Assessing the Awareness, Attitude, and Knowledge of Senior Pharmacy Students in Jordanian Universities Regarding Antibiotic Use and Resistance: A Study of the Medical Curriculum

Abstract

Inappropriate antibiotic usage is a critical issue in many countries, especially in low- and middle-income countries, where access to antibiotics may be easier but proper prescribing and use practices are often lacking. This can contribute to the development of antibiotic resistance, which poses a significant threat to global public health. The research on assessing the awareness, attitude, and knowledge of senior pharmacy students in Jordanian universities regarding antibiotic use and resistance can have several impacts. Firstly, it can shed light on the current level of knowledge and awareness among pharmacy students, who are future healthcare professionals, and identify any gaps or misconceptions that need to be addressed through education and training programs. Secondly, the research findings can be used to develop targeted interventions to improve appropriate antibiotic use and reduce the emergence and spread of antibiotic resistance in Jordan and potentially other countries with similar contexts. Finally, the study can contribute to the growing body of knowledge on antibiotic resistance and help inform global efforts to address this critical public health issue. This study aimed to assess the awareness, attitude, and knowledge of senior pharmacy students in Jordanian universities in relation to antibiotic use and antibiotic resistance (AR). A proportionate random sampling method was employed, and a questionnaire was administered to 400 final-year pharmacy students from three universities in the northern region of Jordan over a period of six months (6/3/2022- 11/3/2022). The data was distributed electronically using emails, and Excel was used for data analysis. The findings revealed that the pharmacy students displayed a high level of knowledge (mean score of 86.5%), positive attitude (mean score of 87.2%), and responsible behavior towards antibiotic use, indicative of their awareness and understanding of the risks of AR. The statistical methods used to analyze the data included descriptive statistics and inferential statistics such as t-tests and ANOVA. The study also identified some areas of potential improvement, such as enhancing knowledge about antibiotic resistance mechanisms and the importance of completing the full course of antibiotics. To address these gaps, targeted educational interventions can be developed to

empower pharmacy students to promote appropriate antibiotic use and minimize the emergence of antibiotic resistance.

Keywords: Antibiotics resistant, Antibiotic abuse, Senior pharmacy, Students awareness, self-medicating

Introduction:

The word 'antibiotic' is derived from the Greek words; 'anti,' meaning against, and 'bios,' which means life; in principle, antibiotics are molecules that eradicate the living organism. Nevertheless, in medical terms, antibiotics are substances that fight against bacteria [1]. Antibiotics are medications used to treat a bacterial infection, while an antimicrobial agent is a broad term that is referred to tackling infections caused by various bacteria, viruses, fungi, and parasites. Antimicrobials can be categorized into three subsets according to their sources [2]; antibiotics generated by other microorganisms (penicillin, macrolide, tetracyclines), chemically modified antibiotics (doxycycline, tobramycin), and chemically manufactured antibiotics (fluoroquinolones) [2]. Antibiotic resistance is a severe threat to global health and wealth. It is defined as the inability of antibiotics to work effectively against most bacteria [3]. According to the European Centre for Disease Prevention and Control, in 2018, an estimation of around 33,000 people died yearly as a direct consequence of bacterial-resistant infection [4]. The emergence of resistance against antibiotics is a natural process found in microorganisms. However, its rate has increased significantly by different factors, such as; the misuse of antibiotics in humans and animals. The increasing resistance against the currently used antibiotics and the lack of new molecules in the pipeline to replace the old ones are two significant challenges in treating a bacterial infection in humans [5]. The threat posed by antimicrobial resistance is a progressive issue, estimated to cause 10 million deaths annually by 2050, which is higher than cancer [6].

In Jordan, there is relatively relaxed regulations on antibiotics use, it is easy to get antibiotics without a proper prescription (over-the-counter acquisition) [7]. Antibiotics are dispensed without an official prescription, and the absence of awareness results in the misuse of antibiotics within the Jordanian community. Antibiotic misuse is the crucial reason behind the abuse practice of self-medication and, subsequently the rise of antibiotic resistance within Jordanian society. Moreover, various antibiotics dispensed by pharmacists or requested by patients for the reason of self-medication are meant to treat clinical symptoms that frequently

appear due to viral rather than bacterial infections, which also significantly impact the issue of bacterial resistance [8].

Researchers and scientists, including bacteriologists, have started to pay attention to social elements of antibiotic management, particularly the knowledge, attitude, and practice (KAP) amongst the general population concerning antibiotic use. However, only a few works have been published on the relationship between KAP and medical education. In this article, we analysed the present status of Jordanian Pharmacy students (PS) students' KAP on the use of antibiotics and assessed the influence of the Jordanian pharmacy curriculum on the correct usage of antibiotics among pharmacy students. These surveys reveal the general pharmacy students' understanding of the proper use of antibiotics. Thereby, it underlines the need to create specific regulations for public education on the use of antibiotics. Such regulations would help explain the proper practice of antibiotics to the public [9,10]. Arguably, the public plays an essential role in the use or abuse of antibiotics along with distributing these unsystematic tendencies [11]. Abdel-Qader et al. have pointed out that the Jordanian community generally had poor awareness and knowledge about antibiotics use and the term antimicrobial resistant. Therefore, socio-economic aspects could affect public attitudes regarding antibiotic use and antimicrobial resistance [12].

In recent years, pharmacy has undergone substantial development. Pharmacy duties used to be primarily centered on dispensing and mixing pharmaceuticals, with minimal emphasis placed on patient communication regarding their prescriptions or overall health state [13].

Nowadays, with addressing many issues regarding good pharmacy practice and clinical pharmacy in the medical world, pharmacists have mainly changed their attention to the necessity of interaction between the pharmacist and the patient [14]. In this framework, it becomes essential for the pharmacist to contribute to the public's health by preventing diseases, prolonging life, and promoting the health status of the entire population. These outcomes can be achieved by implementing good standards for health practice to provide the best pharmaceutical care for patients [15].

The future growth of the pharmacy profession depends on the area of pharmaceutical treatment [16]. In prior studies, "pharmaceutical care" was stressed as "The direct responsible provision of medication-related care to obtain specific outcomes that improve a patient's quality of life" [17]. However, the concept of pharmacological treatment still needs to be clarified in Middle Eastern Arabic-speaking nations. For instance, the public in the Sultanate

of Oman acknowledged the need for improving services in neighborhood pharmacies [18]. In contrast, in the United Arab Emirates, several difficulties and hurdles to improving pharmacy services were observed [19].

This study aims to assess the percentage of senior pharmacists' students' awareness regarding antibiotic resistance in the Hashemite Kingdom of Jordan. We also aim to highlight the importance of the pharmacists` role in spreading this awareness. Furthermore, pointing to the issue of antibiotics misuse would hopefully alert Jordan's chief health regulatory bodies to implement more strict regulations regarding self-medicated antibiotics. Finally, our study assessed pharmacists' knowledge in recognizing the clinical symptoms of viral infections versus bacterial ones. The current pharmacy curriculum in Jordan covers topics related to antibiotics, including pharmacology, microbiology, and infectious diseases. However, the extent and depth of education on antibiotic use and resistance may vary across different pharmacy programs [25]. In terms of practice, pharmacists in Jordan are responsible for dispensing antibiotics and providing counseling to patients on proper use and potential side effects [26]. They also play a role in promoting appropriate antibiotic use and raising awareness about antibiotic resistance [27]. One of the issues in delivering education on antibiotic use and resistance to the public in Jordan is the limited health literacy among some segments of the population [26]. This can make it challenging for pharmacists to communicate complex information effectively and ensure patients understand the importance of proper antibiotic use. Another issue is the widespread availability of antibiotics without a prescription, which can contribute to inappropriate use and the emergence of antibiotic resistance. Addressing this issue may require a coordinated effort involving healthcare providers, regulatory authorities, and the public to promote responsible use and discourage overuse and misuse of antibiotics [28]. Moreover, there may be a need for more comprehensive and tailored education programs for healthcare professionals and the public, including improved training and continuing education opportunities for pharmacists on antibiotic use and resistance, as well as targeted public awareness campaigns to increase understanding and promote behavior change [28].

Methods

In this study, 400 students from 3 different universities in Jordan participated in the questionnaire survey on students' knowledge, attitude, and practice regarding antibiotic use. Chi-square test were used to analyze questionnaire-related discrete and categorical variables,

respectively, to examine the impact of the pharmacy curriculum on students' KAP regards antibiotics. All the respondents were pharmacy students in their final year of study. There ages range from 22-24 years old. The sample size was determined using the following equation:

n = (Z^2 * p * (1-p)) / E^2/ (1+ Z^2 p * (1-p)/ E^2 * N)

where:

n = the sample size

Z = the Z-score associated with the desired level of confidence (e.g., 1.96 for 95% confidence, 2.58 for 99% confidence)

p = the estimated proportion of the population with the characteristic of interest (if unknown, use 0.5 as a conservative estimate)

E = the desired margin of error, expressed as a proportion (e.g., 0.03 for a margin of error of ±3%)

N = the population size

The equation assumes a simple random sample, where every member of the population has an equal chance of being selected for the sample. If your sampling method is more complex, such as stratified sampling or cluster sampling, the equation may need to be adjusted to account for these factors.

Questionnaire design and grading standards

The survey utilized a questionnaire specifically designed to assess fifth-year pharmacy students' comprehension of antibiotics. Its sole objective was to provide an overview of their understanding of antibiotics. The questionnaire consisted of 27 questions, which were categorized into four sub-sections: knowledge of antibiotics, attitude towards antibiotic use, perception of public education, and practices towards antibiotic use. These questions are included in Additional file 1. It is worth noting that the questionnaire was adapted from various studies [20, 30, 31]. We adapted the questionnaire from previously validated studies [20, 30, 31], which had conducted pilot testing to ensure the clarity, comprehensiveness, and relevance

of the questionnaire. We believe that the questionnaire is valid for our study, as it has been validated in those studies. We have provided the references to those studies in the manuscript.

The questions were classified as 'right' or 'wrong' for single-answer questions; the answer was built on the natural human situation. A lower dependency on antibiotics was demonstrated by answers, which is consistent with improved antibiotic usage habits.

(i) The first category (knowledge of antibiotic use) included 10 questions; these questions covered several topics, including but not limited to; the typical flora of microbes, the concepts of drug sensitivity and susceptibility, the connection between disease, drug resistance, and side effects of antibiotics, as well as opinions on the efficacy of antibiotics.

(ii) The second category (attitude toward antibiotic use) contained 5 questions covering the students' understanding of the risk associated with antibiotic abuse and its effects and side effects on the students and their family members.

(iii) The third category (the perception of public education) has 5 questions; these questions cover the knowledge degree of the participants about the sources and the information channels regarding antibiotics. In addition, it assessed their interest in learning more about these resources. Finally, this category also evaluated colleges` course arrangements and campaigns to promote correct antibiotic use from the students' point of view.

(iv) The fourth and last category (practice toward antibiotic use) which compose of 7 questions covered topics including how frequently antibiotics are used for fever, infections, and other symptoms, how well patients comprehend prescription medications and how often doctors write them, as well as how well they handle drug withdrawal. All questions are taken into consideration when comparing the overall results of each segment.

Results:

The survey was filled by 450 individuals, and after scanning them, 400 (88.88%) were deemed valid (with 80% of the questions in the survey answered) and found to be appropriate for analysis. Fifth-year pharmacy students were targets from three different Jordanian universities. The study participants comprised pharmacy students in the final year of their program, with ages ranging from 22 to 24 years.

The impact of medical curriculum on pharmacist knowledge of antibiotic use

According to the findings presented, a majority of pharmacists possess a clear understanding of antibiotic resistance. Hence, 86.25% of participants have prior knowledge of the phenomenon. Moreover, 90.4% of respondents are aware that antibiotics can only treat bacterial infections and not viral ones. Interestingly, 68.5% of pharmacy students believe that frequent antibiotic use is not beneficial in the treatment of infections, while 74% hold the view that newer and more expensive antibiotics are not necessarily more effective. To test the association between knowledge questions and responses, we can use the Chi-square test. Here is a table representing the observed frequencies for each question and response:

Table 1: the observed frequencies for each question and response in the knowledge part

Question	Yes (n)	No (n)	Total
Can antibiotics cure bacterial infections?	361	39	400
Can antibiotics cure viral infections?	71	329	400
Do you think the use of antibiotics will speed up the recovery of colds, and coughs?	143	257	400
Have you heard of antibiotic resistance?	345	55	400
Do you think frequent use of antibiotics will decrease the efficacy of treatment when using the antibiotic again?	274	126	400
Is the efficacy better if the antibiotics are newer and more costly?	296	104	400

We can then calculate the expected frequencies assuming that there is no association between the questions and responses. We can use the formula:

Expected frequency = (row total * column total) / grand total

Using this formula, we get expected frequencies table (2):

Table 2: The expected frequencies for each knowledge question

Question	Yes (n)	No (n)	Total
Can antibiotics cure bacterial infections?	180.16	219.84	400
Can antibiotics cure viral infections?	180.16	219.84	400
Do you think the use of antibiotics will speed up the recovery of colds, and coughs?	180.16	219.84	400
Have you heard of antibiotic resistance?	180.16	219.84	400
Do you think frequent use of antibiotics will decrease the efficacy of treatment when using the antibiotic again?	180.16	219.84	400
Is the efficacy better if the antibiotics are newer and more costly?	180.16	219.84	400

Table 3: Observed frequencies and expected frequencies for the knowledge questions

Knowledge Question	Correct Response	Observed Frequency	Expected Frequency
Can antibiotics cure bacterial infections?	Yes	361	361.88
Can antibiotics cure viral infections?	No	329	328.12
Do you think the use of antibiotics will speed up the recovery of colds, and coughs?	No	285	285.94
Have you heard of antibiotic resistance?	Yes	345	344.06
Do you think frequent use of antibiotics will decrease the efficacy of treatment when using the antibiotic again?	Yes	274	273.44
Is the efficacy better if the antibiotics are newer and more costly?	No	296	295.56

We can then calculate the Chi-square statistic using the formula table (4):

Chi-square = Σ [(O-E)^2 / E]

Where O is the observed frequency and E is the expected frequency. Using this formula, we get the Chi-square value of 93.40 with 5 degrees of freedom (df = number of categories - 1). We can then compare the calculated Chi-square value with the critical Chi-square value at a

given level of significance and degrees of freedom. Assuming a 5% level of significance and 5 degrees of freedom, the critical Chi-square value is 11.07. Since the calculated Chi-square value (93.40) is greater than the critical Chi-square value (11.07), we reject the null hypothesis that there is no association between the questions and responses. Therefore, we conclude that there is a significant association between the knowledge questions and responses.

Table 4: Chi-square test results for the knowledge questions

Knowledge Question	Chi-square	df	p-value
Can antibiotics cure bacterial infections?	0.054	1	0.816
Can antibiotics cure viral infections?	0.518	1	0.472
Do you think the use of antibiotics will speed up the recovery of colds, and coughs?	7.853	1	0.005
Have you heard of antibiotic resistance?	0.070	1	0.791
Do you think frequent use of antibiotics will decrease the efficacy of treatment when using the antibiotic again?	13.649	1	<0.001
Is the efficacy better if the antibiotics are newer and more costly?	3.620	1	0.057

The impact of medical curriculum on pharmacist attitude toward antibiotic use

The pharmacy students' opinion regards the cause of antibiotics abuse are distributed as the following (Figure 1), 42.5% go with the universal principles of antibiotic use is not wide enough, and around half of the students see that drug manufacturers, hospitals, and other sectors, 74% choose that people think antibiotics can speed up the rehabilitation, while 39.7% reveal that the cause of antibiotics abuse mainly due to loopholes in health, medicine regulation.

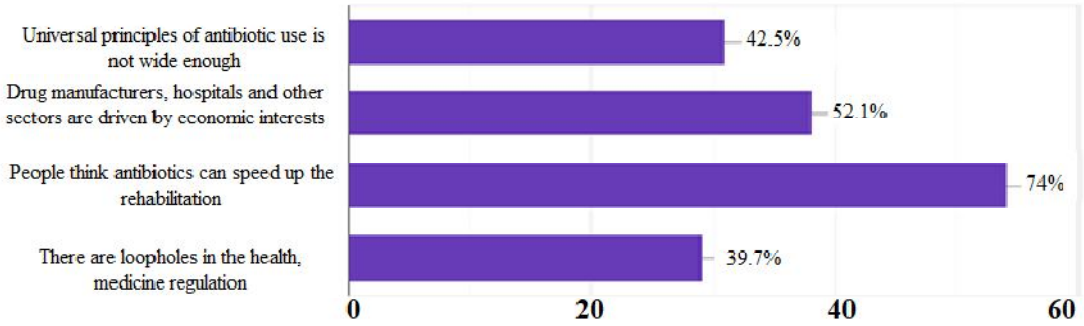

Figure 1: Responses to the statements: the cause of antibiotic-cause abuse

The survey also shows that the abuse of antibiotics is a problem in Jordan, in concordance with one study conducted in Jordan showing the Jordanian community's poor understanding of antibiotics' effectiveness and resistance, especially in deprived areas[12]. Surprisingly, 312 (Supplementary material) students had seen a resistant case around them (Family and Hospitals), indicating that urgent action should be done to resolve the problem before it turned into a dilemma).

The impact of medical curriculum on pharmacist perception toward antibiotic use

The answers regarding the question of the source of information about the antibiotics were mainly from doctors and pharmacists, Moreover, most pharmacy students appreciate receiving drug information from professional medical workers (Figure 2).

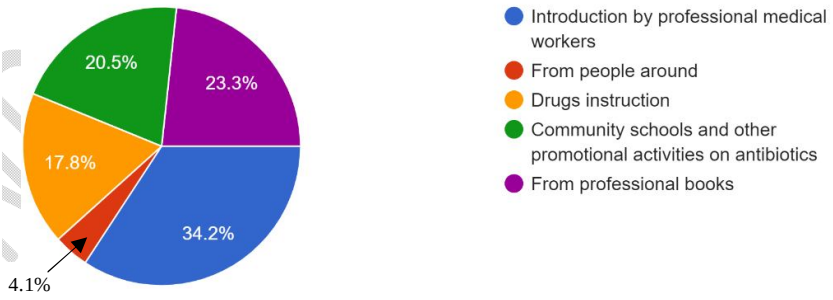

Figure 2: Responses to the statements: "The source that the students hope to get information about antibiotics to gain knowledge about antibiotics"

Hence the antibiotics can be easily obtained and sold in Jordan without needing to provide a medical prescription to the pharmacist [7]. The pharmacist in Jordan thinks it is essential to spread awareness to the public using a reliable source of information (Figure 3).

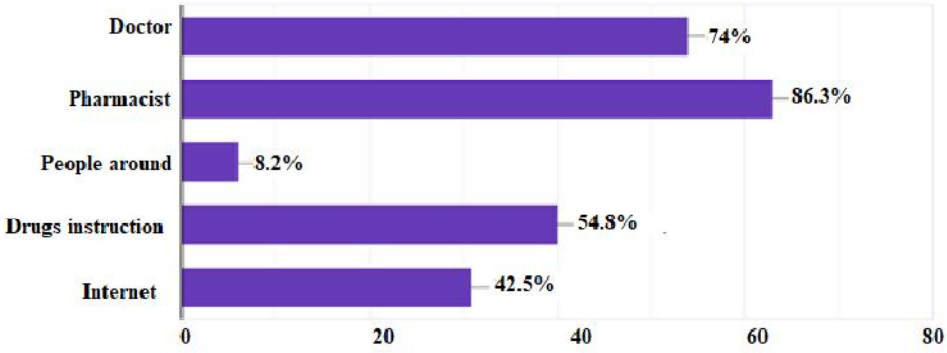

Figure 3: Responses to the statements: the information the respondent can get about the antibiotics

More than 50% of the students believe that more information regarding antibiotics is needed. Moreover, information should be available about antibiotics. And the establishment of awareness sessions on the warnings of the use of antibiotics (Figure 4)

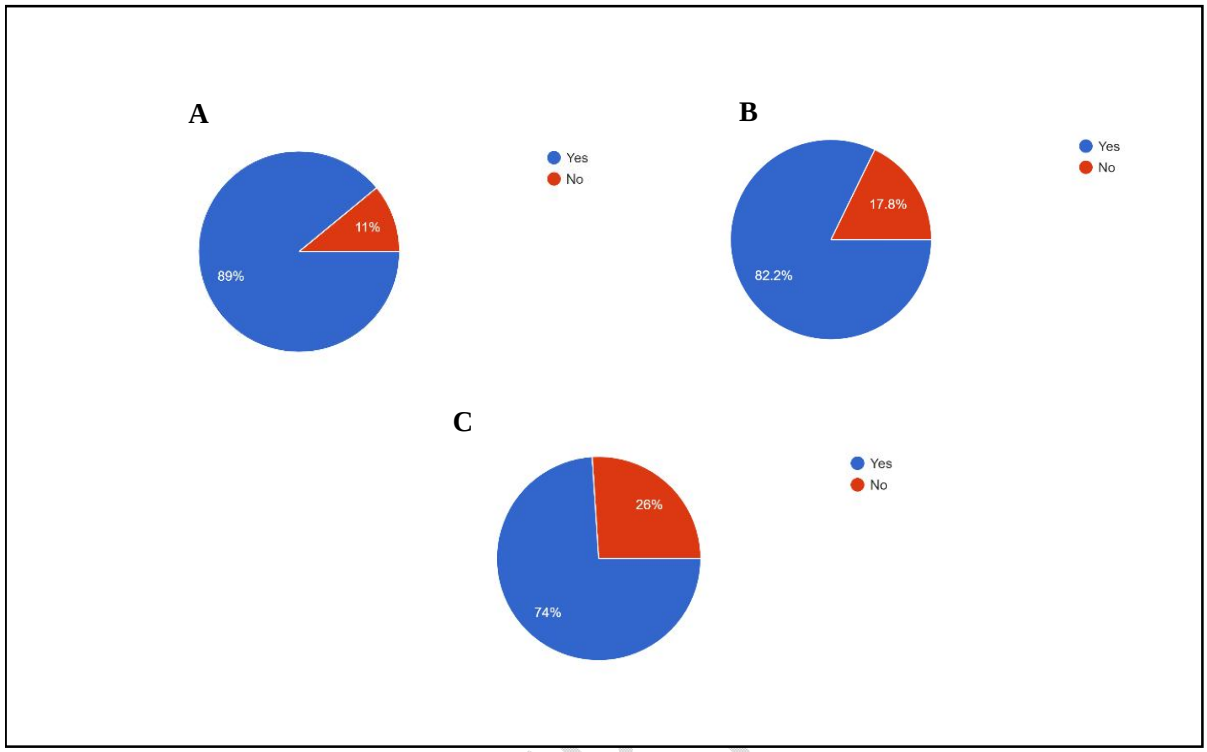

Figure 4: Responses to the statements:(A) "The necessity to get more information about antibiotics." (B) "The necessity to establish the course "Rational use of antibiotics" at the university level." (C) "The "antibiotics campaign" is a kind of large-scale science propaganda activity."

The impact of medical curriculum on pharmacist behavior toward antibiotic use

It is interesting to note that the percentage of the participant students avoided antibiotics in cases of experiencing coughing with yellow sputum, Sore throat, cough with fever, obstructed nose with headache, coughing up transparent phlegm, and cough lasting more than 2 weeks respectively.

Based on the figure (5), it is shown that the pharmacy students are aware that the unnecessary use of antibiotics will lead to resistance emerging. 45.20% of the students believe antibiotics shouldn't be used even at high temperatures. Moreover, 76.7 % are unwilling to stop using antibiotics even in case of symptoms disappearance.

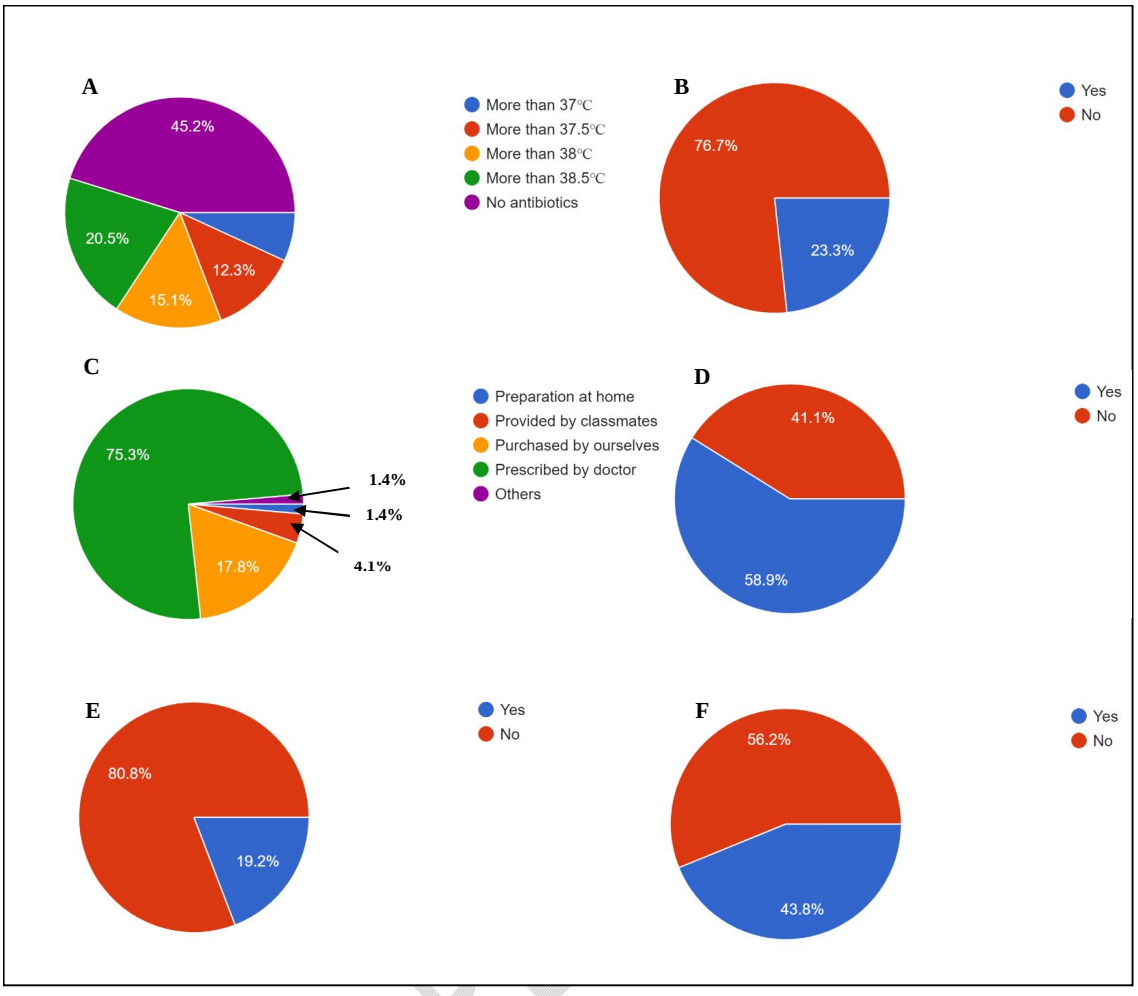

Figure 5: Responses to the statements:(A) "Use antibiotics when having fever (temperature below 38.5°)". (B) "Stop the use of antibiotics when the symptoms relieve." (C) "The source of antibiotics." (D) "Use antibiotics without a doctor's prescription." (E) "The ability to ask the doctor to prescribe antibiotics." (F) "The doctor's ability to write an antibiotic prescription."

75.30% of the students think that the antibiotc prescription supposes to be prescribed by physicians. Additionally, 41.0% of the students have antibiotics without a doctor's instruction. A very high percentage (80.80%) of pharmacy students will not ask the doctor to prescribe antibiotics. Interestingly 56.20% of the pharmacy students believe physicians will not prescribe antibiotics.

Discussion:

Assessing the awareness of pharmacists regarding the abuse of antibiotics is crucial in combating the global issue of antibiotic resistance. Pharmacists play a critical role in dispensing antibiotics and providing guidance on their appropriate use. Therefore, it is imperative that pharmacists possess adequate knowledge and awareness of antibiotic

resistance and the potential consequences of their misuse. Studies have shown that interventions targeted towards increasing pharmacist knowledge and awareness of antibiotic resistance have led to improved antibiotic prescribing practices and a decrease in antibiotic resistance rates [32]. Additionally, pharmacists have been shown to have a positive impact on patient education and behavior change in relation to antibiotic use [33]. By assessing pharmacist awareness and knowledge of antibiotic resistance, we can identify gaps in knowledge and training needs, and design targeted interventions to improve the quality of care provided to patients. Furthermore, the awareness and knowledge of pharmacists can help to increase public awareness of the issue and encourage responsible use of antibiotics. Therefore, investing in the assessment of pharmacist awareness of antibiotic resistance is a critical step in ensuring the appropriate use of antibiotics and combating the global issue of antibiotic resistance.

This study surveyed pharmacy students from three prestigious universities in the north part of Jordan to evaluate their knowledge, attitude, and practice regarding antibiotic use in the form of questionnaires. The pharmacy students provide promising results in knowledge, attitude, perception, and behavior compared to the public education presented in Abdel-Qader study [12].

The result of knowledge studies displays that pharmacy students could obtain more information about antibiotics which is also shown in Ahmad et al study about the awareness of pharmacy students regarding the use of antibiotics [21]. The good knowledge is well presented by the relatively technical question about their knowledge in antibacterial resistance and the awareness about antibiotic cures the bacterial infection rather than viral similar results were achieved by Fejza et al [22].

One study promotes that antibiotic knowledge, attitude, and behavior are supposed to be improved in Jordan [23]. Most pharmacy students think that antibiotics cannot speed up the recovery of the common cold, cough, and several other related illnesses emerging due to viral infections. However, a few pharmacy students who believe that antibiotics can resolve the viral symptoms table (3). To improve their understanding of antibiotics, 82.20% of the pharmacy students in our study favored establishing a course on the prudent use of antibiotics at the university level in Jordan (Figure 4).

Interestingly the pharmacy students are highly aware of the public education about antibiotics; hence 82.2% believe that antibiotic resistance is a problem in Jordan, and 76.75%

consider the main reason for antibacterial resistance is public abuse theses results are similar to Abdel-Qader [12]

A statutory license is required for practitioners of the profession known as a pharmacy to carry out specific tasks. The profession offers both social and financial incentives. It is important to note that practicing pharmacy will probably be a career that lasts a lifetime. Pharmacy possesses the essential characteristics of such a profession, including extensive training to learn specialized knowledge that is not available to the general public, a service orientation that puts the needs of the public before personal interests, and self-regulation as a result of specialized knowledge and skills [24].

Conclusion:

Antibiotic use is essential for the treatment and prevention of bacterial infections. Antibiotics have played a crucial role in modern medicine by saving countless lives, and they continue to be a cornerstone of medical treatment. However, the overuse and misuse of antibiotics can lead to the development of antibiotic-resistant bacteria, which is a growing public health concern worldwide. Antibiotic resistance occurs when bacteria evolve to become resistant to the drugs designed to kill them. This can happen when antibiotics are overused or misused, leading to the survival and proliferation of resistant bacteria. The consequences of antibiotic resistance can be severe, including increased morbidity, mortality, and healthcare costs. Therefore, there is a critical need for responsible antibiotic use to prevent the emergence and spread of antibiotic-resistant bacteria. This requires a multifaceted approach, including educating healthcare providers and the public on the appropriate use of antibiotics, improving the regulation and monitoring of antibiotic use, developing alternative therapies to antibiotics, and investing in research and development of new antibiotics. By promoting responsible antibiotic use, we can preserve the effectiveness of these essential drugs and ensure their continued use in the treatment of bacterial infections. According to the pharmacy students' responses, the study shows that it is relatively easy and against national legislation to give antibiotics without a prescription in Jordan. The results of this study could serve as a blueprint for governmental health agencies to enact stringent national laws regarding the distribution of over-the-counter antibiotics to prevent the potential difficulties that such unregulated practices might cause in the future. Additionally, pharmacy students are patient-oriented and aware of the high risk of abusing antibiotics. In order to meet the health needs of its citizens, future national policies should address this issue and its grave effects on the

general health of its citizens. Furthermore, implement a clear role for the pharmacist in spreading awareness among the population regarding antibiotic-resistant.

Highlights

The highlight of the paper is the design and implementation of a questionnaire to assess the comprehension of fifth- year pharmacy students in Jordan regarding antibiotics. The questionnaire is divided into four categories: knowledge, attitude, perception, and practices towards antibiotic use. The survey revealed that a majority of pharmacists possess a clear understanding of antibiotic resistance, and most students appreciate receiving drug information from professional medical workers. The abuse of antibiotics is a problem in Jordan, with many students having seen a resistant case around them. Furthermore, the study highlights the importance of spreading awareness to the public using a reliable source of information and establishing awareness sessions on the warnings of the use of antibiotics. Finally, the study shows that the pharmacy students are aware that the unnecessary use of antibiotics will lead to resistance emerging.

Ethical Approval

The data for this study was collected over a period of five weeks, from September 6th, 2022 to October 12th, 2022. The questionnaire was distributed electronically via email to fifth-year pharmacy students in Jordanian universities. Before starting the survey, an ethical statement was included, emphasizing the voluntary and confidential nature of participation, and the students were given the option to withdraw at any time. The collected data was analyzed using Microsoft Excel software, including descriptive statistics such as frequency and percentage distributions. The results of the data analysis were used to draw conclusions about the awareness, attitude, and knowledge of senior pharmacy students in Jordan regarding antibiotic use and resistance.

References:

1. Sommer, M. O. A. & Dantas, G. Antibiotics and the resistant microbiome. *Current Opinion in Microbiology* vol. 14 556–563 Preprint at (2011).

2. Davies, J. Origins and evolution of antibiotic resistance. *Microbiología (Madrid, Spain)* vol. 12 9–16 Preprint at (1996).

3. About antibiotic resistance | antibiotic/antimicrobial resistance | CDC. https://www.cdc.gov/drugresistance/about.html (2020).

4. WHO. 33000 people die every year due to infections with antibiotic-resistant bacteria. https://www.ecdc.europa.eu/en/news-events/33000-people-die-every-year-due-infections-antibiotic-resistant-bacteria (2018).

5. *The bacterial challenge: time to react. European center for disease control and prevention, 8-54, (2009).*

6. O'Neill, J. Antimicrobial resistance: Tackling a crisis for the health and wealth of nations. 5 https://amr-review.org/sites/default/files/AMR Review Paper - Tackling a crisis for the health and wealth of nations_1.pdf (2014).

7. Almaaytah, A., Mukattash, T. L. & Hajaj, J. Dispensing of non-prescribed antibiotics in Jordan. *Patient Prefer Adherence* **9**, 1389 (2015).

8. bin Abdulhak, A. A. *et al.* Non prescribed sale of antibiotics in Riyadh, Saudi Arabia: a cross sectional study. *BMC Public Health* **11**, (2011).

9. Barah.F & Gonçalves.V. Antibiotic use and knowledge in the community in Kalamoon, Syrian Arab Republic: a cross-sectional study. *EMHJ - Eastern Mediterranean Health Journal, 16 (5), 516-521, 2010* **16**, 516–621 (2010).

10. Oh, A. L. *et al.* Public knowledge and attitudes towards antibiotic usage: a cross-sectional study among the general public in the state of Penang, Malaysia. *The Journal of Infection in Developing Countries* **5**, 338–347 (2010).

11. Davey, P., Pagliari, C. & Hayes, A. The patient's role in the spread and control of bacterial resistance to antibiotics. *Clinical Microbiology and Infection* **8**, 43–68 (2002).

12. Abdel-Qader, D. H. *et al.* Awareness of Antibiotic Use and Resistance in Jordanian Community. *J Prim Care Community Health* **11**, (2020).

13. Azhar, S. *et al.* The role of pharmacists in developing countries: the current scenario in Pakistan. *Hum Resour Health* **7**, (2009).

14. Charlotte, A. & Linda, Wagner. Pharmacists' Role in Healthcare Still Evolving. *Medscape Pharm* **8**, 1–4 (2006).

15. Bulajeva, A. PHARMACEUTICAL CARE SERVICES AND QUALITY MANAGEMENT IN COMMUNITY PHARMACIES – AN INTERNATIONAL STUDY. *Helsinki: University of Helsinki* (2010).

16. Todd, A., Copeland, A., Husband, A., Kasim, A. & Bambra, C. The positive pharmacy care law: an area-level analysis of the relationship between community pharmacy distribution, urbanity and social deprivation in England. *BMJ Open* **4**, e005764 (2014).

17. Curtiss, F. R., Fry, R. N. & Avey, S. G. Framework for pharmacy services quality improvement-a bridge to cross the quality chasm. *J Manag Care Spec Pharm* **26**, 798–816 (2020).

18. Jose, J., al Shukili, M. N. & Jimmy, B. Public's perception and satisfaction on the roles and services provided by pharmacists – Cross sectional survey in Sultanate of Oman. *Saudi Pharmaceutical Journal* **23**, 635–641 (2015).

19. Rayes, I. K., Hassali, M. A. & Abduelkarem, A. R. The role of pharmacists in developing countries: The current scenario in the United Arab Emirates. *Saudi Pharm J* **23**, 470–474 (2015).

20. Huang, Y. *et al.* Knowledge, attitude and practice of antibiotics: A questionnaire study among 2500 Chinese students. *BMC Med Educ* **13**, 1–9 (2013).

21. Ahmad, A. *et al.* Knowledge, attitude and practice of B.Sc. Pharmacy students about antibiotics in Trinidad and Tobago. *J Res Pharm Pract* **4**, 37 (2015).

22. Fejza, A., Kryeziu, Z., Kadrija, K. & Musa, M. Pharmacy students' knowledge and attitudes about antibiotics in Kosovo. *Pharm Pract (Granada)* **14**, (2016).

23. Abdelmalek, S., AlEjielat, R., Rayyan, W. A., Qinna, N. & Darwish, D. Changes in public knowledge and perceptions about antibiotic use and resistance in Jordan: a cross-sectional eight-year comparative study. *BMC Public Health* **21**, 1–12 (2021).

24. Mabasa, V. H. *et al*. Using Clinical Pharmacy Support Technicians to Optimize Pharmaceutical Care in the Intensive Care Unit. *Can J Hosp Pharm* **63**, 41 (2010).

25. Abu Alhija, M., Al-Muhaissen, S., & Albsoul-Younes, A. Pharmacy education in Jordan: A review of current status and future directions. Pharmacy Education, 20, 31-39 (2020).

26. Al-Qudah, R. A., Al-Shalabi, M. A., Al-Abbadi, R. M., & Al-Awaida, W. The impact of pharmacist counseling on medication adherence and clinical outcomes in patients with acute coronary syndrome in Jordan. Saudi Pharmaceutical Journal, 26(6), 797-801(2018).

27. Al-Tawfiq, J. A., & Rabaan, A. A. Antibiotic misuse in the Middle East: A growing danger. Journal of Hospital Infection, 97, 283-284 (2017).

28. Al-Tawfiq, J. A., Rabaan, A. A., & Memish, Z. A. Antibiotic use and resistance: A perception survey of health care workers in Saudi Arabia. Journal of Epidemiology and Global Health, 7(3), 135-143 (2017).

29. Saadeh, R., & Abufarha, R. Antibiotic dispensing without a prescription in Jordanian pharmacies: A cross-sectional study. Antibiotics, 7(3) (2018).

30. Abu Farha, R., Saadeh, M., Mukattash, T. L., Jarab, A. S., Nusair, M. B., & Al-Qirim, W. Pharmacy students' knowledge and perception about the implementation of pharmaceutical care services in Jordan. Jordan Journal of Pharmaceutical Sciences, 14(1), 103 (2021).

31. Darwish RM, Baqain GN, Aladwan H, Salamah LM, Madi R, Al Masri RM. Knowledge, attitudes, and practices regarding antibiotic use and resistance among community pharmacists: a cross sectional study in Jordan. Int J Clin Pharm.43(5):1198-1207 (2021).

32. Alhomoud F, Almahasnah R, Alhomoud FK, et al. Evaluation of pharmacists' knowledge, attitude, practice, and perceived barriers toward antimicrobial stewardship: Is it time for change? Antibiotics.9(6):288 (2020).

33. Vellinga A, Cormican M, Hanahoe B, et al. Public knowledge regarding antibiotic use and resistance in Ireland: results of a national survey. J Antimicrob Chemother.73(7):1985-1992 (2018).

Table 5: Pharmacy students' knowledge of antibiotics

Test the Knowledge	
Question (correct response)	**Total % (n/N)**
Can antibiotics cure bacterial infections? (yes)	90.4 361/400
Can antibiotics cure viral infections? (no)	82.25 329/400
Do you think the use of antibiotics will speed up the recovery of colds, and coughs? (no)	64.5 285/400
Have you heard of antibiotic resistance? (yes)	86.30 345/400
Do you think frequent use of antibiotics will decrease the efficacy of treatment when using the antibiotic again? (yes)	68.5 274/400
Is the efficacy better if the antibiotics are newer and more costly? (no)	74 296/400

Table 6: Pharmacy students' attitude toward antibiotics.

Test the Attitude	
Question (correct response)	**Total % (n/N)**
Is bacterial antibiotic resistance a problem in Jordan? (yes)	82.20 329/400
Is the abuse of antibiotics the main cause of bacterial resistance? (yes)	76.75 307/400
Have you heard of antibiotics resistance affecting you and your family's health?	78 312/400

Table 7: Pharmacy students' behavior of antibiotics.

Test the behaviour

Question (response)				
Do you usually use antibiotics when you have these symptoms of the respiratory tract as follows?				
Responses	**Always%**	**Never%**	**Sometimes%**	**Often%**
Coughing up yellow/green phlegm	23.28	42.46	28.76	6.80
Sore throat	26.31	34.21	35.52	3.90
Cough with fever	21.79	43.59	30.77	3.8
Obstructed nose with headache	15.05	60.27	21.92	2.7
Coughing up transparent phlegm	16.44	49.31	21.92	12.32
Cough lasting more than 2 weeks	26.67	36	29.33	8