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Knowledge, attitudes, and practice with respect to antibiotic use among pharmacy students: a cross-sectional study

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Abstract. – OBJECTIVE: Antibiotic resistance is a major health threat and efforts should be intensified to reduce its burden. Healthcare providers, especially pharmacists, can be actively involved in the reduction of antibiotic resistance. However, negative practices among pharmacists have been observed. This study evaluated knowledge, attitudes, and practices (KAP) among Jordanian pharmacy students.

PATIENTS AND METHODS: A cross-sectional study used an online questionnaire that was developed and distributed to Jordanian pharmacy students from five different universities. KAP scores were calculated, with students categorized into low and high levels based on each score mean.

RESULTS: A total of 890 pharmacy students completed the questionnaire. High positive response rate (PR%) for the majority of the knowledge items was observed, exceeding 60% in all knowledge items, and similar PR% was observed in attitude items. The variables significantly associated with attitude were age [OR=0.92 (95% CI 0.87: 0.98), *p*=0.01] and knowledge [OR=1.35 (95% CI 1.01:1.82), p=0.04], while knowledge was significantly associated with practice [OR=0.23 (95% CI 0.16:0.31), *p*<0.001].

CONCLUSIONS: Jordanian pharmacy students showed adequate KAP toward the use of antibiotics although several aspects of malpractice were identified. Hence, adequate knowledge about antibiotics among pharmacy students should be ensured as knowledge is associated with attitudes and practices.

Key Words:
Antibiotics, Knowledge, Attitudes, Practice, Pharmacy students.

Introduction

Antibiotics have contributed to the reduction of mortality and morbidity caused by microbes worldwide[1]. However, antibiotic resistance is a global health challenge that threatens the success of antibiotics. According to the Center of Disease Control (CDC), antibiotic resistant bacteria cause more than 2 million infections and the deaths of over 35,000 people annually[2]. Growing number of infections including pneumonia, tuberculosis, gonorrhea, and salmonellosis are becoming harder to treat due to bacterial resistance[3]. Antibiotic resistance is also associated with longer hospitalization period and higher medical costs[3]. Although it happens naturally, antibiotic resistance is accelerated by their misuse and overuse[2]. In developing countries, the situation is exacerbated due to high antibiotic accessibility by the general population. For example, in most Middle Eastern countries, antibiotics are sold as over the counter medicines[4,5].

Pharmacists can significantly contribute to either reducing or increasing antibiotic resistance as they are the most accessible healthcare providers and often represent the first point of contact

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with patients[6]. Moreover, pharmacists have a strong influence on patients' decisions regarding purchasing antibiotics[7]. Unfortunately, several studies have reported[8-10] negative practices of pharmacists in relation to the sale of antibiotics. For instance, in studies conducted in Syria[8], and Saudi Arabia[9], 87% and 98.8% respectively of pharmacists showed no hesitancy in selling antibiotics without prescription to the investigators. Furthermore, in a study[10] conducted in Jordan, 86.6% of the pharmacists surveyed incorrectly believed that selling antibiotics without prescription was legal.

To change such negative behaviors among pharmacists it would be reasonable to begin with assessing pharmacy students' knowledge, attitudes, and practices (KAP) toward antibiotics usage and antibiotic resistance. This will help to identify the gaps that create these negative behaviors, as pharmacy students represent the next generation of pharmacists. In previous work conducted in Trinidad and Tobago and Saudi Arabia, pharmacy students have shown poor attitudes and practices towards antibiotic use. In Jordan, pharmacists' KAP toward antibiotics use and resistance have been investigated in several studies[13-15]. However, this is the first study to assess Jordanian pharmacy students' KAP toward antibiotics usage and resistance.

Patients and Methods

Design and Ethics

This cross-sectional online study was conducted in March 2021. For this study we selected the five universities that had the largest pharmacy campuses by enrollment in Jordan. The three public universities were located in Amman and Irbid, the two largest cities in Jordan. The two private universities were located in Amman, the capital city of Jordan. This was done in order to get a presentative sample of pharmacy students in Jordan.

A questionnaire was distributed online through the official websites of pharmacy departments in the different universities. The study included students from both pharmacy study programs in Jordan (Bachelor's in pharmacy and Doctor of Pharmacy). Ethical approval was obtained from Al-Zaytoonah University Ethics Committee. The research was carried out in accordance with Declaration of Helsinki guidelines and regulations. A consent form was included at the beginning of the questionnaire.

Study Instruments

After a literature review, an English questionnaire was developed and adapted from Khan et al[16]. This questionnaire was found suitable for this study as it was previously applied to evaluate antibiotics KAP among pharmacy students in Saudi Arabia[17]. The content validity of the questionnaire was confirmed by a panel of five experts from the fields of infectious diseases, pharmacology and clinical pharmacy. The questionnaire's face validity among Jordanian pharmacy students was confirmed in a pilot study of 30 pharmacy students (their responses were not included in the final dataset).

The first part of the questionnaire collected the students' characteristics, including age, sex, study program, study year, type of university (public or private), and grade point average. The second part assessed students' knowledge regarding antibiotics usage and resistance with answers of true or false. The third part evaluated the students' attitudes toward antibiotics usage and resistance, and included six 5-point Likert type statements (strongly disagree-strongly agree). The fourth part included eight 5-point Likert type statements (always-never) that assessed the practices regarding antibiotic self-medication. The final part evaluated students' perceptions of the dangers of antibiotic resistance. Respondents had to complete all the questions before being able to submit the questionnaire.

To obtain the positive response rate (PR), the sum of the students' responses of strongly disagree and disagree to the attitude items was calculated. PR% was calculated as the rate of PR by dividing the PR by the total number of responses. The PR for the item "Whenever I take an antibiotic, I contribute to the development of antibiotic resistance" was calculated as the sum of strongly agree and agree. For the practice items, the "Always" response was used to calculate the PR and PR% for items 1e, 2, and 3, while for the rest of items the "Never" responses were used to represent the PR and the PR%.

Three scores were calculated for knowledge, attitudes, and practices. Knowledge score was computed based on the knowledge items: with a correct response one point was awarded, while an incorrect response granted no points. The scoring of the attitude ranged from 1 ("strongly disagree") to 5 ("strongly agree") for all items, except for the item "Whenever I take an antibiotic, I contribute to the development of antibiotic resistance", where reversed scoring was used.

The practice scoring ranged from 1 point for "Always" to 5 points for "Never" for all items except for 1e, 2 and 3 where reversed scoring was used. Students were categorized based on mean scores into having low or high levels of knowledge, attitudes, and practices.

Sampling Type and Sample Size

A convenience sampling method was adopted in this study. The Kish and Leslie formula was used at a 95% significance level and a 5-percentage-point margin of error to determine the required sample size. The minimum required estimated sample size was 385.

Statistical Analysis

Data analysis was conducted using SPSS version 27 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations (SD). Binary regressions with 95% CI were conducted to identify the predictors of knowledge, attitude, and practice. Variables included in the models were age, sex, study program, university type, and grade point average.

Results

A total of 890 students completed the questionnaire. Of these, 691 (77.6%) were female and 199 (22.4%) were male. The mean age of the sample was 22 years. The majority were Bachelor's in pharmacy students (82.5%), and most were in their third or fourth year of study. About two thirds of the participants (59.21%) were public university students (Table I).

Table I. Sample demographics.

Demographics	Frequency (%) or mean (± SD) n = 890
Age	22 ± 3
Sex	
Male	199 (22.4)
Female	691 (77.6)
Study program	
Bachelor's in pharmacy	734 (82.5)
Bachelor's in Doctor of Pharmacy	156 (17.5)
Study year	
First year	38 (4.3)
Second year	26 (2.9)
Third year	127 (14.3)
Fourth year	423 (47.5)
Fifth year	270 (30)
Sixth year	6 (0.7)
University type	
Public	527 (59.21)
Private	363 (40.69)

Assessment of Knowledge of Antibiotics

Nine questions were used to assess antibiotic knowledge. As illustrated in Table II, 763 (86%) of participants agreed that "Inappropriate use of antibiotics can increase the incidence of adverse effects"; 773 (87%) agreed that "Inappropriate use of antibiotics can lead to ineffective treatment"; 718 (81%) agreed that an "Inappropriate use of antibiotics can lead to exacerbation or prolongation of illness". Most participants (814; 92%) agreed that an "Inappropriate use of antibiotics can lead to an emergence of bacterial resistance and additional burden of health care cost to the patient" (795; 89%). Moreover, 819 (92%) students agreed with the statement: "If antibiotics are taken too often it may be less likely to work in the future". On the other hand, only 332 (37.3%) stated that bacteria are germs that

Table II. Assessment of knowledge on antibiotics usage among pharmacy students.

	True	False
Indiscriminate and Injudicious use of antibiotics can lead to		
Increased adverse events (True)	763 (85.74)	127 (14.26)
Ineffective treatment (True)	773 (86.85)	117 (13.15)
Exacerbation or Prolongation of illness (True)	718 (80.67)	172 (19.33)
Emergence of bacterial resistance (True)	814 (91.46)	76 (9.54)
Additional burden of medical cost to the patient (True)	795 (89.32)	95 (10.68)
If taken too often, antibiotics are less likely to work in the future (True)	819 (92.03)	71 (7.97)
Bacteria are germs that cause common cold and flu. (False)	315 (35.39)	575 (64.61)
Antibiotic Resistance is		
An important and serious public health issue facing the World. (True)	601 (67.52)	289 (32.47)
An important and serious public health issue in our Country. (True)	558 (62.69)	332 (37.30)

lead to the common cold and flu. Most (601; 68%) were attentive to the importance of antibiotic resistance and serious public health issues globally and locally.

Assessment of Attitudes Toward Antibiotics

As shown in Table III, six questions assessed students' attitudes toward antibiotics usage. In this research, more than half of the participants did not believe that antibiotics are safe drugs, therefore they can be commonly used to treat various diseases (PR 575; 64.6%). The item "When I have a cold, I should take antibiotics to prevent getting a more serious illness'' received highest PR% (74%) with the PR of 660. Most pharmacy students did not agree with the statement "When I get fever, antibiotics help me to get better more quickly" where the PR was 507 (56.6%). Most of the students (PR 570; 64.04%) disagreed with the statement "When antibiotics are utilized properly for the right indication and right duration, they will also result in bacterial resistance". However, only 44.7% of the students agreed with the point "Whenever I take an antibiotic, I contribute to the development of antibiotic resistance". The majority disagreed with the fact that skipping a dose or two of antibiotics have no role in the emergence of antibiotic resistance (PR 578; 65%).

The Assessment of Medication Practice

As described in Table III, eight questions assessed knowledge of medication practice. The response 'Never' was used to calculate the PR% for the following items: "The doctor prescribes a course of antibiotics for you. After taking 2-3 doses you start feeling better. Do you stop taking the further treatment?"; "Do you save the remaining antibiotics for the next time you get sick?"; "Do you discard remaining leftover medication?"; "Do you give the leftover antibiotics to your friend or relatives if they get sick?"; and "Do you prefer to take an antibiotic when you have cough and sore throat?". Among these questions, the highest positive responses were found to be to the question "Do you stop taking further treatment?" with a PR of 460. On the other hand, the items "Do you discard remaining left-over medications?" and "Do you prefer to take an antibiotic when you have a cough and sore throat?'' received the least positive responses with PRs of 300 and 238, respectively.

The PR in the statements "Do you check the expiry date of the antibiotic before using it?" (PR%=71.6%), "Do you complete the full course of treatment?" (PR%=61%) and "Do you consult a doctor before starting an antibiotic?" (PR%=30.4%) was based on the frequency of "Always" responses.

Assessment of the Variables Associated with Knowledge, Attitudes, and Practice Levels

The means of the three calculated scores were as follows: knowledge 7.21 out of 9, attitude 14.11 out of 30, and practice 30.57 out of 40. Of the 890 participants, 471 had a high knowledge level, 368 had a high attitude level, and 500 had a high practice level.

Table IV shows the results of the binary regressions of knowledge, attitude, and practice. Sex and university type were significant predictors of knowledge and practice. Being female significantly increased the odds of having high levels comparing to males (OR=1.49, p=0.03 and 1.69, p=0.03 respectively), while being a private university student significantly decreased the odds of having high levels compared to public university students (OR=0.65, p=0.01 and 0.68, p=0.03, respectively). The significant predictors of attitude were age (OR=0.92, p=0.01) and knowledge (OR=1.35, p=0.04). Knowledge was a significant predictor of practice level, as having low knowledge decreased the odds of having a high practice level (OR=0.23, p<0.001).

Perception of the Importance of the Factors Causing Antibiotic Resistance

Perceptions of the importance of different factors causing antibiotic resistance are shown in Figure 1. The factor with the most frequent "important" response was "Mutational and evolutionary changes in the microorganism" (59.7%), while the factor with the lowest frequency was "Use of antibiotics for self-limited bacterial infections" (35.7%).

Discussion

This is the first study to assess pharmacy students' knowledge, attitudes, and practices toward the usage of antibiotics in Jordan. Given the high prevalence of dispensing antibiotics without prescription in Jordan as previously reported[18] is crucial to understand the knowledge and attitude

Table III. Assessment of attitudes and practice toward antibiotics usage among the pharmacy students.

	Strongly disagree	Somewhat disagree	Undecided	Somewhat agree	Strongly agree	PR frequency	PR%
[a]When I have a cold, I should take antibiotics to prevent getting a more serious illness.	427 (48%)	233 (26.2%)	95 (10.7%)	98 (11%)	36 (4%)	660	74.2
[a]When I get fever, antibiotics help me to get better more quickly.	246 (27.6%)	261 (29.3%)	127 (14.3%)	204 (22.9%)	51 (5.7%)	507	56.63
[b]Whenever I take an antibiotic, I contribute to the development of antibiotic resistance.	137 (15.4%)	198 (22.2%)	157 (17.5%)	229 (25.7%)	169 (19%)	398	44.7
[a]Skipping one or two doses does not contribute to the development of antibiotic resistance.	330 (37.1%)	248 (27.9%)	157 (17.6%)	91 (10.2%)	63 (7.1%)	578	64.94
[a]Antibiotics are safe drugs; hence they can be commonly used.	326 (36.6%)	249 (28%)	128 (14.4%)	137 (15.4%)	49 (5.5%)	575	64.61
[a]When antibiotics utilized properly for the right indication and right duration, will also result in bacterial resistance?	332 (36.2%)	238 (26.7%)	146 (16.4%)	127 (14.3%)	56 (6.3%)	570	64.04
	Never	**Seldom**	**Sometimes**	**Usually**	**Always**	**PR Frequency**	**PR%**
1. The Doctor prescribes a course of antibiotic for you. After taking 2-3 doses you start feeling better.							
a. [c]Do you stop taking the further treatment?	460 (52%)	71 (8.0%)	137 (15.4%)	130 (14.6%)	92 (10.3%)	460	51.68
b. [c]Do you save the remaining antibiotics for the next time you get sick?[c]	388 (43.6%)	86 (9.7%)	159 (17.9%)	168 (18.9%)	89 (10.0%)	388	43.59
c. [c]Do you discard the remaining, leftover medication?	300 (33.7%)	117 (13.1%)	210 (23.6%)	151 (17.0%)	112 (12.6%)	300	33.70
d. [c]Do you give the leftover antibiotics to your friend/roommate if they get sick?	423 (47.5%)	91 (10.2%)	162 (18.2%)	152 (17.1%)	62 (7.0%)	423	47.52
e. [d]Do you complete the full course of treatment?	26 (2.9%)	22 (2.5%)	97 (10.9%)	202 (22.7%)	543 (61.0%)	543	61
2. [d]Do you consult a doctor before starting an antibiotic?	24 (2.7%)	69 (7.8%)	257 (28.9%)	269 (30.2%)	271 (30.4%)	271	30.4
3. [d]Do you check the expiry date of the antibiotic before using it?	14 (1.6%)	23 (2.6%)	81 (9.1%)	135 (15.2%)	637 (71.6%)	637	71.6
4. [c]Do you prefer to take an antibiotic when you have cough and sore throat?	238 (26.7%)	176 (19.8%)	265 (29.8%)	157 (17.6%)	54 (6.1%)	238	26.74

PR=Positive response, [a]= PR was based on the frequency of Strongly disagree and disagree, [b]= PR was based on the frequency of Strongly agree and agree, [c]= PR was based on the frequency of Never, [d]= PR was based on Always.

Table IV. Binary regressions of knowledge, attitudes, and practice levels.

	Knowledge level				Attitudes level				Practice level			
	Odds Ratio	95% Confidence Interval		*p*-value	Odds Ratio	95% Confidence Interval		*p*-value	Odds Ratio	95% Confidence Interval		*p*-value
		Lower	Upper			Lower	Upper			Lower	Upper	
Age	1.02	0.97	1.08	0.39	0.92	0.87	0.98	**0.01**	1.01	0.95	1.06	0.82
Sex												
Females compared to males	1.49	1.04	2.13	**0.03**	0.73	0.51	1.05	0.09	1.67	1.14	2.47	0.01
Study program												
B-pharm compared PharmD	0.62	0.42	0.92	**0.02**	1.48	1.00	2.18	0.05	0.70	0.45	1.07	0.10
University type												
Private compared to public	0.65	0.47	0.90	**0.01**	1.05	0.76	1.47	0.76	0.68	0.48	0.97	**0.03**
Grading point average	1.00	0.99	1.00	0.49	1.00	1.00	1.01	0.44	1.00	1.00	1.00	0.68
Knowledge level												
Low compared to high	-	-	-	-	1.35	1.01	1.82	**0.04**	0.23	0.16	0.31	**< 0.001**
Attitudes level												
Low compared to high	-	-	-	-	-	-	-	-	1.38	1.00	1.89	0.05

Bold indicates significance at $p < 0.05$.

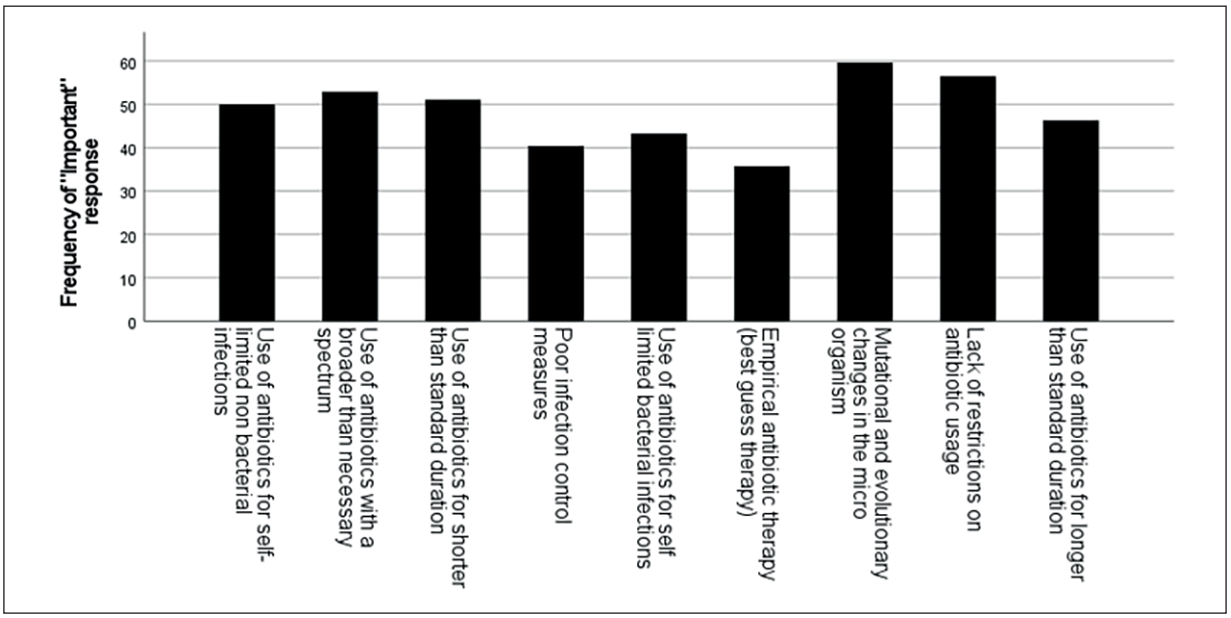

Figure 1. The students' perception of the importance of the different factors causing antibiotic resistance.

of the pharmacy students in order to develop effective interventions and policies to address the issue of antibiotic resistance in the broader public health interest.

Most of participants showed good knowledge about the indiscriminate and injudicious use of antibiotics, as well as future effectiveness of antibiotics following frequent dispensing. Only two thirds of participants had positive responses regarding the causes of the common cold and flu, as well as the knowledge about bacterial resistance. Concerning attitudes towards antibiotics usage, about two third of students had positive response rate indicating accurate attitude toward antibiotic usage. As for assessment of antibiotics medication practice among the pharmacy students, positive response rates varied from high (98.3%) to low (26.7%), indicating a fluctuation among the practice of antibiotic usage among themselves.

A similar work[19] was conducted with medical students in Mali and reported poor knowledge and misuse of antibiotics. Furthermore, according to a survey[20] conducted in South Africa, only a small minority of medical students possessed confident knowledge related to antibiotics. In another survey[21] conducted in Malaysia, the majority of university medical students were unaware of the proper use of antibiotics. Importantly, our results are similar to a previous study[22] with Chinese medical students, that reported that during their consultation with a clinician for a self-limiting sickness, over half had taken antibiotics, with 39% receiving injectable antibiotics. Although four out of five students said that colds are self-limiting and remit without treatment, three-quarters of those who took antibiotics thought they were necessary. The higher the rate of knowledge, the more likely it was to anticipate appropriate prescribing behavior[23]. Students' beliefs that antibiotics were required could be due to a lack of knowledge regarding the nature of their sickness.

In terms of antibiotic usage, a total of 34 studies[24] conducted in developing countries indicated that the overall rate of antimicrobial self-medication among adult adults was 38.8%, with relatively high levels in Ethiopia (86%) with antibiotics primarily obtained from pharmacies. Another study[25] indicated that self-medication with antibiotics is frequent among students in Ghana, where self-medication was reported to be 70%. Students with higher medical training were more likely to self-treat with antibiotics and be prescribed antibiotics, according to previous findings[26]. This could be because these students have the training and confidence to self-treat or seek antibiotics from a doctor, which seems counterintuitive[26]. Similar outcomes were found in a French study[27]. To the best of our knowledge, no previous work has evaluated the knowledge and antibiotic usage of pharmacy students.

In binary regression analysis, significant differences were found related to sex, study program, university type, with knowledge, while attitude was significantly associated with age only, on the other hand practice level was associated with sex and university type. Importantly, a low knowledge score was associated with low attitude and poor practice concerning antibiotic usage. Students who lack knowledge about the dangers of indiscriminate and injudicious use of antibiotics, the frequency of antibiotics usage, how to treat common cold and flu and the ramifications of antibiotic resistance had low attitude and malpractice related to antibiotic usage. Furthermore, many students believed that antibiotics provide a significant advantage and that there are few barriers to using antibiotics.

Higher Knowledge scores could indicate better students with higher high school scores that will be admitted into public and not private schools and into PharmD instead of BPharm programs. Alongside the knowledge that influences attitudes and practices there are other factors that determine antibiotic overuse. For example, 64.7% of students reported using antibiotics for self-limiting illnesses, including common colds. Therefore, it should be clarified that antibiotic may be particularly lifesaving in severe infection, while self-limiting, including common colds and uncomplicated diarrhea, do not require antibiotics. Moreover, antibiotics are widely available at retail pharmacies and even marketplaces, where they can be easily acquired and stored at home. Antibiotics are often referred to "peanuts" in Jordan, due to their widespread use[18].

Actions should be implemented to address the problem of antibiotic overuse. Patients, medical students, pharmacists, medical staff, policymakers, and hospitals administrations should all be included in the process[28]. Given the prevalence of self-medication, it is evident that addressing the demand side is critical[29]. Health promotion initiatives aimed at the general population, as well as at pharmacists, must be carried out with basic, straightforward messaging. Knowledge of antibiotic resistance can also be raised through the use of mass and social media. Antibiotic and antimicrobial resistance knowledge should also be included in Pharmacy school curricula as lack of awareness is acknowledged as a risk factor for antibiotic abuse[30,31]. Medical personnel must therefore improve their antibiotic expertise.

According to a Swedish research[32], feedback on prescribing, or reviewing prescriptions, as well as ongoing education and behavioral change initiatives, are required to prevent inappropriate antibiotic prescribing. Pharmacists should also be given greater knowledge and training related to when to safely prescribe antibiotics. In many circumstances, community pharmacists are the first point of contact for patients. As a result, their understanding and behavior are critical to attaining the goal of reducing antibiotic abuse. Antibiotics should ideally be sold in compliance with legislation and with a valid prescription[18]. Antibiotics were provided without a prescription in 61% of pharmacies in Sri Lanka, according to a previous report[29]. According to another study[33], most pharmacists lack adequate knowledge of drugs used in lower- and middle-income countries (LMICs). As a result, ongoing education on the proper use of antimicrobial drugs should be emphasized.

Finally, antibiotic guidelines should be issued by policymakers. Antibiotic prescribing guidelines that combine specialist consultation can help clinicians to improve their prescribing behavior[34]. In addition, as inappropriate prescribing of antibiotics is not restricted to community pharmacies, dedicated antibiotic committees should be established in hospitals. A study in Nigeria[35] found that antibiotic prescribing in hospitals had a high level of decision autonomy, necessitating the setting up of a hospital Drugs and Therapeutic Committee.

Our findings showed inadequate knowledge, perception, and medication practice among pharmacy students. These students will soon graduate and have the potential to have a negative impact on public health due to overprescribing of antibiotics. A pharmacist's understanding of therapeutics is essential as a healthcare provider. Therapeutic failures are caused not just by noncompliance with medicine, but also by using unsuitable medication. The dosage form, the dose, and the duration of treatment are all important considerations. Pharmacists have a critical role in healthcare for the proper selection of medications, administration, and monitoring of therapy in order to promote patient health.

Students in private universities had lower scores than students from public universities. This might be partly due to more emphasis within the public universities' curriculum on the usage and knowledge of antibiotics. Taking all that into consideration, curricula should be revised and compared between public and private faculties in order to emphasize the importance of antibiotics usage, knowledge and perception.

Limitations of the Study

There are some limitations to this study. As this is a cross-sectional study, it is difficult to attribute causal relationships. Self-administered questionnaires, such as the one used in this study, are prone to social desirability bias. Future research should investigate the differences between what pharmacists' report in relation to their prescribing practices and what they actually do.

Although the online methodology should have limited the impact of social desirability bias, any prejudice in response would be likely to lead to an underestimate of the reported rates, as evidenced by the high perceived severity scores and low perceived benefits and barriers scores. Because this was an online survey, searching for and finding the correct answer may have overstated their knowledge. The questionnaire responses were typically finished in 15 minutes, leaving little time for students to look up answers online, and the results would only alter knowledge, not behavior. We did not examine which other therapies students could have taken instead of antibiotics. Due to the enrollment of a large sample size from different Jordanian universities, we believe that our sample is likely to be representative of the pharmacy student population in Jordan.

Conclusions

Pharmacy students showed adequate KAP toward the use of antibiotics with several aspects of malpractice. Significant differences in knowledge related to university type were reported; warranting a revision of study curriculum in private universities to focus on this important issue. Furthermore, as knowledge was a significant predictor of attitude and practice, universities should ensure that pharmacy students acquire adequate education about antibiotics.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Ethical Approval

Ethical approval was obtained from Al-Zaytoonah University Ethics Committee. The research was carried out in accordance with Declaration of Helsinki guidelines and regulations.

Informed Consent

Informed consent was obtained from all participants included in the study.

Availability of Data and Materials

The data that support the findings of this study are openly available in Zenodo data, DOI 10.5281/zenodo.5907077 – https://zenodo.org/record/5907078#.YfFyF_5Bzb0.

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Authors' Contribution

Conceptualization: Walid Al-Qerem and Jonathan Ling; methodology: Walid Al-Qerem and Alaa Hammad; Data collection: Walid Al-Qerem, Alaa Hammad, Anan Jarab, Mais Saleh, and Haneen A Amawi; formal analysis: Walid Al-Qerem, Fawaz Alasmari and Jonathan Ling; resources: Fawaz Alasmari; data curation: Mais Saleh and Haneen A Amawi; writing – original draft preparation: Walid Al-Qerem, Alaa Hammad, Anan Jarab, Mais Saleh, Haneen A Amawi, Jonathan Ling, and Fawaz Alasmari; writing – review and editing: Walid Al-Qerem, Alaa Hammad, Anan Jarab, Mais Saleh, Haneen A Amawi, Jonathan Ling, and Fawaz Alasmari; visualization: Walid A-Qerem. supervision: Walid Al-Qerem; project administration: Walid Al-Qerem; funding acquisition: Fawaz Alasmari. All authors have read and agreed to the published version of the manuscript.

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