Research Article

Knowledge About Antibiotics And Antibiotic Resistance Among Health-Related Students In Jordan University

Sonia Mohammad kraishan[1] , Saja Khaled Abed Alkareem Talafha[2]

[1]lecturerer Faculty of Nursing Al-Balqa Applied University / Aqaba University College * Amman, Jordan. Sonia.kraishan@bau.edu.jo
[2]Lectuerer Faculty of Irbid University College Department of Applied Health Sciences Al-Balqa Applied University Amman, Jordan Talafhasaja2@bau.edu.jo

Abstract

Background: antibiotic resistance stems from improper usage of antibiotics, constitutes a threat for global health worldwide and in developing countries like Jordan in particular.
Aim: this study aims to examine the knowledge of antibiotic use and antibiotic resistance among pharmacy and nursing students across Al-Balqa Applied University in Jordan, namely, Mutah University in Karak, Al-Balqa University in Tafila, Al-Hussein University in Ma'an, and A branch of Al-Balqa University at Ma'an University
Methodology: this cross-sectional study used a questionnaire that was distributed to 300 pharmacy and nursing students.
Findings: The study results revealed that 73.3 % of pharmacy and nursing students were aware of the term "antibiotic resistance," and 77 % of them were instructed about antibiotic resistance in their courses. Most students exhibited advanced basic comprehension as reflected by correct response percentages ranging between 66.3 % to 87.3% for antibiotics, 69.3% to 69.3%-77.7% for antibiotic use, and 68.3%-84% for antibiotic resistance. However, there are still some ongoing misunderstandings, particularly about the use of antibiotics for viral infections.
Conclusion: Despite strong foundations of knowledge among students, the study indicates that targeted educational interventions are required to fill the gaps and understand misconceptions as prescribed. This study fills in a notable gap in the literature by identifying the antibiotic knowledge of healthcare students at various southern extensions of Al-Balqa Applied University, a demographic that has been largely overlooked in previous research.

Keywords: antibiotic knowledge, antibiotic use, antibiotic resistance, Al-Balaqa Applied University, Jordan.

Introduction

Nowadays, the consumption of medicines among individuals has considerably increased (Caban & Stepnowski, 2021). The medication prescriptions constitute an integral of humans' lives worldwide (Charchar et al., 2024). Accordingly, medicines play a critical role in curbing, mitigating, and preventing diseases. Therefore, the majority of individuals resort to medications (Akbar et al., 2021). Among these medications is antibiotic, which is considered as one of the most effective medications for treating and preventing bacterial infections (Mancuso et al., 2021). Antibiotics are used to treat severe infections and in surgical and medical procedures (Hassani et al., 2022). The effectiveness of these medications lies in treating and preventing bacterial infections (Nwobodo et al., 2022).
However, antibiotics as modern medicines might be ineffective in certain cases such as misuse, over use of antibiotics, or poor hygiene leading to antibiotic resistance (Baquero, 2021). According to Nwobodo et al. (2022) antibiotic resistance emerges upon the change of bacteria due to the use of antibiotics. Further, Christaki et al. (2020) indicate that antibiotic resistance results when bacterial evolution and development of strategies for survival against originally successful antibiotics. Antibiotic resistance occurs as a result of the excessive use of antibiotics in agriculture and in human medicine, which increase the occurrence of resistant bacteria (Urban-Chmiel et al., 2022). The main grounds of the presence of resistant bacteria are the overuse of antibiotics and/or inappropriate prescription of antibiotics (Dhyani et al., 2025). This issue leads to incurable infectious diseases (Aghamohammad & Rohani, 2023). Antibiotic resistance is considered one of the critical public health problems in spite of the exerted efforts worldwide to decrease the causes of the resistance (Morgan et al., 2011). It influences all regions regardless of their socioeconomic status (Mallah et al., 2022). Antibiotic resistant bacteria led to the death of more than 700,000 people each year and it is projected that the annual mortality rate due to antibiotic resistance will surpass by 2050 (Wellcome Trust, 2016). Antibiotic resistance emerges due to the antibiotic misuse (Mallah et al., 2022). Factors contributing to the improper use of antibiotics are easy access to antibiotics, lack of access to healthcare

facilities, youth and old age, and female gender (Grigoryan et al., 2019). Besides, low level of education is considered one of the leading reasons behind antibiotic misuse (Senadheera et al., 2017). However, Grigoryan et al. (2006) point out that high level of education is correlated with the greater risks of antibiotic misuse.

Statement of the Problem

Antibiotic resistance is considered a global health threat, which requires public knowledge for the optimal use of antibiotics and to decrease the proliferation of antibiotic resistance (Waaseth et al., 2019). To support this claim, World Health Organization (2016) indicates that antibiotic resistance constitutes threat not only for health but also for development, and food security.

This issue has several problems that are manifested in increasing mortality rates, morbidity, costs, and persistence of infectious diseases (Church & McKillip, 2021). This is due to the fact that controlling pathogens causing acute or chronic infections become challenging (Kozlov et al., 2024). Since antibiotic resistance emerges from genetic mutations, resistant bacterial strains can emerge globally (Chinemerem Nwobodo et al., 2022). This issue can be found in an array of resources, such as plants, water, soil, animals, and humans (Zeb et al., 2022).

In Jordan, Abdelmalek et al. (2021) indicate that antibiotic resistance is an increasing problem in general and in Jordan as a developing country in particular. They add collaborative efforts of academic institutes, World Health Organization and the Ministry of Health (MoH) work collaboratively to raise public awareness regarding the appropriate usage of antibiotics and the use of social media platforms for promoting health issues along with launching campaigns for health awareness. However, they argue that there is a need for inclusive, better suited, and public educational campaigns should be organized to raise the public awareness regarding this issue.

To counteract this problem, several solutions can be used such as increase the antibiotic knowledge by raising the public awareness regarding this issue (Abdelmalek et al., 2021). To raise knowledge about antibiotic resistance, it is recommended to organize educational activities on the correct usage of antibiotics, along with the necessity of adhering to the preventive measures; including handwashing, food hygiene, vector control, immunization, and the use of appropriate alternatives to the antibiotics for symptom alleviation (Nusair et al., 2021). Along similar lines, World Health Organization (2001) stress the importance of prohibiting self-initiation of treatment and encouraging health care seeking behavior. Moreover, World Health Organization developed a plan to address antibiotic resistance by (i) raising the public awareness regarding this issue, (ii) boosting behavioral change, (3) organizing communication programs that are tailored to various consumers and audiences (World Health Organization, 2015).

Literature Review

Antibiotics and Antibiotic Resistance

Antibiotics are defined as medications that are used to treat infectious diseases since the beginning of 20th century (Al-Taani et al., 2022). There are various uses of antibiotics that extends beyond medicines. To support this claim, Zhang et al. (2022) point out that antibiotics are used in livestock industries, agriculture, and modern medicine. To clarify, Qiao et al. (2018) state that antibiotics are used in agriculture as bacterial infections in plants and animals as they are considered growth enhancers by promoting the feed efficiency. They add that antibiotics are used for treating and preventing human diseases. To illustrate, antibiotics are employed in a variety of drug treatment strategies due to their importance in healing and accelerating the recovery from any disease (Akbar et al., 2021).

The misuse of antibiotics is the major reason behind antibiotic resistance, particularly in low-and-middle-income countries (Chen et al., 2021). Antibiotic resistance is resulted in form of genes that emerge from several factors; including the ongoing release of antibiotics promoting the generation of these genes and causing chemical pollution (Jian et al.,2021). Antibiotic resistance is considered a global concern, which affects developing and developed countries and thus needs a global response to counteract this issue (Nukaly et al., 2024). If not effectively addressed, antibiotic resistance could cause a $100.2 trillion global GDP reduction and result in 10 million deaths annually by 2050 (O'Neill, 2014; de Kraker et al., 2016). Similarly, Jianvitayakij et al. (2024) indicate that antibiotic resistance constitutes a critical global health concern.

Antibiotic resistance results from unnecessary and excessive use of antibiotics (Laupland et al., 2016). Antibiotic is an issue of global concern for scientists; however, the majority of the patients are oblivious about the side effects of the excessive usage of antibiotics (Blaser, 2016). This issue is aggravated in developing countries due to the easy

access of these medications in pharmacies that are available for patients without prescriptions (Church & McKillip, 2021). Therefore, patients purchase these medications without adhering to the correct doses or by omitting doses without consulting their doctors (Kozlov et al., 2024). Possibly, their lack of awareness about the seriousness of this issue (Islam, 2021). Unknowingly, they believe that taking medicines will improve their health (Ashiru-Oredope et al., 2021).

Accordingly, the factors leading to antibiotic resistance are poor compliance with dosage promotion, advertising, and regimens, self-medication, and misperceptions (Muteeb et al., 2023). Other factors that contribute to antibiotic resistance are a positive view on the value of medications, high education level, and health professional background (Waaseth et al., 2019).

The results of these factors affect the individuals' health by reducing the therapeutic capacity of antibiotics against animal and human pathogens (Aslam et al., 2021). Since the 21st century, antibiotic resistance has become a considerable burden for humans because it poses great risk to the ecological environment and public health. It constitutes an economic burden and leads to hundreds of thousands of mortalities (Muteeb et al., 2023).

Knowledge of Antibiotics, Antibiotic Resistance, and Misuse of Antibiotics

Several studies were conducted to investigate the antibiotic resistance, knowledge, and attitudes about antibiotic resistance among individuals. In their study, Nukaly et al. (2024) carried out a study about antibiotic resistance and use among medical students. To this end, a questionnaire was distributed to (353) medical students in Jeddah, Saudi Arabia, to explore their knowledge regarding antibiotic use and resistance among medical students. The study found that the majority of students accounting for (92.40%) agreed that antibiotics were beneficial in counteracting bacteria, while the minority of them (25. 20%) claimed that antibiotics were ineffective in combating viruses. A majority of the respondents (53.80%) postulated that bacterial infections might be treated without the use of antibiotics. This indicates that Saudi students are knowledgeable about the importance of antibiotics. However, nursing students in Thailand do not have adequate knowledge regarding antibiotic use and resistance. This is evident in Jianvitayakij et al. (2024), which found that the majority of the students have lack understanding of antibiotic resistance and have misconceptions about curable diseases. Therefore, the study called for integrating antibiotic content into nursing curriculum.

In addition, Waaseth et al. (2018) investigated the knowledge of antibiotic and their resistance in Norway. The study further examined the impact of attitudes, beliefs, and sociodemographic factors on this knowledge. The sample contained (877) Norwegian pharmacy customers. The data were collected using a questionnaire aiming to assess the knowledge, beliefs, and antibiotic resistance among the respondents. The data were analyzed quantitatively. The study found that more than half of the respondents (57%) have knowledge about antibiotics, whereas (71%) of them are familiar with antibiotic resistance. The majority of them (90%) are aware that antibiotics may grow resistance to germs, hence, needless usage of them can reduce their efficacy. In addition, a minority of them (30%) pointed out that antibiotics are effective against influenza, colds, and viruses. Knowledge of antibiotics was adversely correlated with male gender, a less restricted attitude toward antibiotic usage, and young age. Waaseth et al.'s (2018) results align with Nukaly et al. (2024) concerning the familiarity of antibiotics and antibiotic resistance among the respondents.

Similarly, Akbar et al. (2021) investigated the knowledge of future healthcare workers in Saudi Arabia regarding antibiotics and antibiotic resistance. The study further investigated the factors affecting the students' knowledge. To this end, the study distributed a questionnaire to (284) pharmacy, nursing, and clinical laboratory science students. The data were analyzed using multiple regression analysis. The findings showed that students' knowledge of antibiotics and antibiotic resistance was above average. The study identified several factors affecting students' knowledge, including attendance at seminars/training, awareness about antibiotic resistance, perception of the gravity of the antibiotic resistance issue, program, gender, and academic level. The study recommended improving students' knowledge about antibiotics by reviewing and enhancing the curricular content to meet the particular learning needs of students regarding such concepts.

However, Javed et al. (2023) conducted a study on the knowledge, awareness, and practices towards antibiotics and antibiotic resistance among educated vs. uneducated people in Pakistan. The study used a validated questionnaire for collecting the data to (3,600) participants. The study found that (55.5%) of the participants purchase non-prescription antibiotics. Similarly, (55.5%) of them reported buying antibiotics with medical prescriptions.

Interestingly, the study revealed that the majority of self-antibiotic takers (56.9%) cease antibiotic use early when they feel better. The majority of the respondents (90%) indicated that pharmacists and doctors' staff do not guide them regarding the appropriate use of antibiotics. More importantly, (60.3%) of the respondents unknowingly believe that antibiotics could ameliorate their recovery from colds and coughs. A minority of them (20%) believed that antibiotics disrupted the balance of beneficial bacteria. Moreover, the study found that (15.9%) of respondents hold the view that the overuse of antibiotics leads to bacterial resistance.

Within the Jordanian context, Karasneh et al. (2021) carried out a study on the antibiotic use, resistance, attitudes and behaviors among healthcare providers. The sample consisted of 613 prescribers; (409) physicians and (204) dentists. The data were collected using an online questionnaire. The study found that knowledge on the optimal use, associated side effects, or unnecessary use of antibiotics was high (90%). Their knowledge regarding the spread of antibiotics accounted for (62.2%). The study found that (28.4%) of participants prescribed antibiotics either multiple times a day or more than once a week. For those who prescribed antibiotics, (63.4%) indicated that they never or rarely provided resources on the responsible use of antibiotics for infections.

Numerous studies (Chen et al., 2021; Al-Magableh et al., 2023; Mallah et al., 2022) investigated the misuse of antibiotics. First off, Chen et al. (2021) conducted a study on the lack of antibiotic knowledge and misuse of antibiotics by medical students in Mali. To this end, a questionnaire was distributed to 446 medical students. The study found that the level of knowledge concerning antibiotics and antibiotic resistance was very poor among students, with a percentage 4.12 out of 10. The study recommended promoting the students' education on the rational use, antimicrobial resistance, and the mechanism of antibiotics.

Similarly, Al-Magableh et al. (2023) carried out a study on the misuse of antibiotics in Jordan. To achieve this objective, (28) articles published from 2013 to 2023 were reviewed. The study found that the main reasons behind antibiotic misuse in Jordan are attributed to the convenience of purchasing antibiotics without a prescription, as well as the availability of antibiotics. The study further found a widespread occurrence of antibiotic misuse among Jordanians, particularly among children with upper respiratory tract infections. The study found some reasons behind the prevalence of antibiotic misuse in Jordan, including the level of education, financial circumstances, and cultural factors.

In their study, Mallah et al. (2022) examined the correlation between the education level and the misuse of antibiotics among the general population. To this end, the study conducted a systematic literature review by reviewing (85) studies related to the topic under investigation. The results revealed that higher education levels were generally correlated with lower levels of antibiotic misuse, especially in high-income countries. By contrast, the findings in Europe revealed that a high education level was not a predictor of antibiotic misuse. This implies that educational level was not the main predictor of antibiotic misuse across distinct countries.

This study is different from the previous studies in investigating the knowledge about antibiotics, antibiotic resistance, and antibiotic misuse among Jordanians who studied nursing and pharmacy in Al-Balqa Applied University in Jordan, namely, Mutah University in Karak, Al-Balqa University in Tafila, Al-Hussein University in Ma'an, and A branch of Al-Balqa University at Ma'an University. By doing so, this study bridges the gap in the literature concerning the lack of studies conducted in this field.

Methodology

Study Population and Data Collection

In this study, the researcher used a cross-sectional descriptive study by employing a validated questionnaire. The study completed the validation process employing a representative sample, showing sufficient validity and reliability. This study was carried out from October 2024 to March 2025 among nursing and pharmacy in branches of Al-Balqa Applied University in Jordan, namely, Mutah University in Karak, Al-Balqa University in Tafila, Al-Hussein University in Ma'an, and A branch of Al-Balqa University at Ma'an University. A sample of 300 students was selected using convenience sampling. The students were Jordanian students majoring in nursing and pharmacy at Al-Balqa Applied University who consented to participate.

The participants possess either diploma-level or bachelor's degree qualifications. The rationale behind selecting them in particular is attributed to the differences between pharmacy and nursing students in terms of their

knowledge regarding antibiotics, their use, and antibiotic resistance. Akbar et al. (2021) indicate that nursing students exhibited higher knowledge concerning antibiotics and their appropriate use compared to pharmacy students. However, they found that pharmacy students have higher knowledge levels concerning antibiotic resistance compared to nursing students. Such differences might be related to the differences in the content and curricular focus across the two programs (Inácio et al., 2017). Nursing education might concentrate on the practical aspects of patient education and antibiotic administration (Lee et al., 2015). However, pharmacy curricula might concentrate on the microbiological and pharmacological mechanisms behind antibiotic resistance (Khan et al., 2021). However, the study excluded those who do not have professional courses and who are still in the preparatory program of the university.

Instrument of the Study

The study used a survey questionnaire to collect the data. The questionnaire contained a section for investigating the demographic variables of the participants, including program, gender, year level, and type of living community. To measure the variable regarding background on antibiotics and antibiotic resistance, the study used a questionnaire in the form of a yes/no question to measure the respondents' awareness of antibiotic resistance. These questions revolved around the students' knowledge regarding antibiotic resistance and the students' awareness concerning the problems of antibiotic resistance throughout their course study. Moreover, the questionnaire addressed if the students enrolled in a pharmacology course in college, if they attended training/seminars regarding antibiotic resistance in the past year, if they opine that antibiotic resistance is a serious issue, and if they are familiar with the WHO agenda on antibiotic resistance.

The study adopted an instrument from Akbar et al. (2021) to assess the students' knowledge of antibiotics, their use, and resistance. Akbar et al.'s (2021) instrument was validated by a jury of six experts who refined the content of the instrument in terms of its suitability in measuring the variables under investigation. The instrument has an acceptable reliability that was manifested in the alphas of 0.71 for knowledge of antibiotics, 0.82 for antibiotic use, and 0.76 for antibiotic resistance.

The questionnaire was in the form of a 4-point Likert scale. In the section entitled 'knowledge of antibiotics, the true examples i.e. penicillin and amoxicillin, while false examples i.e. paracetamol antibiotics, the effectiveness of the antibiotics, the justification and the principle of use, effect on normal microflora of the body, duration treatment, the sensitivity of antibiotics (allergic reaction), and the relationship of antibiotics' with disease. Antibiotic knowledge questions addressed the self-prescription and the indication of antibiotic use. The section entitled 'knowledge of antibiotic resistance' contained questions concerning causes, world issues, and education of antibiotic resistance. The form of responses to these questions is 'True or False'. The study coded the right answer as one, while zero was used to code the wrong answers. The study calculated each section of the questionnaire using a possible score range. To clarify, the scores for knowledge of antibiotics ranged between 0-10, while the scores for knowledge of antibiotic use ranged between 0-5, whereas knowledge of antibiotic resistance varied between 0-8. The low scores signify a poor level of knowledge, whereas a high score signifies a high level of knowledge.

Procedure

The students' approval to participate in the study was taken before the students answered the questionnaire. The researcher informed the respondents concerning the objectives of the study, the required involvement, their right to refuse or cancel participation. For recruitment and data collection, the students were approached during their breaks. The questionnaire was provided for those who signed the informed consent. The respondents were informed that they have to answer the questionnaire independently.

Data Analysis

The study analyzed the data quantitatively using SPSS version 27. To analyze the demographic data and knowledge variables, the study used means, standard deviation, frequency count, and percentages. To analyze the demographic factors affecting the participants' knowledge of antibiotic resistance, uses, and knowledge, the study conducted multiple linear regression. The study created dummy variables for "program" and "academic year level" before including them in the regression analysis. P values less than 0.05 were considered significant.

Descriptive Statistics of the Demographic Variables of the Participants
The following table presents the results of the descriptive statistics for the study sample.

Table 1. Descriptive statistics of the demographic variables

demographic variables		
Age (Mean±SD)	21.15(1.16)	
Gender (Freq, %)	Male	127(42.3%)
	Female	173(57.7%)
Program (Freq, %)		
	Nursing	158(52.7%)
	Pharmacy	142(47.3%)
Year level (Freq, %)		
	2nd year	89(29.7%)
	3rd year	116(38.7%)
	4th year	95(31.7%)
Academic Level (Freq, %)		
	Diploma	81(27%)
	Bachelor	219(73%)
Type of community (Freq, %)		
	Urban	169(65.3%)
	Rural	131(43.7%)
Awareness about the term antibiotic resistance (Freq, %)		
	No	80(26.7%)
	Yes	220(73.3%)
Learned about antibiotic resistance problems during the course study (Freq, %)		
	No	69(23%)
	Yes	231(77%)
Attended Pharmacology course in college (Freq, %)		
	No	217(72.3%)
	Yes	83(27.7%)
Attendance of seminars/ trainings about antibiotic resistance in the last year (Freq, %)		
	No	209(69.7%)
	Yes	91(30.3%)
Do you believe that antibiotic resistance is a serious healthcare problem? (Freq, %)		
	No	86(28.7%)
	Yes	214(71.3%
Awareness about the WHO agenda on antibiotic resistance (Freq, %)		
	No	205(86.3%
	Yes	95(31.7%)

Table 1 indicated that the mean of age of the participants was (21.15), females constituted (52.7%) of the participants, and nursing students constituted the highest percentage (52.7%). In addition, the results showed that 116 (38.75) were third-year students, which is the highest percentage, while undergraduate students constituted (73%) of the participants. The percentage of students from urban communities was (65.3%), while the percentage of students from rural communities was (43.7%). In addition, 220 (73.3%) of the participants indicated that they were aware of the term antibiotic resistance, with 181 (60.3%) of them learning about the problems associated with antibiotic resistance during the study courses. 231 (77%) of the participants also reported that they had enrolled in a pharmacology course, while 209 (69.75%) of them had not attended seminars/training courses on antibiotic resistance in the past year. It is worth noting that 214 (71.3%) of participants believe that antibiotic resistance is a

serious health problem, but 205 (86.3%) of participants are not aware of the WHO agenda about antibiotic resistance.

Respondents' Attitudes towards Knowledge of Antibiotics

The following table presents the results of respondents' attitudes towards knowledge of antibiotics.

Table 2. Descriptive analyses on the knowledge

N	Items	Correct Answer (Freq, %)	Wrong Answer (Freq, %)
1	Amoxicillin and penicillin are antibiotics	243(81%)	57(19%)
2	Paracetamol is an antibiotic	226(75.3%)	74(24.7%)
3	For viral infections, antibiotics are effective	201(67%)	99(33%)
4	For bacterial infection, antibiotics are effective	259(86.3%)	41(13.7%)
5	Antibiotics can be used as a substitute for anti-inflammatory drugs for any kind of pain and inflammation	199(66.3%)	101(33.7%)
6	The use of antibiotics increases the recovery from coughs and colds	211(70.3%)	89(29.7%)
7	It is appropriate to stop taking the antibiotics once the symptoms are relieved	260(86.7%)	40(13.3%)
8	Our body has good bacteria	262(87.3%)	38(12.7%)
9	Antibiotics can kill the good bacteria of the microflora of our body	212(70.7%)	88(29.3%)
10	Antibiotics can cause allergic reactions	261(87%)	39(13%)

Table 2 shows that students have a high level of knowledge about antibiotics, with the percentage of correct answers ranging between 66.3% and 87.3%. The item "Our body has good bacteria" received the highest percentage of correct answers, with 262(87.3%) students answering correctly, while the item "Antibiotics can be used as a substitute for anti-inflammatory drugs for any kind of pain and inflammation" had the lowest percentage of correct answers, with 199(66.3%) students answering correctly.

Respondents' Attitudes towards Knowledge on Antibiotic Use

The following table presents the results of respondents' attitudes towards knowledge of antibiotics.

Table 2. Descriptive analyses of knowledge on antibiotics

N		Correct Answer (Freq, %)	Wrong Answer (Freq, %)
1	Antibiotics are preferred to be used for fever	214(71.3%)	86(28.7%)
2	Antibiotics are preferred to be used for common colds	231(77%)	69(23%)
3	Antibiotics are preferred to be used for cough	210(70%)	90(30%)
4	Once the patient feels better, stop the use of antibiotics	208(69.3% (	92(30.7%)
5	Antibiotic therapy is safe to use for any ailment without consulting a doctor	233(77.7%)	67(22.3%)

The findings in Table 2 showed that students have an advanced level of knowledge regarding the uses of antibiotics. The percentages of correct answers ranged between 69.3% and 77.7%. The item "Antibiotic therapy is safe to use for any ailment without consulting the doctor" received the highest percentage of correct answers, with 233

students (77.7%) answering correctly, while the item "Once the patient feels better, stop the use of antibiotics" received the lowest percentage of correct answers, with 208 students (69.3%) answering correctly.

Respondents' Attitudes towards Knowledge on Antibiotic Resistance

The following table presents the results of respondents' attitudes towards knowledge on antibiotic.

Table 3. Descriptive analyses on Knowledge on Antibiotic Resistance

N	Items	Correct Answer (Freq, %)	Wrong Answer (Freq, %)
1	Antibiotic resistance is a phenomenon in which bacteria resist the effect of an antibiotic to which it was previously sensitive before	223(74.3%)	77(25.7%)
2	The antibiotic resistance problem is a worldwide problem	243(81%)	57(19%)
3	Antibiotic resistance is also a problem is Saudi Arabia	205(68.3%)	95(31.7%)
4	Misuse of antibiotics is the leading cause of antibiotic resistance	233(77.7%)	67(22.3%)
5	Frequent use of antibiotics leads to the loss of sensitivity of antibiotics towards a specific pathogenic bacterium	252(84%)	48(16%)
6	It is necessary to gain more knowledge about the judicial use of antibiotics	240(80%)	60(20%)
7	During antibiotic treatment, skipping some doses does not contribute to the development of antibiotic resistance	228(76%)	72(24%)
8	It is essential to complete the course of antibiotic therapy even if disease symptoms are relieved	220(73.3%)	80(26.7%)

The findings in Table 3 illustrated that the students had a high level of knowledge regarding antibiotic resistance, with correct response rates ranging between 68.3% and 84%. The highest agreement was recorded for item "Frequent use of antibiotic leads to the loss of sensitivity of antibiotic towards specific pathogenic bacteria", where 252 students (84%) answered correctly, while the lowest correct response rate was recorded for item "Antibiotic resistance is also a problem is Saudi Arabia", with 205 students (68.3%) answering correctly.

Discussion

Discussion on the Descriptive Statistics

The descriptive statistics showed that the mean age of the participants was 21.15 years (SD = 1.16). Male participants accounted for 42.3% (127), while female participants accounted for 57.7% (173) of the total participants. As far as the program of study is concerned, most participants belonged to the cohort of nursing students (158 participants), representing 52.7% of all participants, followed by pharmacy students (142 participants) (47.3%). In terms of the academic year, the third-year students comprised the largest group (116 participants, 38.7%), followed by fourth-year students (95 participants, 31.7%) and second-year students taking the third (89 participants, 29.7%). Concerning their academic background, over 73% of the students were pursuing a bachelor's degree (219 respondents), while 27% were diploma students (81 respondents).

From the overall total of the participants, 56.3% (169) were from the community residing in urban areas; the remainder of 43.7% (131) was from rural locales. Out of all the participants, 220 participants (73.3%) were aware of

the antibiotic resistance, while 80 (26.7%) were not. Furthermore, 231 respondents of the sampled group, 77%, reported that they studied the notion of antibiotic resistance in their course, while 69 people (23%) did not.
The statistics indicated that most students did not enroll in a pharmacology course; that is, 217 (72.3%) did not, while only 83 (27.7%) students took it. Regarding seminars or training sessions on antibiotic resistance in the past year, 69.7% (209 participants) stated that they did not attend any, and 30.3% (91 participants) claimed they did. Without the total, 214 students (71.3%) were very apprehensive about the issue of antibiotic resistance in healthcare, while 86 (28.7%) disagreed. Finally, concerning awareness about the WHO agenda for antibiotic resistance, 205 (68.3%) had not been informed, and 95 (31.7%) had.
The finding shows that even though the majority of students know about antibiotic resistance and view it as a critical healthcare problem, there are significant shortcomings in their education and practical training in the use of antibiotics. The high rate of students (73.3%) being aware of the resistance to antibiotics may be attributed to increased awareness and focus by the media regarding the issue around the world. However, low participation in specialized seminars and pharmacology classes shows that institutional approaches may not be fully implemented and embraced in all academic disciplines.
Results correspond to the ones reported earlier by Nukaly et al. (2024), who mentioned that the Saudi medical students had a deep understanding of antibiotics and the concept of antibiotic resistance, but also stressed the importance of enhancing educational programs. Similarly, Akbar et al. (2021), supported these findings, showing that healthcare students acquired more knowledge via seminar and course attendance, which highlighted the need for formal instruction. The lack of involvement in formal pharmacology courses revealed here mirrors results from Jianvitayakij et al. (2024), who observed poor antibiotic awareness among Thai nursing students due to low curricular coverage.
Notably, although most participants understood the importance of antibiotic resistance, an impressive percentage (68.3%) knew nothing about the WHO agenda for managing the problem. This knowledge gap in global health reflects the results of Chen et al. (2021) and Karasneh et al. (2021), who indicated that healthcare professionals and students are both unaware of international efforts that are aimed at addressing antibiotic resistance. Moreover, the higher awareness among females and bachelor's degree holders in this study are in consistent with Waaseth et al. (2018), who concluded that the demographic variables such as gender and academic background affected knowledge levels.
In the Jordanian context, this study supports previous results by Al-Magableh et al. (2023) and Mallah et al. (2022), who indicated that unrestricted access to antibiotics and cultural factors are crucial determinants of antibiotic misuse. These results align with those presented by Javed et al. (2023), who found that educated populations often turn to self-medication, advising increased educational programs, even among university students.
In general, the results suggest the necessity to teach antibiotic resistance more systematically in Jordanian university courses for nursing and pharmacy. Formal courses and more exposure to global health projects like the WHO agenda could assist students in becoming better-informed future healthcare professionals, able to efficiently combat antibiotic resistance.

Discussion on Respondents' Attitudes Towards Knowledge on Antibiotics: Findings, Explanations, and Literature Connections

As Table 2 shows, participants displayed a high level of knowledge of antibiotics, and varying rates of responses to correct answers were from 66.3% to 87.3%. The highest percentage of correct answers was obtained for the statement “Our body has good bacteria,” with 262 students (87.3%) answering this question correctly. Similarly, many students answered the questions about “Antibiotics can cause allergic reactions” correctly (261 students, 87%) and “For bacterial infection, antibiotics are effective” (259 students, 86.3%).
By contrast, the statement, “Antibiotics can be used as a substitute for anti-inflammatory drugs for any kind of pain and inflammation,” showed the lowest accuracy, with only 199 students (66.3%) answering correctly. A smaller percentage of students answered correctly that "For viral infection, antibiotics are effective" (67%, 201 correct responses) and "The use of antibiotics increases recovery from coughs and colds" (70.3%, 211 correct responses).
According to the study findings, participants have strong knowledge, namely, the use of antibiotics as a means of combating bacterial infections, the existence of beneficial bacteria in the body, as well as the risks of allergic reactions that antibiotics can cause. Nonetheless, there are misunderstandings, specifically, with the use of

antibiotics as opposed to anti-inflammatory agents in the case of viral infections are present and the effectiveness of antibiotics against viruses.

One justification for the observed knowledge gaps could be the partial integration of detailed antibiotic education into their study curricula. Even when antibiotic education is provided to some students, widespread misconceptions about viral infections and excessive use of antibiotics in the treatment of relatively minor inflammation explain why it is necessary to devote more attention to the definition of the specific role and boundaries of antibiotics. This result is consistent with the argument from Akbar et al. (2021), who advocate for changes to the curriculum in such a way that antibiotic education in particular becomes more relevant for students' needs.

These results, compared to previous studies, align with the research by Nukaly et al. (2024), who found that most Saudi medical students grasp antibiotics' impact on bacterial infections, but still have misunderstandings regarding their use for viral conditions. In the same vein, Waaseth et al. (2018) reported that despite 90% of customers in Norwegian pharmacies knowing that antibiotics can lead to resistance, 30% wrongly thought that they were effective against viruses, creating massive global confusion.

By contrast, the results indicate that the participants showed higher knowledge of antibiotics than studies in lower-resource settings. For instance, Chen et al. (2021) noted a very low level of knowledge of Malian medical students about antibiotics, as they obtained only a 4.12 mean score out of 10. Similarly, Jianvitayakij et al. (2024) reported a lack of knowledge among Thai nursing students. stressing the significant role of education and training programs in forming awareness.

Concerning the misconceptions surrounding the discontinuation of antibiotics after symptom relief, this study revealed 260 students (86.7%) who accurately understood that antibiotics should not be stopped early, which is in line with the results of Akbar et al. (2021) and Karasneh et al. (2021), where healthcare providers showed awareness of the need of completing antibiotic courses. However, this is contrary to the findings of Javed et al. (2023), who found that 56.9% of Pakistanis were self-quitting antibiotics before completing their course when they felt better, which indicates that Jordanian healthcare students are more susceptible to antibiotic awareness.

In addition, "understanding that antibiotics can harm the body's microflora ", answered correctly by 212 students, 70.7%, is crucial since inappropriate use of antibiotics may disturb the balance of beneficial bacteria, therefore causing health issues. This corresponds with research by Blaser (2016), who underlined the major risks of disturbing human microflora by extensive antibiotic use.

To conclude, despite students at Al-Balqa Applied University and its branches showing good knowledge regarding antibiotics, this study highlighted some ongoing misunderstandings, especially about the use of antibiotics for viral infections and inflammation. These results highlight the importance of developing more effective and tailored educational approaches, like the suggestions proposed by Akbar et al. (2021) and Nukaly et al. (2024), so that students can make responsible antibiotic choices and educate patients effectively.

Discussion on Respondents' Attitudes towards Knowledge on Antibiotic Use

As shown in Table 2, students answered correctly about antibiotic use at an advanced level, with correct response rates ranging from 69.3% to 77.7%. The highest number of students chose the correct option for the item 'Antibiotic therapy is safe to use for any ailment without consulting the doctor,' with 233 students (77.7%) answering correctly. However, the response rate for correct answers was the lowest for the statement 'Once the patient feels better, stop the use of antibiotics,' where 208 students (69.3%) selected the right answers. These findings show that despite that most students know that antibiotics must be used with caution, there is still a gap in recognizing the significance of completing the recommended course even when symptoms improve.

These findings may be explained by the students' partial understanding of the suitable use of antibiotics, may be influenced by public health campaigns and academic education on the risks of antibiotic abuse. Consequently, the presence of misconceptions about stopping antibiotic treatment signals that increased emphasis is needed on treatment compliance. According to previous literature, antibiotic overuse, including the early discontinuation of treatment once symptoms subside, contributes considerably to antibiotic resistance (Chen et al., 2021; Jianvitayakij et al., 2024). As found in Ashiru-Oredope et al. (2021) and Islam (2021), many patients believe that improvement in symptoms indicates the infection has ended and accordingly stop taking antibiotics too soon.

Comparatively, Nukaly et al. (2024) discovered that nearly all Saudi medical students, at a rate of 92.4%, knew the role of antibiotics for bacterial infections, although some remained misconceptions about viral infections. Similarly,

Waaseth et al. (2018) revealed that 71% of customers in Norwegian pharmacies recognized antibiotic resistance, despite the fact that 30% mistakenly thought antibiotics could be used for viral infections like colds and influenza. As shown, these results are consistent with those of the present investigation, demonstrating that educated individuals have substantial but not perfect knowledge of antibiotics.

In contrast, some previous studies produced unsatisfactory results. Jianvitayakij et al. (2024) illustrated that Thai nursing students' knowledge about antibiotic resistance and use was lacking, so they urged educational improvements. Similarly, Javed et al.'s (2023) study showed that antibiotics are frequently misused in Pakistan; around 56.9% of individuals there stop their antibiotic course when symptoms improve, and 60.3% assert that antibiotics could cure common colds.

Karasneh et al. (2021) indicated, in their Jordanian context study, that 90% of healthcare providers had good knowledge about antibiotic use (90%), but there were still knowledge gaps relating to antibiotic resistance (62.2%) and the provision of educational resources to patients. Moreover, investigations by Al-Magableh et al. (2023) and Mallah et al. (2022) show that accessibility without prescription, cultural customs, and different educational levels cause prevalent antibiotic abuse in Jordan.

Therefore, even if the present research corresponds with the results of Nukaly et al. (2024) and Waaseth et al. (2018) in terms of rather high knowledge levels among university students, it also reflects similar challenges identified by Javed et al. (2023) and Chen et al. (2021) regarding persistent misconceptions that contribute to antibiotic misuse. These results highlight the critical necessity of improved education on the full treatment course and safe antibiotic use to combat the developing threat of antibiotic resistance.

Discussion on Respondents' Attitudes towards Knowledge on Antibiotic Resistance

As revealed by Table 3, student knowledge of antibiotic resistance was substantial, with responses showing correct answers between 68.3% and 84%. Out of all the questions, the item "Frequent use of antibiotics leads to the loss of sensitivity of antibiotics towards specific pathogenic bacteria" received the highest correct rate, with 252 student responses (84%). In contrast, only 205 (68.3%) of students answered correctly about "Antibiotic resistance is also a problem in Saudi Arabia." These results indicate that students are mostly aware that antibiotic resistance is an international issue and that the practice of misusing and frequently using antibiotics promotes resistance. However, it appears that the extent of antibiotic resistance is less obvious to the students in local settings like Saudi Arabia.

The results observed may be explained by the impact of global awareness campaigns and educational programs highlighting antibiotic resistance and its abuse risks. Students' high correct response rates on the use of antibiotics causing resistance match the research highlighting the main causes of resistance, including overuse and poor adherence to recommended regimens and overuse (Chen et al., 2021; Laupland et al., 2016; Muteeb et al., 2020). The slightly lower knowledge regarding local antibiotic resistance concerns may result from less frequent regional media coverage or educational focus compared to worldwide arguments.

The pattern described above is in line with earlier studies. Nukaly et al. (2024) reported that over 92% of Saudi medical students understood the use of antibiotics against bacteria, although some misconceptions continued regarding viral illness. Likewise, according to Waaseth et al. (2018), 71% of Norwegian pharmacy customers knew about antibiotic resistance, and 90% could identify how taking antibiotics unnecessarily made resistance worse. These results correspond well with what the current study found, showing that most students understand how and why antibiotic resistance develops.

Akbar et al. (2021) also found that Saudi Arabia's pharmacy, nursing, and clinical laboratory students showed above-average knowledge of antibiotic resistance, with factors including seminar attendance and awareness campaigns improving their understanding. This implies that knowledge levels are much influenced by organized educational exposure, which would help to explain the high scores obtained by students in this study.

However, studies conducted in various settings have exposed significant information gaps in antibiotic resistance. Jianvitayakij et al. (2024) noted that Thai nursing students had insufficient knowledge and notable misunderstandings about antibiotic resistance, calling for curriculum changes. Chen et al. (2021) also found that Mali medical students had a weak average knowledge score (4.12 out of 10) about antibiotics and resistance, implying that knowledge levels are context-dependent and influenced by educational infrastructure and information access.

Additional research reveals that inappropriate antibiotic use remains a big issue. For example, Javed et al. (2023) noted that about 56.9% of participants who used antibiotics on their own stopped using them when they observed

improvement; 60.3% of respondents thought antibiotics treat colds and coughs. These misunderstandings are in contrast to the present results, in which the majority realized the need to complete their antibiotic course.

Karasneh et al. (2021) revealed in the Jordanian setting that prescribers had a high degree of knowledge about antibiotics (90%) and awareness regarding unnecessary use (62.2%). However, a substantial portion of healthcare providers did not regularly guide patients on appropriate antibiotic use, suggesting a gap between knowledge and practice.

The results of this study align with the major pattern found in studies from Saudi Arabia and Norway (Nukaly et al., 2024; Waaseth et al., 2018; Akbar et al., 2021), but are quite different from those in Mali, Thailand, and Pakistan (Chen et al., 2021; Jianvitayakij et al., 2024; Javed et al., 2023), which report an overall poorer understanding of antibiotic resistance. The study thus validates that despite a few misunderstandings about regional antibiotic resistance issues, indicates the need for more localized training efforts, Jordanian pharmacy and nursing students have rather high awareness.

Ultimately, this study adds to the available literature by examining the knowledge of antibiotic resistance among nursing and pharmacy students from Mutah University in Karak, Al-Balqa University in Tafila, Al-Hussein University in Ma'an, and a location of Al-Balqa University at Ma'an University. This study underlines the continuous need for stressing thorough, localized, and useful antibiotic stewardship education to help further reduce the worldwide problem of antibiotic resistance.

Conclusion

This study investigated among pharmacy and nursing students in many branches of Al-Balqa Applied University in Jordan their awareness of antibiotic usage, abuse, and resistance. The results showed that most students, especially with regard to their proper use and the risks connected with their abuse, have a high level of awareness about antibiotics and antibiotic resistance. Nonetheless, several gaps and misunderstandings remain, especially in terms of acknowledging regional antibiotic resistance issues and distinguishing the efficacy of antibiotics against viral diseases. These results suggest that universities include more targeted educational modules in nursing and pharmacy curricula, emphasizing the risks of inappropriate antibiotic use, the need to complete prescribed courses, and raising awareness about both global and regional antibiotic resistance challenges, Furthermore, seminar participation, workshops, and WHO-led projects should be encouraged to improve pragmatic knowledge and promote safe antibiotic use.

The study findings offer significant implications to curriculum developers, policymakers and education specialists in healthcare settings aiming to promote better antibiotic usage among future health professionals. Improving educational initiatives related to antibiotics can reduce the expanding threat of antibiotic resistance in Jordan and aid worldwide health efforts. Nonetheless, certain limitations should be noted: the study was limited to a particular set of universities, thus caution should be used when extending results to all healthcare students in Jordan; the study relied on self-reported questionnaires, which may introduce response bias; and the sample was drawn from a convenience method rather than randomized selection, so limiting the generalizability of outcomes. Future studies are urged to use randomly selected, larger samples, include recurrent data collecting, and investigate not only students' attitudes, knowledge, and beliefs but also their actual activities.

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