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ORIGINAL RESEARCH

# Evaluation of Knowledge of Food–Drug and Alcohol–Drug Interactions Among Undergraduate Students at King Saud University – An Observational Study

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**Background and Objective:** The role of pharmacists in society is unique since they are providers of drug information and medication counseling to patients. Hence, the present study was designed to investigate the knowledge, of undergraduate pharmacy students regarding food drug (FDIs) and alcohol–drug interactions (ADIs) at King Saud University, Riyadh Saudi Arabia.

**Methodology:** An online cross-sectional study was conducted among undergraduate pharmacy students at King Saud University, Riyadh, Saudi Arabia from October 2021 to January 2022, using self-administered 24-items questionnaires focused on evaluating the knowledge of FDIs and ADIs.

**Results:** Of the 200 questionnaires distributed, 142 students responded, of whom 40.8% (n = 58) of the students did not agree with the statement that patients can eat more green leafy vegetables with warfarin. Just over half 52.8% (n = 75) agreed that milk affects the efficacy of tetracycline. Regarding the students' knowledge about amiodarone interactions with grapefruit 43% (n = 61) of them were knowledgeable, while 43.7% (n = 62), knew that atorvastatin cannot be taken with grapefruit. A total of 44.4% (n = 63) of the students reported being knowledgeable about FDIs. In terms of the individual questions, Alcohol interactions with antihistamines and paracetamol received the highest percentages of 52.8% (n = 75) and 50.7% (n = 72), respectively, followed by warfarin and methotrexate (45.1%; 41.5%). In this study, 39.4% (n = 56) of the participants were found knowledgeable about ADIs. The overall knowledge of interactions among the students was 47.9% (n = 68). The total knowledgeable levels were significantly associated with educational levels and having previous information about interaction (p = 0.0001).

**Conclusion:** In conclusion, undergraduate pharmacy students exhibited poor knowledge of FDIs and ADIs. As a result, more focus and effort should be given to raising awareness of potential FDIs and ADIs. Our study highlights the need for improving pharmacy students' knowledge about FDIs and ADIs.

**Keywords:** knowledge, students, interactions, alcohol, food, drugs

## Introduction

Food-drug interactions (FDIs) are becoming a rising concern in the healthcare system and are regarded as a significant challenge among users of the medication.[1] FDIs are defined by the Food and Drug Administration (FDA) as beverages that can primarily alter medications' pharmacokinetic and pharmacodynamic properties, resulting in changes in their medical effects.[2–5] In this regard, FDIs may enhance or inhibit drug absorption, distribution, metabolism, and excretion, or alter their clinical or physiological effects on the body, resulting in unexpected side effects or the creation of new pharmacological effects that medications would not produce on their own.[5,6]

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On the other hand, alcohol–drug interactions (ADIs) are a serious problem, when combined, can cause significant adverse outcomes or a dramatic drop in the efficacy of those medications.[7] Internal bleeding, heart problems, and breathing difficulties are all made more likely by alcohol interactions with antihistamines and nonsteroidal anti-inflammatory drugs.[7] A serious heart condition can develop when monoamine oxidase inhibitors (MAOIs) and alcohol are combined.[7] The risk of liver damage and stomach bleeding is increased when arthritis drugs are combined with alcohol.[7] Similar to this, drinking alcohol while taking an antihypertensive and psychiatric medication can cause fainting, drowsiness, and changes in heart rate and hepatic failure.[7]

Patient safety is correlated with multiple factors and FDI is among those. Monitoring the drug effect after drug ingestion is crucial in healthcare, to prevent interactions of the administered drug with other foods[8,9] since it was evidenced that some patients take drugs immediately after the food.[10] According to recent estimates, the prevalence of FDIs among elderly patients was 58.8% with an average of 0.8 per individual.[10] The outcomes of FDIs lead patients to suffer from severe toxicity and increased hospitalization and medical cost. The pharmacist's role in health care concerning various aspects is well documented, including patient counseling and education.[11]

Healthcare professionals, including pharmacists, must recognize probable FDIs, ADIs, and other medication interactions to reduce the risk of drug-related problems, which can result in life-threatening complications and increased costs.[12] As a result, health-care providers (HCPs) in all practice settings must be vigilant in checking for potential FDIs and ADIs with medications and foods, as well as counseling patients on foods and other beverages to avoid when taking drugs. For example, investigations have discovered that grapefruit juice (GFJ) has strong pharmacological interactions with practically all types of medicines due to the suppression of CYP3A enzymes.[13–15] When combined with GFJ, the overall exposure of some medications can be increased by more than fivefold, increasing the risk of unwanted consequences.[15] Similarly, the anticoagulant drug warfarin should be avoided with dietary supplements containing a high-protein diet which raises serum albumin levels resulting decrease in the international normalized ratio (INR).[16]

Similarly, alcohol and a high diet of vitamin K-rich foods, such as broccoli, Brussels sprouts, kale, parsley, and spinach, reduce the effectiveness and safety of anticoagulant drugs resulting in strokes, or heart attacks.[7,17] Tyramine-containing foods (matured cheese, red vine, ripped bananas, yogurt) cause hypertension among the users of alcohol and monoamine oxidase inhibitors (MAOI).[7,18] To avoid such interactions, studies have proposed that medications be taken one hour before or two hours after eating. As a result, the presence of food in the digestive tract may not inhibit nor interfere with the absorption of a nutrient.[17] A previous study in Saudi Arabia reported that healthcare professionals' knowledge of drug–herb interactions was inadequate.[12,19] Additionally, an earlier study focused on community pharmacists reported unsatisfactory knowledge about common FDIs.[20]

The Joint Commission on Accreditation of Health Care Organizations established some requirements, including that pharmacists take a complete medication history for patients, be aware of clinically relevant drug–drug interactions and FDIs, and provide adequate counseling to patients about potential FDIs before discharge.[21] Pharmacists play an important role in the safe and effective use of pharmaceuticals, and they are frequently the first healthcare experts from whom people seek medical guidance.[22] In this view of pharmacy, students were future practicing pharmacists posing adequate knowledge in their graduation not only helps in achieving excellent grades but also helps at their practice site, for identification, and evolution of FDIs and ADIs. There have been several reports published previously from around the world to study the knowledge of pharmacists or healthcare professionals towards food–drug interactions.[12,19–23] As per our knowledge, no such research has been conducted so far among Saudi undergraduate pharmacy students to examine the knowledge towards food–drug interactions. Hence, the present study was designed to investigate the knowledge, regarding FDIs and ADIs among pharmacy students at King Saud University, Riyadh Saudi Arabia.

# Methodology

## Study Design, Sample, and Data Collection

A cross-sectional, online survey was conducted between October 2021 to January 2022 among male students enrolled in the third and fourth year of their PharmD program at the college of pharmacy Saudi University Riyadh, Saudi Arabia. Students aged ≥18 years who expressed a willingness to complete the survey were included. Students below the age of 18 and students from other disciplines were excluded from the study. The students were assured that the data would be used only for research and would be maintained confidential throughout the study. Others who do not match the inclusion criteria were excluded.

## Sample Size Estimation

There were approximately 200 residential students currently enrolled in PharmD third and fourth-year courses at the KSU campus. Similar to the previous study, we calculated the required sample size using the Raosoft sample size calculator (http://www.raosoft.com/samplesize.html) with a 95% CI and a pre-determined margin of error of 5%. Because we were unaware of the potential results for each question, we assumed that the response distribution for each question would equal 50%.[22] Although the sample size was projected to be 132, we opted to poll at least 200 students to assure greater reliability.

## Questionnaire Design

The questionnaire used in this study was developed after a review of available literature about the knowledge, of food–drug interactions.[20] It consisted of 24-items questions, divided into 3 sections. The first section included 6 questions dedicated to obtaining information about the student's demographics and personal information like year of study, gender, nationality, sources of FDIs, and whether knowing FDIs. The second section is comprised of 12 questions about knowledge, and the last section talks about the knowledge of ADIs (6 items), respectively. Knowledge-related questions were three-choice-based questions (Yes/No/I do not know). The detailed information about the questionnaires were given in Annexure-1. The prepared survey tool was subjected to a team of experts who were experienced in preparing questionnaires about drug–food interactions. Their opinions and views were collected about the survey and modified accordingly, furthermore to estimate the time of the survey and to ensure the readability of the questionnaires and ease of administration, a pilot study was conducted among randomly selected pharmacy students (n = 10). The result of the pilot study was not included in the final analysis. The pilot study revealed that the estimated time to complete the questionnaire was 8 minutes. The reliability of the questionnaire was calculated using Cronbach's Alpha value, which was 0.80, indicating that questionnaire was reliable to carry out the study.

A convenience sampling strategy was used to collect the data from the target population. Data was gathered using an online questionnaire. Google forms that we made produced the electronic link. In order to determine the point of contact for the targeted population for the purpose of data collection, we first spoke with the course instructor. The online survey made use of social media (WhatsApp). A disclosing statement followed by consent and agreement to use filled-out information for publication purposes were highlighted at the start of the survey, after the study title. The students were informed that their participation was voluntary and anonymous, and those who read the following page and nodded in agreement were given the go-ahead to answer the research questions on it.

For three-choice-based questions, one answer was considered correct, and a score of one was given if it was chosen. The overall knowledge score for each section was computed. The knowledge of ADIs was assessed by assuming that one who scored >3 of the 6 indicates poor, while good knowledge indicates <3 of the 6. While the knowledge of general FDIs was assessed by assuming that one who scored >4 of the 9 was considered poor, while good knowledge indicates <5 of the 9. The overall knowledge of drug interactions was assessed by assuming that one who scored >7 of the 14, was poor knowledge while good knowledge indicates <7 of the 14.

## Statistical Analysis

A descriptive analysis was conducted to assess the frequencies and percentages of the study population. Chi-square/Fisher exact test was used for categorical variables analysis whenever applied. The data were analyzed using Statistical Package for Social Sciences version 26.0 (SPSS Inc., Chicago, IL, USA), and a p-value of <0.05 was considered statistically significant.

# Results

## Demographic Information

Of 200 questionnaires distributed, 142 students responded, giving a response rate of 71%, of whom 93.7% were aged between 18 and 25 years (n = 133), and almost 95.1% of them were Saudi nationals. Around 49.3% (n = 70) were in the 3rd year and 50.7% (n = 72) in the 4th year. More than one-third of the students claimed that they do not have enough information about FDIs. According to findings, 60.6% (n = 86) of the participants stated that the elderly are more susceptible to FDIs. Table 1 contains the demographics and other characteristics of the study subjects. In this study, the

**Table 1** Demographic Characteristics and Basic Information of the Study Sample

| Characteristics | Frequency (n) | Percentage (%) |
|---|---|---|
| Age | | |
| 18–25 | 133 | 93.7 |
| 26–30 | 09 | 6.3 |
| Level of education | | |
| Third-year | 70 | 49.3 |
| Fourth-year | 72 | 50.7 |
| Nationality | | |
| Saudi | 135 | 95.1 |
| Non-Saudi | 7 | 4.9 |
| Do you think you have enough information about FDIs and ADIs? | | |
| Yes | 50 | 35.2 |
| No | 54 | 38 |
| I Do not know | 38 | 26.7 |
| Which of the following age groups is most susceptible to FDIs? | | |
| Children | 31 | 21.8 |
| Adults | 7 | 4.9 |
| Elderly | 86 | 60.6 |
| I do not know | 18 | 12.7 |

most common source for the FDIs and ADIs was social media 50.7% (n = 72), followed by, ministry of health 47.2% (n = 67), drug information resources 42.3% (n = 60), and lectures 38.7% (n = 55) (Figure 1).

Table 2 describes the Pharmacy students "knowledge of FDIs. Regarding the students" knowledge about FDIs, 43% (n = 61) of the students were knowledgeable that amiodarone is avoided with grapefruit, while 43.7% (n = 62), knew that atorvastatin cannot be taken with grapefruit (Figure 2). Nearly three-quarters of the students do not know that cauliflower consumption can affect the efficacy of levothyroxine (n = 121). Most of the students did not know that caffeine consumption affects the efficacy of diazepam (n = 83). Nearly 58 (40.8%) of the students did not agree with the statement that patients can eat more green leafy vegetables with warfarin. Just over half (52.8%) agreed that milk affects the efficacy of tetracycline.

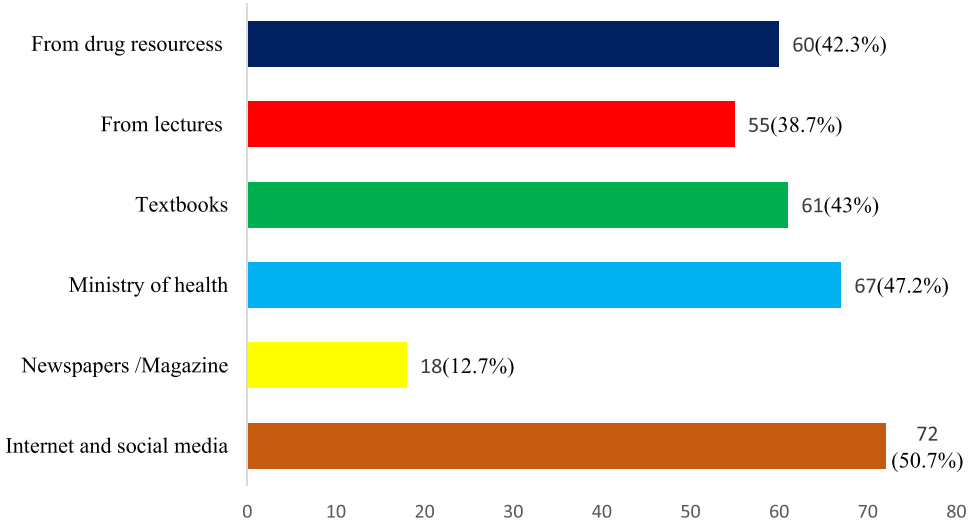


**Figure 1** Source of knowledge of FDIs and ADIs.

**Table 2** Participants' Knowledge About Food–Drugs Interactions

| Food–Drugs Interactions Questionnaire | Correct Answer (n) (%) |
|---|---|
| Can amiodarone be taken with grapefruit? | 61(43%) |
| Can atorvastatin be taken with grapefruit? | 62(43.7%) |
| Does cauliflower consumption affect the efficacy of levothyroxine? | 23(16.2%) |
| Does caffeine consumption affect the efficacy of diazepam? | 61(43%) |
| Patients can eat more green leafy vegetables with Coumadin | 58(40.8%) |
| Patients taking theophylline should avoid excessive coffee and tea? | 12(8.5%) |
| Does milk affect the efficacy of tetracycline? | 75(52.8%) |
| Patients taking monoamine oxidase inhibitors (MAOIs) should avoid eating aged cheeses? | 67(47.2%) |
| Does the wheat bran diet affect the efficacy of digoxin? | 17(12%) |
| Do protein-rich foods affect the efficacy of levodopa? | 17(12%) |
| Grapefruit juice can be safely consumed with all antibiotics? | 61(43%) |
| Patients should avoid taking spironolactone with food rich in potassium? | 16(11.3%) |

Also, a large proportion (64.1%) of participants were unaware that the wheat bran diet affects the efficacy of digoxin. Moreover, approximately half and more than half of the participants answered correctly about the interaction of antihistamines and paracetamol with alcohol. On the other hand, less than half of the participants 61 (43%) were aware that Grapefruit juice cannot be safely consumed with all antibiotics and only 11.3% of the students (n = 16) agreed that patients should avoid taking spironolactone with food rich in potassium. Further information regarding food–drugs interactions knowledge is provided in Table 2.

Although, most of the students were unaware of the interactions of ADIs. Table 3 describes the participant's responses toward ADIs. In terms of the individual questions, Alcohol interactions with antihistamines and paracetamol received the highest percentages of 52.8% (n = 75) and 50.7% (n = 72), respectively, followed by warfarin and methotrexate (45.1%; 41.5%). In this study, only a few students (39.4%) achieved a good knowledge of ADIs. A total of 44.4% (n=63) of the undergraduates reported being knowledgeable about FDIs. The FDIs' and ADIs' knowledge level was significantly associated with the level of education (p = 0.0001) and having information about DIs (Table 4).

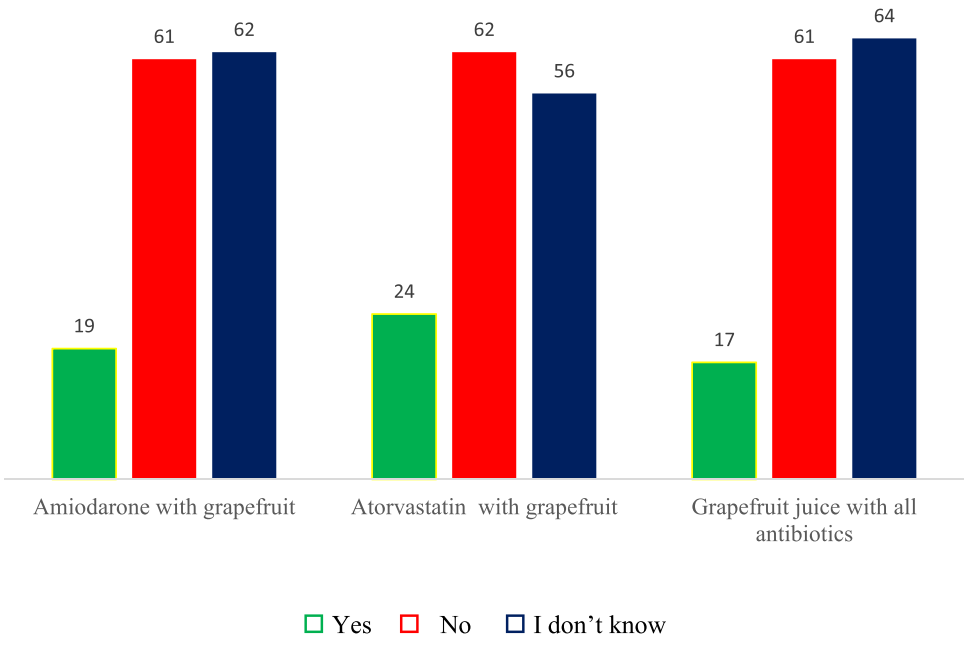


**Figure 2** Knowledge of grapefruit interactions with selected drugs.

**Table 3** Participants' Knowledge About Alcohol–Drugs Interactions (ADIs)

| Alcohol–Drugs Interactions Questionnaire | Frequency (n) | Percentage (%) | Correct Answers, (%) |
|---|---|---|---|
| Do antihistamines interact with alcohol? | | | |
| Yes | 75 | 52.8 | 75(52.8) |
| No | 9 | 6.3 | |
| I Do not know | 58 | 40.8 | |
| Does Paracetamol interact with alcohol? | | | |
| Yes | 72 | 50.7 | 72(50.7%) |
| No | 12 | 8.5 | |
| I Do not know | 58 | 40.9 | |
| Does Metformin interact with alcohol? | | | |
| Yes | 53 | 37.3 | 53(37.3%) |
| No | 14 | 9.9 | |
| I Do not know | 75 | 52.8 | |
| Does isoniazid interact with alcohol? | | | |
| Yes | 51 | 35.9 | 51(35.9%) |
| No | 8 | 5.6 | |
| I Do not know | 83 | 58.5 | |
| Does warfarin interact with alcohol? | | | |
| Yes | 64 | 45.1 | 64(45.1%) |
| No | 18 | 5.6 | |
| I Do not know | 70 | 49.3 | |
| Does methotrexate interact with alcohol? | | | |
| Yes | 59 | 41.5 | 59(41.5%) |
| No | 9 | 6.3 | |
| I Do not know | 74 | 52.1 | |

Regarding the association between socio-demographic factors and overall pharmacists' knowledge score, we found that level of education and having information about FDIs has a significant effect on the knowledge score of undergraduate pharmacy students ($p = 0.0001$) except for age ($p < 0.05$). Although the overall knowledge of FDIs among the students was 47.9% ($n = 68$). The total knowledge of FDIs was not significantly associated with age ($p < 0.05$) it was associated with educational levels and having information about FDIs ($p = 0.0001$). Detailed information Influence of respondents' characteristics on their knowledge levels is given in Table 5.

## Discussion

To the best of our knowledge, there were limited studies that evaluated the knowledge of FDIs among undergraduate pharmacy students in Saudi Arabia. Not much literature was identified nationally and internationally about knowledge of FDIs,[21–23] however, most of the literature reported practicing pharmacists' knowledge of FDIs.[19,20,24] This study would add a significant contribution to the efficacy and safety of Drugs and Food use among patients, individuals in Saudi Arabia, and other countries and would serve as a reference for the much-needed upcoming studies. The findings could also be used by educational and healthcare institutions to develop appropriate training initiatives to improve pharmacists' and other healthcare professionals' knowledge of clinically significant FDIs.

Although the overall FDIs knowledge in this study was 47.9%. The highest knowledge score was reported for common FDIs (44.4%), followed by ADIs (39.4%). These results were comparable to a previously published study by Radwan et al in 2018, who reported that 52.5% of the pharmacist answered correctly about FDIs. Similarly, another study among undergraduates reported that 34% them were aware of thyroid hormones' interactions with Food.[24] Additionally, a study by Aljawharah et al reported low levels of knowledge which respect to Caffeine interactions with drugs at 21.6%.[21] In this light, the current study reported 43% of the knowledge score for caffeine drug interactions. Although the knowledge of FDIs may differ from one study to another which may be influenced by several factors including the study

**Table 4** Influence of Respondents' Characteristics on Their Knowledge Level About Food–Drug Interactions, and Alcohol–Drug Interactions

| Participants Characters | Number of Respondents | Food–Drug Interactions | | | Alcohol–Drug Interactions | | |
|---|---|---|---|---|---|---|---|
| | | Not Knowledgeable (N=79; 55.6%) | Knowledgeable (N=63; 44.4%) | *P* value | Not Knowledgeable (N=86; 60.6%) | Knowledgeable (N=56; 39.4%) | *p* value |
| Age | | | | | | | |
| 18–29 years | Respondents | 75 | 58 | 0.485 | 83 | 50 | 0.084* |
| | % within age | 56.4% | 43.6% | | 62.4 | 37.6 | |
| | % within knowledge categories | 94.9% | 92.1% | | 96.5 | 89.3 | |
| 26–30 years | Respondents | 04 | 0.5 | | 03 | 06 | |
| | % within age | 44.4% | 55.6% | | 33.3 | 66.7 | |
| | % within knowledge categories | 5.1% | 7.9% | | 3.5 | 10.7 | |
| Education | | | | | | | |
| Third-year | Respondents | 59 | 11 | 0.0001 | 56 | 14 | 0.0001 |
| | % within the level of education | 84.3% | 15.7% | | 80.0 | 20 | |
| | % within knowledge categories | 74.7% | 17.5% | | 65.1 | 25 | |
| Fourth-year | Respondents | 20 | 52 | | 30 | 42 | |
| | % within the level of education | 27.8% | 72.2% | | 41.7 | 58.3 | |
| | % within knowledge categories | 25.3% | 82.5% | | 34.9 | 75.0 | |
| Information about DFIs and ADIs ? | | | | | | | |
| Yes | Respondents | 18 | 32 | 0.0001 | 21 | 29 | 0.0002 |
| | % within information | 36.0% | 64.0% | | 42 | 58 | |
| | % within knowledge categories | 22.8% | 50.8% | | 24.4 | 51.8 | |
| No | Respondents | 40 | 14 | | 41 | 13 | |
| | % within information | 74.1% | 25.9% | | 75.9 | 24.1 | |
| | % within knowledge categories | 50.6% | 22.2% | | 47.7 | 23.2 | |
| I do not know | Respondents | 21 | 17 | | 24 | 14 | |
| | % within information | 55.3% | 44.7% | | 63.2 | 36.8 | |
| | % within knowledge categories | 26.6% | 27.0% | | 27.9 | 25 | |

**Note**: *Fisher exact test.

method, types of respondents, and demographics of the subjects, it is evidenced that practicing pharmacists would be found to have good knowledge and then student pharmacists.

In this study, more than half of the students (52%) demonstrated milk affects the efficacy of tetracycline, while 47.2% of the students reported monoamine oxidase inhibitors (MAOIs) should avoid eating aged cheeses. The current findings were in line with previous findings published elsewhere. For instance, a study in Saudi reported that 21% of the students were knowledgeable about milk interaction with tetracycline, while 29% agreed that MAOIs should avoid taking cheeses or milk products.[21] Similarly, another recent study found that 82.1% of the students were knowledgeable about milk drug interactions.[22] Accordingly, Tyramine, an amino acid-like substance, is found in aged cheese and other fermented foods. This interaction has the potential to regulate blood pressure and myocardial infarction. Healthcare students' awareness about such potential interactions during their graduation would help at their practice site, which could prevent life-threatening events.[25,26] Additionally, this finding evidenced variations in the knowledge of FDIs in some aspects, which necessitates additional educational programs to improve the awareness of FDIs among students is needed.

**Table 5** Cross-Tabulation Between Demographic Characteristics and Knowledge Categories of Overall DFIs

| Participants Characters | Number of Respondents | Not Knowledgeable (N=74; 52.1%) | Knowledgeable (N=68; 47.9%) | P value |
|---|---|---|---|---|
| Age | | | | |
| 18–25 years | Respondents | 71 | 62 | 0.244* |
| | % within age | 53.4% | 46.6% | |
| | % within knowledge categories | 95.9% | 91.2% | |
| 26–30 years | Respondents | 03 | 06 | |
| | % within age | 33.3% | 66.7% | |
| | % within knowledge categories | 4.1% | 8.8% | |
| Education Level | | | | |
| Third-year | Respondents | 56 | 14 | 0.0001 |
| | % within education level | 80.0% | 20.0% | |
| | % within knowledge categories | 75.7% | 20.6% | |
| Fourth-year | Respondents | 18 | 54 | |
| | % within education level | 25.0% | 75.0% | |
| | % within knowledge categories | 24.3% | 79.4% | |
| Do you have information about DFIs and ADIs? | | | | |
| Yes | Respondents | 14 | 36 | 0.0001 |
| | % within having information | 28.0% | 72.0% | |
| | % within knowledge categories | 18.9% | 52.9% | |
| No | Respondents | 40 | 14 | |
| | % within having information | 74.1% | 25.9% | |
| | % within knowledge categories | 27.0% | 20.6% | |
| I do not know | Respondents | 20 | 18 | |
| | % within having information | 52.6% | 47.4% | |
| | % within knowledge categories | 27.0% | 26.5% | |

**Note**: *Fisher exact test.

In this study, there was a statistically significant association between knowledge level and prior exposure to DFIs and ADIs. Furthermore, the knowledge was significantly associated with the year of study. However, the age group of the undergraduates had no significant effect on their knowledge of DFIs and ADIs. Studies examining the variation between knowledge of drug interactions and characteristics of undergraduate pharmacy students are currently lacking. There have been some studies about the evaluation of FDIs and ADIs among prospective students,[21–23] but those earlier studies did not look at the relationship between the knowledge score and the characteristics of undergraduates. The fact that senior undergraduates consistently demonstrate a higher level of theoretical knowledge than juniors. Additionally, prior exposure to FDIs and ADIs during the graduation process (through a course, congress, seminar, etc.) may have affected this circumstance.

With regard to grapefruit interactions, 43% of the students were knowledgeable about it. While the previous study among Indian health care students reported that 64% of them were knowledgeable about grapefruit interactions.[22] Although Grapefruit is well known and most commonly used fruit for its wide variety of benefits for the cardiovascular system and for preventing various types of cancers. However, it has been found that Grapefruit acts as an inhibitor of the intestinal cytochrome P – 450 3A4 system, which is responsible for the first-pass metabolism of many drugs, which destroys efficacy and safety, and even leads to more toxic effects.[20,27] In addition to this, studies reported that more than 82 varieties of drugs are known to interact with Grapefruit.[27,28] A significant proportion of undergraduates were unfamiliar with grapefruit–drug interactions. Taking either atorvastatin or antibiotics concomitantly with grapefruit could lead to undesirable outcomes, with serious side effects. In this light, atorvastatin consumption with grapefruit causes the breakdown of muscle tissue that leads to the release of muscle fiber contents into the blood, while amiodarone is known to show polymorphic ventricular tachycardia effects.[29,30] Earlier two studies reported inadequate knowledge of FDIs among students in the Northern region of Saudi Arabia and another international country.[21,22] While literature demonstrated better knowledge of FDIs among community pharmacists.[20,24] This variation is because practicing

pharmacists were more aware of the FDIs, than students. However, in the current study, only 35.2% of students reported having information about FDIs, while the previous study reported the highest levels of awareness about FDIs.[23]

With regard to ADIs, the knowledge was significantly lower in comparison to food–drug interactions, lesser extent the undergraduates were familiar with the alcohol-isoniazid, alcohol-metformin, and alcohol-methotrexate interactions. It is well documented that alcohol is known to interact with multiple drugs, likewise, alcohol-warfarin causes an increased risk of gastrointestinal bleeding, while alcohol with methotrexate or isoniazid enhances the hepatotoxic effect of these medications.[31,32] Despite that most drugs are warned to take with some food products, as prescribed, most of their users take them immediately after the food, with or without knowing the harmful outcomes. Therefore, it was important to understand the knowledge of pharmacists in dealing with DIs, since undergraduates are the future practicing pharmacist,[33–35] and evaluating their knowledge about the DIs would help in better prescribing during their practice site. Furthermore, there is a need to introduce educational activities about FDIs and ADIs beginning from their graduation. The presence of such activities and requirements in the Saudi curriculum can help in improving the pharmacists' knowledge and practice of FDIs.

There are certain limitations to the current study. First, the findings were based on a self-administered online questionnaire, which could have increased the risk of biases such as social desirability bias or recall bias. Second, the findings were based on a specific university in Saudi Arabia, making them non-representative of other academic institutions at both national and international levels and therefore not internationally applicable. Third, because women are still not appointed or allowed to study together in university settings in Saudi Arabia, both have different campuses, therefore female students did not include. Despite these limitations, our research proposes that more emphasis be placed on raising individual awareness of the FDIs provided by healthcare professionals to improve the health of everyone else in the community.

## Conclusion

In conclusion, undergraduate pharmacy students exhibited poor knowledge of FDIs and ADIs. Furthermore, the overall knowledge of both FDIs and ADIs was significantly associated with the level of education and previous knowledge of interactions. In today's society, the concept of combining drugs, food, and alcohol is becoming more popular, which has transformed the healthcare industry. As a result, there is a need to raise understanding among pharmacy students to close the knowledge gap created by FDs and ADIs. Our research could aid in the investigation of the most effective and practical methods for increasing students' awareness and knowledge about FDIs. Integrating full-time FD and ADIs courses into pharmacy curricula, as well as continuing training modules, are all important things to take. Incorporating DIs into clinical practice will undoubtedly enhance treatment outcomes, reduce adverse medication effects, and have a favorable impact on patient care in the future.

## Institutional Review Board Statement

This study was approved by the research ethics committee college of medicine King Saud University Riyadh Saudi Arabia with the following Approval of Research Project No. E-21-6371. Written informed consent was obtained from all participants in the study.

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## Disclosure

The authors declare that they have no competing interests.

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