacted by KAB. In addition, STEM students were chosen as the target population sample in this study, because these students will someday become aligned in medical and health-allied courses such as pharmacy, microbiology, and medicine, from which these students can be of help in reducing the magnitude of AMR by educating people and promoting awareness in the current times and future as well. Likewise, non-STEM students should also be aware and educated regarding antibiotic resistance to reduce the increasing resistant cases in clinical settings. Hence, the current KAB of the STEM students in one of the private universities in Malolos, Bulacan, Philippines were assessed concerning antibiotic resistance and usage. After knowing students' KAB about antibiotic use, the results can serve as a valuable tool for government and non-government organizations handling health concerns and awareness of antibiotic resistance at the academic level. To reduce the impact of AMR, proper policy responses based on the strong governance and cooperation are required **(23)**.

2. Materials and Methods

This study was reviewed and approved by the Research Ethics Committee of the chosen university in Malolos, Bulacan, Philippines (Ethics Code: 279/202204-CabuhatK01, issued on 12.May.2022). Additionally, approval of the university was sought before the commencement of this study. Any sensitive information about the participants was completely anonymous and confidential. Prior to the study, participants were asked if they were willing to participate via assent and consent forms through an electronic survey form.

Research Setting and Design

A cross-sectional Google form-based survey was carried out among STEM students in one of the universities in Malolos, Bulacan, Philippines in May to June 2022 to assess their KAB regarding antibiotic resistance.

Research Participants and Sampling

A total of 245 Grade 12 STEM students were invited to participate in this study. The sample size was calculated from the known population size (N=668) with a 95% confidence interval, 5% margin of error, and 50% response distribution **(24)**. A stratified sampling technique (proportion to size) was utilized to calculate the sample size for each class section. All the participants who signed an informed consent and assent form did not receive compensation.

KAB Instrument Development and Validation

The KAB instrument was established following an extensive review of the relevant literature **(21, 25, 26)**. Before the start of the study, the research questionnaire was sent to at least three validators (Medical Doctor, Licensed Medical Technologist, and Language Instructor), and they were asked to check the relevance, appropriateness, and clarity of the statements. The questionnaire was prepared in English with Filipino translation; the translation validity was ensured by the process of forward and reverse translation using persons skilled in both languages. A pilot survey was undertaken with 30 participants to assess the effectiveness of the survey questionnaire. Modifications were made to address any possible concerns with the questions or queries concerning the instrument if any **(20)**. The questionnaire consisted of data on respondents' demographic variables (age and gender) and 28 structured questions on knowledge, attitudes, and behavior about antibiotic use and resistance. For content reliability, Cronbach's alpha was determined with the coefficient of 0.7, indicating acceptable internal consistency. The 13-item Likert scale questions for knowledge were answerable by "Yes", "No" or "I do not know" while the remaining question was answered by identifying what disease can be cured by antibiotics. There were seven-item questions for attitude, which were answerable by "strongly agree", "agree", "neutral", "disagree", and "strongly disagree". On the other hand, there were seven questions constructed for behavior that were answerable by "never", "seldom", "sometimes", "often", and "always".

Data Collection

Data collection was carried out by one of the researchers from the team. Before distributing the survey, the students were informed about the time limit and confidentiality of their answers. Teachers were notified that they were not permitted to be involved when their students were answering the survey. The questionnaire was issued and collected when completed, normally on the same day **(11)**.

Data Processing, Analysis, and Interpretation

Only those questionnaires that had all the questions answered were subjected to statistical analyses. The collected data were saved in an Excel file and analyzed using JASP version 0.8.5.1, a statistical software supported by the University of Amsterdam **(27)**. The descriptive data were reported as frequencies, percentages, and graphs. A score of <60% was considered poor KAB while ≥60% was considered good KAB. The response "I do not know" was interpreted as incorrect **(28)**. Pearson correlation analysis was performed to identify whether there exists a significant correlation between KAB scores and demographic variables. A significance level of 0.05 was considered in the study. Moreover, significant differences between the mean KAB scores of males and females were also investigated using an independent sample t-test to identify whether gender affects the KAB levels of the participants.

3. Results

Demographic Profile of Respondents

A total of 245 STEM students representing 14 class sections participated in the study, with a response rate of 100%. An online survey comprising 28 questions was used to assess their KAB associated with antibiotic use and resistance.

Identification of Antibiotics and Infections Treated with Antibiotics

In the present study, students identified that skin/wound infection (n=191, 78%), urinary tract infection (UTI) (n=174, 71%), and gonorrhea (n=77, 31%) were treated with antibiotics. However, other diseases caused by viruses such as sore throat (n=142, 58%), cold & flu, (n=116, 47%) dengue (n=64, 26%), measles (n=56, 23%), HIV (n=63, 26%) and COVID-19 (n=56, 23%) have incorrectly identified that antibiotics are effective to use. Other respondents identified that headache (n=72, 29%) and diarrhea (n=74, 30%) were treated with antibiotics shown in Figure 1.

Knowledge of STEM Students About Antibiotics

Having good knowledge is a key driver in reducing the magnitude of antibiotic resistance. This paper assessed the knowledge of STEM students in Philippines regarding antibiotic use and resistance. The results of students' percentage rate of knowledge item responses and scores about antibiotic use and resistance are presented in Table 1.

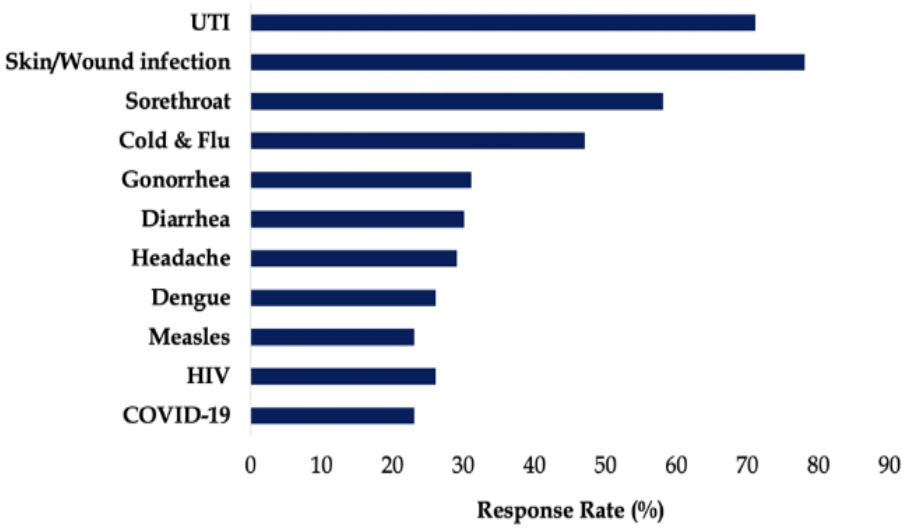

Figure 1. Response rates on infections possibly treated with antibiotics based on the STEM students' knowledge. Abbreviation: UTI – Urinary tract infection; HIV – Human immunodeficiency virüs; COVID-19 – Coronavirus disease – 19.

Table 1. Percentage rate of knowledge items responses and scores

Knowledge items	Correct answer	Answer	%	n	% (n) Incorrect answer
Can antibiotics cure bacterial infections?	Yes	Yes	86.9	213	
		No	6.1	15	13 (32)
		I do not know	6.9	17	
Can antibiotics cure viral infections?	No	Yes	31.4	77	
		No	42.9	105	57.1 (140)
		I do not know	25.7	63	
Antibiotics can affect or kill "good bacteria" present in our body.	Yes	Yes	45.3	111	
		No	24.1	59	54.7 (134)
		I do not know	30.6	75	
Can antibiotics be used as prophylaxis and treatment for animal infections?	Yes	Yes	36.3	89	
		No	25.7	63	74.3 (182)
		I do not know	38.0	93	
Can you buy antibiotics without a prescription?	No	Yes	65.3	160	
		No	25.7	63	74.3 (182)
		I do not know	9.0	22	
Do you think the use of antibiotics will speed up the recovery of colds and coughs?	No	Yes	50.6	124	
		No	35.9	88	64.1 (157)
		I do not know	13.5	33	
Do you think frequent use of antibiotics will decrease the efficacy of treatment when using them again without the doctor's prescription?	Yes	Yes	46.9	115	
		No	33.1	81	53.1 (130)
		I do not know	20.0	49	

Knowledge items	Correct answer	Answer	%	n	% (n) Incorrect answer
One may be infected with bacteria that are difficult to treat if this person does not complete the treatment regimen.	Yes	Yes	62.9	154	
		No	14.3	35	37.1 (91)
		I do not know	22.9	56	
There are people allergic to antibiotics.	Yes	Yes	84.5	207	
		No	3.3	8	15.5 (38)
		I do not know	12.2	30	
Taking antibiotics for the wrong indication leads to antibiotic resistance	Yes	Yes	58.4	143	
		No	6.5	16	41.6 (102)
		I do not know	35.1	86	
Antibiotics become ineffective for treating infections if it is misused and overused.	Yes	Yes	81.2	199	
		No	7.3	18	18.8 (46)
		I do not know	11.4	28	
Missed antibiotic can be taken with the next one.	No	Yes	16.3	40	
		No	60.8	149	39.2 (96)
		I do not know	22.9	56	
Antibiotic resistance can lead to a high number of deaths if action is not taken.	Yes	Yes	57.1	140	
		No	7.3	18	42.9 (105)
		I do not know	35.5	87	

Most of the students (86.9%) correctly agreed that antibiotics could be used to treat bacterial infections. A slight majority (62.9%) concurred that one might be infected with bacteria that are difficult to treat if the infected person does not complete the treatment regimen. Likewise, students (60.8%) agreed that missed antibiotics could not be taken with the following one. Most of the respondents (81.2%) were also cognizant that when antibiotics are misused or overused, antibiotics become ineffective in treating bacterial infections. Likewise, large portions of the respondents (84.5%) were aware that there are people allergic to antibiotics. On the other hand, only 42.9% agreed that antibiotics are used to treat viral infections. Hence, only 35.9% of the respondents correctly disagreed that the use of antibiotics will speed up the recovery of colds and coughs. Furthermore, only 58.4% believed that taking antibiotics for the wrong indication leads to antibiotic resistance. Meanwhile, almost 75% of the students wrongly agreed that antibiotics could be bought over the counter without prescription from a doctor. Moreover, 46.9% of the respondents were only aware that the frequent use of antibiotics will decrease the efficacy of treatment when using them again without a doctor's prescription. A total of 45.3% correctly agreed that antibiotics can affect or kill "good bacteria" present in the human gut and could change the microbial communities as well, and some respondents (25.7%) answered that antibiotics could not be used as prophylaxis and treatment for animal infections. Lastly, only 57.1% of the students correctly agreed that a high mortality rate would be recorded if action on AMR was not taken into account.

Attitude and Behavior of Students about Antibiotic Use

Good attitude and behavior reflect good practices and mindset regarding antibiotic usage to fight against antibiotic resistance in bacterial pathogens. This study assessed the attitude and behavior of STEM students regarding antibiotic use. The results of students' attitudes toward antibiotic use and resistance are presented in Table 2. In addition, the relative frequencies of the students' responses according to their attitude level are shown in Figure 2.

Table 2. Percentage rate of attitude items responses

Attitude items	% (Agree)	% (Neutral)	% (Disagree)	Remarks/Interpretation
There is an abuse of antibiotics at present.	61.6	30.6	7.8	High-level
Antibiotic resistance is currently known as a global public health concern.	56.3	40	3.7	Low-level
Abuse of antibiotics has become the main cause of bacterial resistance.	62.4	34.7	2.9	High-level
Antibiotic resistance affects you and your family's health.	52.7	36.7	10.6	Low-level
It is necessary to obtain knowledge about the proper uses of antibiotics.	88.2	11.8	0.00	High-level
There is a need to educate students on the rational use of antibiotics.	88.2	9.8	2.0	High-level
It is necessary to carry out large-scale 'antibiotics campaign' promotion.	83.7	15.5	0.8	High-level

**The designated cut-off for the identification of a high level of attitude is ≥ 60%.*

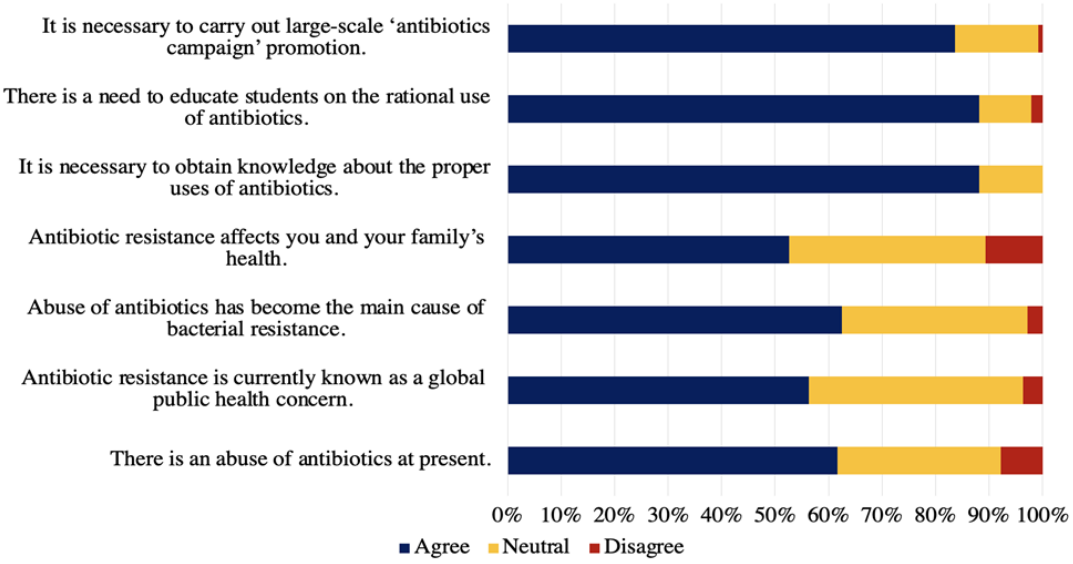

Figure 2. Relative frequencies of STEM Students' attitude on a 5-point Likert scale. *The designated cut-off for the identification of a high level of attitude is ≥ 60%.*

In terms of the attitude level, responses of strongly agree (SA) and agree (A) were combined as they accord to the same degree. The results showed that there is a high level of attitude because 84% of the students agreed to have an antibiotic campaign promotion for better dissemination of emergence of antibiotic resistance in our society. The need to educate people regarding antibiotic resistance, as well as the necessity to obtain knowledge about the proper use of antibiotics, needs further attention (88.2%). There were 88.2% who responded on the need to educate students on the rational use of antibiotics and the need to obtain proper knowledge of their uses. Furthermore, many students (61.6%) agreed that there is a current abuse of antibiotic use and they (62.4%) believed that abuse of antibiotic use is the main driver of antibiotic resistance. On the other hand, 52.65% of the respondents agreed that AMR puts them and their family's health at risk, which indicates a low level of attitude (<60%). Lastly, 56% of respondents agreed that AMR is one of the

currently known public health concerns worldwide, which also indicates a low level of attitude in the cross-sectional survey conducted.

In terms of the level of behavior, the combination response percentages of always (A) and often (O) were the outcomes. In the behavior portion, there were survey questionnaires with both positive and negative statements and premises shown in Figure 3. Positive statements in the questionnaire received a higher level of behavior, which indicates that the students agreed that before taking antibiotics they must check the expiration date (90.2%), need to complete the antibiotic full treatment (86.1%), and consult a doctor for a prescription (66.5%). On the other hand, negative statements or premises have lower behavior levels in the study. Many students knew that taking antibiotics when having a cough and sore throat, or even if they are experiencing frequent urination is not a good idea (21.6%). Meanwhile, only 45.3% of the students did not prefer to buy antibiotics over-the-counter from a pharmacy rather than from a doctor who can prescribe them properly. Furthermore, some students agreed that it is not a good practice to share antibiotics with others if the physician does not prescribe them and to use left-over antibiotics, which scored 47.3% and 80.4%, respectively.

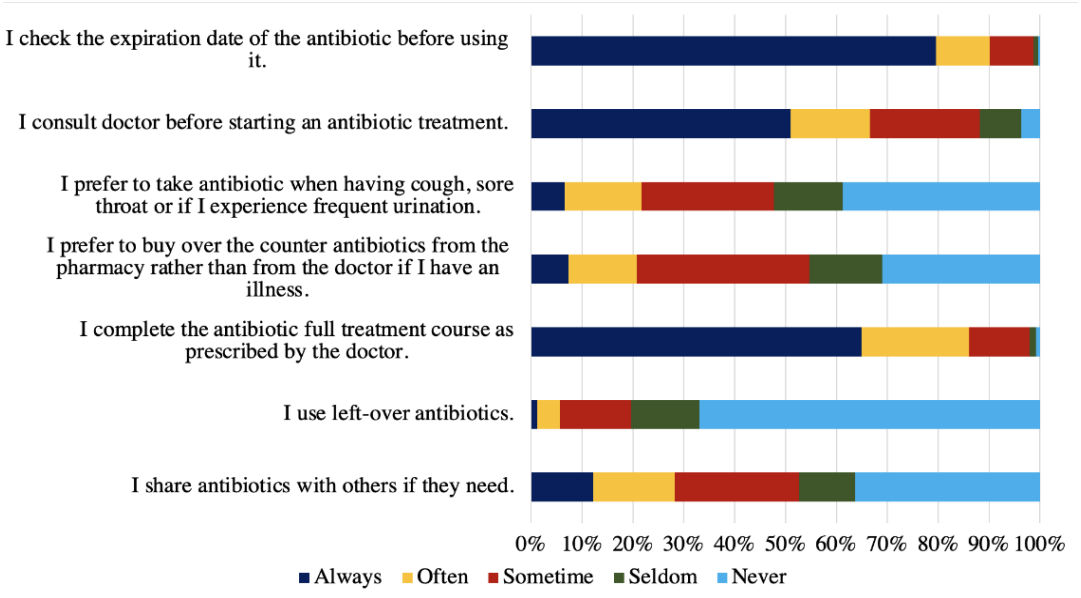

Figure 3. Relative frequencies of STEM Students' behavior on a 5-point Likert scale on KAB

Association of KAB Regarding Antibiotic Use

The results showed that attitude and behavioral scores are moderately correlated with knowledge scores (r = 0.47 and 0.24) with P<0.001 indicating significance. Also, it appeared that behavioral and attitude scores had a weak yet significant correlation (r = 0.19, *P*=0.002) (Table 4). In terms of the comparison between the mean KAB scores of male and female students, the results showed that knowledge and behavior scores differ significantly (*P*=0.02 and <0.001, respectively), with females having significantly higher mean knowledge and behavior scores than male student participants (Table 3). Further data exploration through descriptive scatter plots is shown in Figure 4 and are presented in Tables 3 and 5, which shows the gender results of KAB in STEM students.

Table 3. Pearson correlations of KAB

		r		P
Knowledge score	Attitude score	0.47	***	<0.001
Knowledge score	Behavioral score	0.24	***	<0.001
Attitude score	Behavioral score	0.19	**	0.002
Knowledge score	Age	0.04		0.545
Attitude score	Age	-0.10		0.136
Behavioral score	Age	-0.01		0.856

*: P<0.05, **: P<0.01, ***: P<0.001

Table 4. Descriptive statistics of the KAB score of STEM Students

	Knowledge score		Attitude score		Behavioral score	
	Female	Male	Female	Male	Female	Male
N	123	122	123	122	123	122
Mean	2.66	2.44	4.08	3.97	4.17	3.87
Std. Deviation	0.66	0.81	0.48	0.53	0.62	0.70
Minimum	0.53	0.00	3.00	2.71	2.71	2.00
Maximum	3.60	3.60	5.00	5.00	5.00	5.00

Table 5. Independent sample T-Test (KAB Score & Gender) of STEM students

	t	P
Mean knowledge score	2.29*	0.02
Mean attitude score	1.73	0.09
Mean behavioral score	3.63***	<0.001

*: P<0.05, **: P<0.01, ***: P<0.001

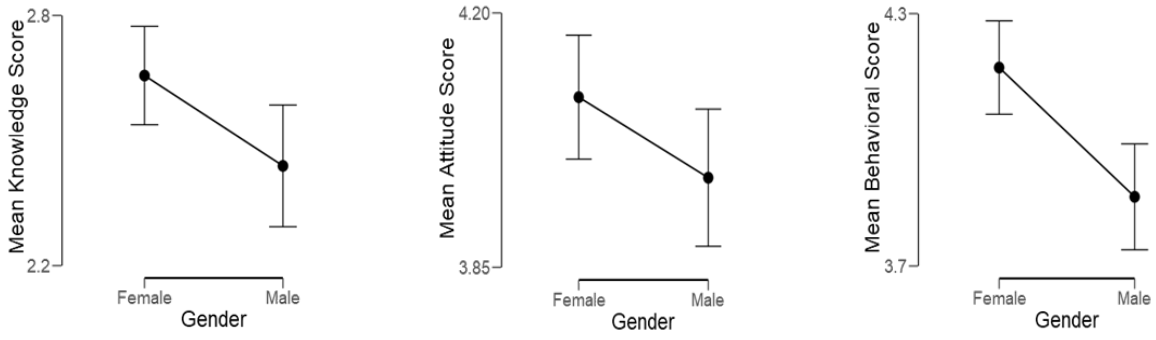

Figure 4. Descriptive scatter plots of the mean KAB scores of STEM Students

4. Discussion

To the best of our knowledge, this is the very first cross-sectional study on the KAB of students about the use of antibiotics in Philippines. The present study surveyed 245 senior high school STEM students to provide additional data on their knowledge, attitudes, and behaviors related to antibiotic usage. Antibiotics have been at the frontline in the human battle against infectious pathogenic microorganisms; however, their excessive use seriously threatens their efficacy **(29)**. Hence, antibiotic resistance is a global health concern. According to projections, 10 million deaths and a $100 trillion economic loss would occur by 2050 if the issue is not addressed **(30)**.

Based on the gathered data, a slight majority (60%) have correctly identified that antibiotics can be used against bacterial infections such as wounds and UTIs. The current finding is consistent with a previous study **(31)**, wherein respondents accurately

recognized skin infections and UTIs as conditions that may be treated with antibiotics. Similarly, a study reported that UTIs that can be treated with antibiotics have also been accurately identified **(32)**. However, 23-58% of respondents identified that antibiotics could be used to treat viral infections, including COVID-19, measles, HIV, dengue, colds, flu, and sore throat. In addition, based on the current survey on their knowledge about antibiotic use, many students believed that antibiotics are effective against viral infections. This result conforms to prior studies showing that antibiotics have been used for viral infection **(3, 22, 33)**. Choices may have been made due to misunderstanding of distinction between viral and bacterial illnesses, and if the false assumption is not dispelled, this poor decision may result in emergence of bacterial resistance **(31)**. Moreover, many students are unaware that antibiotic resistance development is due to the use of antibiotics for wrong indications. Several studies have found that university students misuse antibiotics owing to self-medication and lack of appropriate knowledge of antibacterial drugs, notably, their indications, pathogen specificity, and adherence to dosing regimens **(19)**. Due to inappropriate use of antibiotics for the lack of knowledge, the emergence of MDR bacteria will continuously rise **(34)**. Furthermore, more than 50% of respondents are unaware that good bacteria are not affected by antibiotics. According to the study, incorrect use of antibiotics may impact gut microbes, lead to selection pressure, and eventually contribute to emergence of drug resistance **(35)**. In addition to improper use of antibiotics, many responses reveal that people think antibiotics could be purchased over the counter. This result conforms to the prior conducted studies among students, particularly in East China **(36)**, Bangladesh **(10)**, and Ghana **(37)**. Consumption of antibiotics without prescription has been increasing globally, and this is acknowledged as a major risk factor for AMR development. As a result, policies all over the world prohibit people from purchasing antimicrobials over the counter since they are thought to foster the development of resistant microorganisms **(38)**. According to the forecast, it will have a cascade of disastrous effects by 2030 and 2050, when terrible poverty would be experienced and millions of people will die, respectively **(39)**. Thus, AMR is considered a silent pandemic **(40)**.

The vast majority of respondents (80.4%) stated that they never use leftover antibiotics. However, only 47.3% of them did not share antibiotics, while others answered sometimes (24.5%) and always (28.2%). Antibiotics are not supposed to be shared with friends and family since improper use of antibiotics can lead to significant problems, resistance, and even death **(41)**. Almost half of the respondents (45.3%) preferred to buy antibiotics over-the-counter during the survey. Antibiotics purchased without prescription are widely known sources of antibiotic misuse and abuse, which can result in antibiotic resistance, recurring sickness, higher expenses, and treatment adverse effects **(42)**. Self-medication with antibiotics, whether through the use of leftover antibiotics, antibiotics obtained without prescription from the pharmacy, or antibiotics obtained from a friend or family member, is typically a behavioral issue that reflects ignorance of the people, misconceptions, and an overly optimistic view of antibiotics as a “cure for everything” **(43)**. On the other hand, completing the antibiotics’ full course is advised for proper recovery from bacterial infection **(44)**. Most of the participants responded that they always finished the course of antibiotic treatments as prescribed by the doctor, which corroborated the previous findings in Nepal (78.9%) and India (74.2%). Although the results are high, it can be noticed that some of the respondents answered sometimes and never. One of the global problems with the use of antibiotics is non-completion of the prescribed antibiotics. This non-judicial use of antibiotics should be discouraged since it will serve as a cause of AMR spread **(45)**. When students were asked if they preferred to take antibiotics for a cough, sore throat, or frequent urination, a low level of attitude (52.2%) was noted. Nonetheless, this figure is higher than in a survey undertaken in Nepal, where 30% of students responded that antibiotics are their first choice of medication when they have a cough or sore throat **(18)**. This can be explained by students' lack of knowledge that antibiotics are ineffective against viral infections. As a result, some of them responded sometimes and always. A slight majority of the respondents (66.5%) always consulted doctor before taking antibiotics. This result was higher than the results obtained from Nigeria and Nepal among students (20% and 30%, respectively). Even if the result from our study is quite high compared to previous studies, it can be observed that some of the respondents did not consult a doctor prior to antibiotic consumption. This behavior toward antibiotic use can be attributed to their lack of knowledge in some medical-allied subject courses such as microbiology and pharmacology, which are typically not offered in senior high school (SHS), especially for STEM students. Hence, they might have less knowledge and understanding of antibiotic usage. As a recommendation, it is vital to integrate their science subject to have special topics on AMR that discusses the current challenges on fighting bacterial infections and bacterial resistance **(45)**. Although a large proportion of respondents (90.2%) always check the expiration date of antibiotics, it

should be highlighted that some of them do not practice them religiously.

According to the Food and Drug Administration (FDA), expired medicine may be less effective or unsafe owing to a change in chemical composition or a decrease in efficacy. Some expired drugs are at risk of bacterial growth, and ineffective antibiotics can result in more severe diseases and antibiotic resistance **(46)**. In the study of Alkhalifah et al. **(47)**, most of the students (76.5%) stated that they preferred to complete the antibiotic course treatment [combined always (41.2%) and sometimes (35.3%)], which is found to be higher in the results shown in Figure 3 by 86% [combined always (65%) and often (21%)]. Meanwhile, in our results, most of the students (66%) responded that before taking antibiotics they must consult a doctor for prescription. A similar result was observed by Dejene et al. **(3)**, who had moderate knowledge, positive attitude, and good practices concerning antimicrobial use and resistance in Northwest Ethiopia and were found to have higher level of 48%, 54%, and 50%, respectively. In another positive result, 67% of students stated that they never use leftover antibiotics for future needs. The same result with a higher percentage rate of 62.4%, was that they were infrequently keeping leftover antibiotics at home for future use **(47)**.

On the other hand, the gender results also reveal that even for attitude scores, female students generally have higher mean scores. This can be explained by two factors: First, some infectious diseases affect men and women differently. In particular, UTI is more common in adult women than in men and accounts for over 20% of antibiotic prescriptions in English primary care. However, respiratory tract infections (RTIs) account for more than twice as many prescriptions as UTIs and women are not more susceptible to these conditions than men, although gender differences in comorbidities may underlie some variation in prescribing. Second, as in many countries like United Kingdom (UK), women consult their general practitioner more often than men, and the consultation rate is linked to prescribing antibiotics **(48)**.

Lastly, the rest of the results in our study have varying percentages in their statement. This means that variation in the number of positive and negative premises has slightly proven to have lacking knowledge about antibiotic use that would implicate and affect the other parameters such as attitude and behavior of the students in relation to the use of antibiotics and presence of antibiotic resistance.

5. Conclusion

The results of the current cross-sectional study showed that there is a need to improve knowledge regarding antibiotic resistance and its use, especially among students. The findings from this study might provide useful additional evidence for the development of an effective framework for improving antibiotic knowledge dissemination, particularly in academic institutions. As recommended, a continuous and extensive cross-sectional study of KAB in Philippines can be done. Assessing their knowledge is critical because they play a significant role in AMR stewardship of currently effective antibiotics and in raising awareness about antimicrobial resistance as a global health problem.

6. Declarations

Acknowledgment

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Ethical Considerations

The study was approved by the Ethics Committee Board of the La Consolacion University Philippines (LCUP) in June 2022. The objectives of the study and type of information to be obtained were explained to the students, and informed written consent was obtained. The confidentiality of the data was assured.

Authors' Contributions

Kevin Smith P. Cabuhat and Christian Joseph N. Ong participated in conceptualization and visualization, analyzed and interpreted data, and conducted the survey. Jeffhraim Balilla participated in data processing and analysis of the responses in the survey. Rorimar L. Mallari, Jeffhraim Balilla, Mary Ylane S. Lee and Llewelyn M. Espiritu participated in methodology and supervision. Kevin Smith P. Cabuhat and Christian Joseph N. Ong participated in writing, reviewing, and editing the manuscript. All authors read and approved the final manuscript.

Conflict of Interests

The authors declare no conflict of interest.

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References

1. Adedeji WA. The treasure called antibiotics. Ann Ib Postgrad Med. 2016;14(2):56-7. [PMID] [PMCID]
2. Hutchings MI, Truman AW, Wilkinson B. Antibiotics: past, present and future. Curr Opin Microbiol. 2019;51:72-80. [DOI:10.1016/j.mib.2019.10.008] [PMID]
3. Dejene H, Birhanu R, Tarekegn ZS. Knowledge, attitude and practices of residents toward antimicrobial usage and resistance in Gondar, Northwest Ethiopia. One Health Outlook. 2022; 4(1):10. [DOI:10.1186/s42522-022-00066-x] [PMID] [PMCID]
4. Boonyasiri A, Tangkoskul T, Seenama C, Saiyarin J, Tiengrim S, Thamlikitkul V. Prevalence of antibiotic resistant bacteria in healthy adults, foods, food animals, and the environment in selected areas in Thailand. Pathog Glob Health. 2014;108(5):235-45. [PMID] [PMCID] [DOI:10.1179/2047773214Y.0000000148]
5. Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: a global multifaceted phenomenon. Pathog Glob Health. 2015; 109(7):309-18. [PMID] [PMCID] [DOI:10.1179/2047773215Y.0000000030]
6. Pormohammad A, Nasiri MJ, Azimi T. Prevalence of antibiotic resistance in Escherichia coli strains simultaneously isolated from humans, animals, food, and the environment: a systematic review and meta-analysis. Infect Drug Resist. 2019;12: 1181-97. [DOI:10.2147/IDR.S201324] [PMID] [PMCID]
7. Derakhshan S, Navidinia M, Haghi F. Antibiotic susceptibility of human-associated Staphylococcus aureus and its relation to agr typing, virulence genes, and biofilm formation. BMC Infect Dis. 2021;21(1):627. [PMCID] [DOI:10.1186/s12879-021-06307-0] [PMID]
8. Center for Disease Control and Prevention. 2019 AR Threats Report. 2013. [Accessed 29 Jan 2025]. Available from: [https://www.cdc.gov/antimicrobial-resistance/data-research/threats/]
9. de Kraker ME, Stewardson, AJ, Harbarth S. Will 10 Million People Die a Year due to Antimicrobial Resistance by 2050?. PLoS Med. 2016;13(11): e1002184. [PMID] [PMCID] [DOI:10.1371/journal.pmed.1002184]
10. Marzan M, Islam DZ, Lugova, H. Knowledge, Attitudes, and Practices of Antimicrobial Uses and Resistance Among Public University Students in Bangladesh. Infect Drug Resist. 2021;14:519-33. [DOI:10.2147/IDR.S289964] [PMID] [PMCID]
11. 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;20:1861. [PMID] [PMCID] [DOI:10.1186/s12889-020-09971-0]
12. Islahudin F, Tamezi AM, Shah NM. Knowledge, Attitudes and Practices about Antibiotic Use among the General Public in Malaysia. Southeast Asian J Trop Med Public Health. 2014;45(6): 1474-82.
13. Lim JM, Duong MC, Cook AR, Hsu LY, Tam CC. Public knowledge, attitudes and practices related to antibiotic use and resistance in Singapore: a cross-sectional population survey. BMJ Open. 2021;11(9):e048157. [PMCID] [DOI:10.1136/bmjopen-2020-048157] [PMID]
14. Askarian M, Maharlouie N. Irrational Antibiotic Use among Secondary School Teachers and University Faculty Members in Shiraz, Iran. Int J Prev Med. 2012;3(12):839-45. [PMCID] [DOI:10.4103/2008-7802.104854] [PMID]
15. Di Gennaro F, Marotta C, Amicone M, Bavaro DF, Bernaudo F, Frisicale EM, et al. Italian young doctors' knowledge, attitudes and practices on antibiotic use and resistance: A national cross-sectional survey. J Glob Antimicrob Resist. 2020; 23:167-73. [DOI:10.1016/j.jgar.2020.08.022] [PMID]
16. Ashraf S, Ashraf S, Ashraf M, Imran MA, Choudhary ZA, Hafsa HT, et al. Knowledge, attitude, and practice of clinicians about antimicrobial stewardship and resistance among hospitals of Pakistan: a multicenter cross-sectional study. Environ Sci Pollut Res Int. 2022; 29(6):8382-92. [PMID] [PMCID] [DOI:10.1007/s11356-021-16178-2]
17. Shrestha R. Knowledge, Attitude and Practice on Antibiotics Use and its Resistance among Medical Students in A Tertiary Care Hospital. JNMA: J Nepal Med Assoc. 2019;57(216):74-9. [DOI:10.31729/jnma.4224] [PMID] [PMCID]
18. Battah M, Halboup A, Othman G, Mansoure AA, Sulaiman SA, Ali F, et al. Knowledge, attitude, and practice of antibiotic use and its resistance among undergraduate students at the University of Science and Technology, Sana'a, Yemen. J Hunan Univ Nat Sci. 2021;48(11):34-43.
19. Sunusi LS, Awad MM, Hassan NM, Isa CA. Assessment of knowledge and attitude toward antibiotic use and resistance among students of International University of Africa, medical

complex, Sudan. Glob Drugs Ther. 2019;4:1-6. [DOI:10.15761/GDT.1000171]

20. Crucis PM, Encarnacion EM, Lapuz AM, Magno ME, Pantia JS, Solis LA. Knowledge, attitude and practices on the use of antimicrobials among residents in Towerville Phase 5, Barangay Minuyan, San Jose del Monte, Bulacan, Philippines: A Questionnaire Survey. J Asian Ass Sch Pharm. 2019;8:64-71.
21. 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;19(1):1558. [PMID] [PMCID] [DOI:10. 1186/s12889-019-7924-5]
22. Chapot L, Sarker MS, Begum R, Hossain D, Akter R, Hasan MM, et al. Knowledge, Attitudes and Practices Regarding Antibiotic Use and Resistance among Veterinary Students in Bangladesh. Antibiotics. 2021;10(3):332. [PMID] [DOI:10.3390/antibiotics10030332] [PMCID]
23. Naing S, van Wijk M, Vila J, Ballesté-Delpierre C. Understanding Antimicrobial Resistance from the Perspective of Public Policy: A Multinational Knowledge, Attitude, and Perception Survey to Determine Global Awareness. Antibiotics. 2021; 10(12):1486. [PMID] [PMCID] [DOI:10.3390/antibiotics10121486]
24. Raosoft Inc. Sample size calculator. 2025. [Accessed 29 Jan 2025]. Available from: [http://www.raosoft.com/samplesize.html]
25. 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;13:1-9. [DOI:10.1186/1472-6920-13-163] [PMID] [PMCID]
26. El Sherbiny NA, Ibrahim EH, Masoud M. Assessment of knowledge, attitude and behavior towards antibiotic use in primary health care patients in Fayoum Governorate, Egypt. Alex J Med. 2018;54(4):535-40. [DOI:10.1016/j.ajme.2018.06.001]
27. Goss-Sampson MA. Statistical Analysis in JASP 0.10: A Guide for Students. 2019. [Accessed 29 Jan 2025]. Available from JASP (Jeffreys's Amazing Statistics Program): [https://jaspstats.org/jasp-materials]
28. Lubwama M, Onyuka J, Ayazika KT, Ssetaba LJ, Siboko J, Daniel O, et al. Knowledge, attitudes, and perceptions about antibiotic use and antimicrobial resistance among final year undergraduate medical and pharmacy students at three universities in East Africa. PLoS One. 2021;16(5):e0251301. [PMID] [PMCID] [DOI:10.1371/journal.pone.0251301]
29. Al-Taani GM, Al-Azzam S, Karasneh RA, Sadeq AS, Mazrouei NA, Bond SE, et al. Pharmacists' Knowledge, Attitudes, Behaviors and Information Sources on Antibiotic Use and Resistance in Jordan. Antibiotics. 2022;11(2):175. [PMCID] [DOI:10.3390/antibiotics11020175] [PMID]
30. Vijay D, Bedi JS, Dhaka P, Singh R, Singh J, Arora AK, et al. Knowledge, Attitude, and Practices (KAP) Survey among Veterinarians, and Risk Factors Relating to Antimicrobial Use and Treatment Failure in Dairy Herds of India. Antibiotics. 2021;10(2):216. [PMID] [PMCID] [DOI:10.3390/antibiotics10020216]
31. 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;9(6):349. [PMID] [PMCID] [DOI:10.3390/antibiotics9060349]
32. Poyongo BP, Sangeda RZ. Pharmacists' Knowledge, Attitude and Practice Regarding the Dispensing of Antibiotics without Prescription in Tanzania: An Explorative Cross-Sectional Study. Pharmacy. 2020;8(4):238. [PMCID] [DOI:10.3390/pharmacy8040238] [PMID]
33. Jairoun A, Hassan N, Ali A, Jairoun O, Shahwan M, Hassali M. University students' knowledge, attitudes, and practice regarding antibiotic use and associated factors: a cross-sectional study in the United Arab Emirates. Int J Gen Med. 2019; 12:235-46. [DOI:10.2147/IJGM.S200641] [PMID] [PMCID]
34. Cambaco O, Alonso Menendez Y, Kinsman J, Sigaúque B, Wertheim H, Do N, et al. Community knowledge and practices regarding antibiotic use in rural Mozambique: where is the starting point for prevention of antibiotic resistance?. BMC Public Health. 2020;20(1):1183. [PMID] [PMCID] [DOI:10.1186/s12889-020-09243-x]
35. Wu-Wu JW, Guadamuz-Mayorga C, Oviedo-Cerdas D, Zamora WJ. Antibiotic Resistance and Food Safety: Perspectives on New Technologies and Molecules for Microbial Control in the Food Industry. Antibiotics. 2023;12(3):550. [PMID] [DOI:10.3390/antibiotics12030550] [PMCID]
36. Min S, Zhou Y, Sun Y, Ye J, Dong Y, Wang X, et al. Knowledge, attitude, and practice associated with antimicrobial resistance among medical students between 2017 and 2022: A survey in East China. Front Public Health. 2022;10: 1010582. [DOI:10.3389/fpubh.2022.1010582] [PMID] [PMCID]

37. Virmani S, Nandigam M, Kapoor B, Makhija P, Nair S. Antibiotic use among health science students in an Indian university: A cross sectional study. Clin Epidemiol Glob Health. 2017;5(4):176-9. [DOI:10.1016/j.cegh.2017.04.005]
38. Haque M, Rahman NA, McKimm J, Kibria GM, Azim Majumder MA, Haque SZ, et al. Self-medication of antibiotics: investigating practice among university students at the Malaysian National Defence University. Infect Drug Resist. 2019;12:1333-51. [DOI:10.2147/IDR.S203364] [PMID] [PMCID]
39. World Health Organization (WHO). SInternational organizations unite on critical recommendations to combat drug-resistant infections and prevent staggering number of deaths each year. 2019. [Accessed 29 Jan 2025]. Available from: [https://www.who.int/news/item/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-r]
40. Soto SM. Antibiotic Resistance in Bacterial Pathogens. Antibiotics. 2023;12(3):451. [PMID] [DOI:10.3390/antibiotics12030451] [PMCID]
41. Kandasamy G, Sivanandy P, Almaghaslah D, Khobrani M, Chinnadhurai M, Vasudevan R, et al. Knowledge, attitude, perception and practice of antibiotics usage among the pharmacy students. Int J Clin Pract. 2020;74(11):e13599. [DOI:10.1111/ijcp.13599]
42. Alhomoud F, Almahasnah R, Alhomoud FK. "You could lose when you misuse"–factors affecting over-the-counter sale of antibiotics in community pharmacies in Saudi Arabia: a qualitative study. BMC Health Serv Res. 2018;18: 915. [DOI:10.1186/s12913-018-3753-y] [PMID] [PMCID]
43. Gaygısız Ü, Lajunen T, Gaygısız E. Community Use of Antibiotics in Turkey: The Role of Knowledge, Beliefs, Attitudes, and Health Anxiety. Antibiotics. 2021;10(10):1171. [PMID] [PMCID] [DOI:10.3390/antibiotics10101171]
44. Memon I, Alrashid AA, Alshammari HS, Rehman DE, Feroz Z, Nagro A, et al. Assessing the Effects of Basic Medical Science Courses on the Knowledge and Attitude towards Antibiotic Usage among Pre-Professional Students in Saudi Arabia. Pharmacy. 2021;9(2):108. [PMID] [DOI:10.3390/pharmacy9020108] [PMCID]
45. Alex IO. Knowledge of antibiotic use and resistance among students of a medical school in Nigeria. Malawi Med J. 2019;31(2):133-7. [DOI:10.4314/mmj.v31i2.5] [PMID] [PMCID]
46. U.S. Food and Drug Administration (US FDA). Don't Be Tempted to Use Expired Medicines. 2021. [Accessed 29 Jan 2025]. Available from: [https://www.fda.gov/drugs/special-features/dont-be-tempted-use-expired-medicines]
47. Alkhalifah HM, Alkhalifah KM, Alharthi AF, Elzahrany YR, Aljuhani MA. Knowledge, attitude and practices towards antibiotic use among patients attending Al Wazarat health center. Fam Med and Prim Care. 2022;11(4):1299-307. [DOI:10.4103/jfmpc.jfmpc_1431_21] [PMID] [PMCID]
48. Smith DR, Dolk FC, Smieszek T, Robotham JV, Pouwels KB. Understanding the gender gap in antibiotic prescribing: a cross-sectional analysis of English primary care. BMJ Open. 2018;8(2): e020203. [PMID] [PMCID] [DOI:10.1136/bmjopen-2017-020203]