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Original Article

Assessing Knowledge Gaps and Awareness of Diabetes-Related Drug-Drug, Drug-Food, and Drug-Disease Interactions Among Pharmacy and Non-Pharmacy Students in Saudi Arabia

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ABSTRACT:

Background: Even though pharmacy students receive formal education and training on pharmacotherapy and interactions between drugs (DDIs), food (DFIs), and disease (DDIs), limited data exist on the comparison between professional knowledge gaps among pharmacy and non-pharmacy undergraduate students, which represents the educated population of society. **Objectives:** The objective of this study was to assess and compare the awareness and perceptions of DDIs, DFIs, and DDsI related to diabetes mellitus among pharmacy and non-pharmacy students to identify educational needs and potential gaps in understanding of chronic diseases, particularly diabetes mellitus. **Materials and Methods:** A cross-sectional study was conducted between October 2024 and April 2025 among 570 students (285 pharmacy, 285 non-pharmacy) using a validated questionnaire. Univariate and multivariate logistic regression analyses identified predictors of KAP. **Results:** Multivariate logistic regression showed that, among pharmacy students, age >25 years was associated with higher knowledge (AOR = 1.2, 95% CI: 1.3–1.9, $p = 0.01$), while postgraduate status was associated with lower knowledge (AOR = 0.2, 95% CI: 0.4–0.9, $p = 0.01$). Among non-pharmacy students, female gender was associated with higher knowledge (AOR = 0.4, 95% CI: 0.2–0.9, $p = 0.02$), whereas postgraduate students showed lower knowledge compared with undergraduates (AOR = 0.2, 95% CI: 0.4–0.9, $p = 0.05$). **Conclusion:** Although pharmacy students showed better understanding of DDIs, DFIs, and DDsI in relation to Diabetes Mellitus, there are evident gaps in attitudes and practices of both groups. Female gender, older persons, predicted positive outcomes, while postgraduate education showed a knowledge-attitude gap.

Keywords: Drug-drug interactions, Drug-food interactions, Medication safety, Health professions education, Diabetes education.

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INTRODUCTION

The growing complexity in pharmacotherapy with the co-administration of multiple drugs has fueled concerns regarding possible Drug-Drug Interaction (DDI) and Drug-Food Interaction (DFI) (Debus *et al.*, 2022). These interactions result in decreased efficacy and higher risks of side effects, and in some cases, failure of treatment (Raoul, Moreau-Bachelard, Gilabert, Edeline, & Frénel, 2023). The role of healthcare providers, including pharmacists, in detecting and preventing these interactions is critical to provide better patient outcomes (Ahmed & TAMIM, 2025). The primary task of the Pharmacist is detecting and managing drug-drug interactions (Babladi, Hirve, Bhalki, Owais, & Joy, 2025), drug-food interactions (Wakabayashi, Karasawa, Okamoto, Chiba, & Tanaka, 2025) in various disease conditions and drug interactions with various diseases, like antifungal drugs in oncology (Akbar, Aamir, Saleem, & Khan, 2025). But the awareness and knowledge levels among pharmacy and non-pharmacy students, the future healthcare providers, and possible medication users, are an important subject for research (Mansoor *et al.*, 2025).

In Saudi Arabia, there has also been a rising incidence of polypharmacy and self-medication practices because of the accessibility of over-the-counter and nutritional supplements. Diabetes is also a leading contributor to morbidity, mortality, and healthcare expenditure in the country, largely due to its associated complications such as cardiovascular disease, nephropathy, neuropathy, and retinopathy (Mannasaheb *et al.*, 2022). This is pertinent to the importance of sufficient awareness and

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knowledge concerning drug-drug and drug-food interactions for university students, specifically for those studying a field related to the healthcare sector. Previous literature has identified gaps within the understanding of DDIs and DFIs for healthcare and pharmaceutical university students worldwide, supporting the significance of enhanced educational awareness initiatives (Khong, Tuan Mahmood, Tan, Voo, & Wong, 2024; Makkaoui *et al*., 2021).

Being aware that the knowledge concerning drug-drug, drug-food, and drug-disease interactions will be superior among pharmacy students, the investigation of awareness of non-pharmacy students is as relevant. Comparing awareness of these groups allows the identification of gaps in knowledge and unsafe behavior regarding medicines (self-medication, over-the-counter drugs consumption, and health supplement use). This comparison spotlights deficiencies in not only professional versus non-professional students but also the academic community in general.

MATERIALS AND METHODS

Study Design

A cross-sectional study was conducted at the University of Hafr Al Batin, Kingdom of Saudi Arabia, in October 2024 and concluded in April 2025.

Study Instrument and Translation

The questionnaire for conducting the survey has been developed by referring to the existing literature on knowledge awareness, attitudes, and practices of drug interaction, as well as drug-food interaction in diabetic patients (Alhubail, Alharthi, Alsayyah, & Younis, 2023; HARMOUSH, 2021; Zaidi *et al*., 2021). To check the appropriateness, clarity, relevance, and completeness of the questionnaire, a validation of the questionnaire among three different researchers independently has been done. The final version of the questionnaire consists of a total of 38 items. The research instrument was initially developed in English. Later on, the instrument was translated into Arabic by a professional translator in the respective field. Back-translation was done. The reliability testing was done by Cronbach's alpha and it was 0.8.

Data collection tools and techniques

The questionnaire survey was conducted online for students pursuing pharmacy and non-pharmacy programs offered within the University of Hafr Al Batin, Saudi Arabia. To qualify for consideration, all items on the questionnaire must be filled. Incompletely filled questionnaires were discarded, and follow-up notices were directed towards those who failed to respond. Using the Raosoft software, taking into consideration that the sample populace is normally distributed, numbering more than 50, the sample size for the research necessitated a minimum of 250.

Data analysis plan

Data were analyzed using SPSS version 28 (IBM Corp., Armonk, NY). Descriptive statistics (frequencies and percentages) summarized sociodemographic characteristics and knowledge levels. Logistic regression was performed to examine associations between categorical variables, which were converted into dummy variables. Gender was coded as male = 0 and female = 1; age as <20 = 0, 20–25 = 1, and >25 = 2; education as undergraduate = 0 and postgraduate = 1; residence as urban = 0 and rural = 1; and marital status as unmarried = 0 and married = 1. Statistical significance was set at $p < 0.05$.

Ethical consideration

Ethical clearance for this study was granted by the Ethics Committee of Hafr Al-Batin University under reference number HPO-05-FT-24/09 dated 24-12-24.

RESULTS

Sociodemographic Variables among Participants

A total of 570 students successfully filled out the questionnaire, consisting of 285 pharmacy and 285 non-pharmacy students, to form the final data for analysis. Table 1 describes the demographic comparison between the two groups. A statistically significant difference in gender distribution was found, where females consisted the majority in the pharmacy group (68.8%) and males in the non-pharmacy group (67.7%). However, age distribution did not show a statistically significant difference, where the majority in both groups consisted of 20-25-year-old students.

Knowledge Gaps in Diabetes Drug, Drug Food, and Drug Disease Interaction among Pharmacy and Non-Pharmacy Students

Students in pharmacy showed significantly better recognition of drug-drug (81.4% vs. 53.7%), drug-disease (85.3% vs. 54.7%), and drug-food (90.5% vs. 55.4%) interactions than those in non-pharmacy groups. They also had better recognition of consequences, with 47.7% having an accurate understanding of an increased risk of adverse reactions as a consequence of drug interaction, compared with less precise understanding shown by non-pharmacy groups (57.2%). It was interesting that 85.6% of pharmacy students could recognize the importance of consulting medical professionals while taking various medications. The knowledge was still deficient in both groups on the details of some of these complications, such as hypertension (66.3% in pharmacy groups) (Table 2).

Association between sociodemographic characteristics and Knowledge Regarding Diabetes drugs, drug-food, and disease Interactions

Logistic regression analysis identified significant associations between sociodemographic factors and knowledge related to

Table 1: Demographic characteristics among Pharmacy and Non-Pharmacy students.

Variables	Pharmacy Students (%)	Non-Pharmacy students (%)	*p*-value
Gender			
Male	89 (31.2)	193 (67.7)	0.01
Female	196 (68.8)	92 (32.3)	
Age (Years)			
Below 20	113 (39.6)	88 (30.9)	0.3
20-25	160 (56.1)	173 (60.7)	
Above 25	12 (4.2)	24 (8.4)	
Education			
Undergraduate	216 (75.8)	218 (76.5)	0.01
Postgraduate	69 (24.2)	64 (22.5)	
Residence			
Urban	212 (74.4)	221 (77.5)	0.3
Rural	73 (25.6)	64 (22.5)	
Marital Status			
Married	42 (14.7)	50 (17.5)	0.5
Unmarried	243 (85.3)	235 (82.5)	

drug–drug, drug–food, and drug–disease interactions among pharmacy students. Students aged >25 years showed higher knowledge (AOR = 1.2, 95% CI: 1.3–1.9, p = 0.01), while those aged 20–25 years demonstrated better practices (AOR = 1.1–1.9, p = 0.001). Detailed results are presented in Table 3.

Association between sociodemographic characteristics and Knowledge Regarding Diabetes drugs, drug-food, and disease Interaction

In Table 4, the analysis revealed significant gender and age-based disparities in DDs, DFs, and DDs awareness among non-pharmacy students. Females demonstrated significantly higher knowledge (AOR=0.4, 95% CI:0.2-0.9, p=0.02) compared to males. Students aged 20-25 showed more positive knowledge (OR=1.1-1.5, p=0.01). Postgraduates displayed paradoxically lower knowledge (AOR=0.2, 95% CI:0.4-0.9, p=0.05) than undergraduates.

DISCUSSION

This study assessed knowledge gaps regarding Drug-drug, drug-food, and drug-disease interactions among pharmacy and non-pharmacy undergraduate students while also examining the influence of sociodemographic factors on DDI, DFIs, and DDsI awareness. Pharmacy students scored significantly higher in knowledge of DDIs, DFIs, and DDsI when compared with non-pharmacy students at 81.4% vs. 53.7%. This is consistent with a study done by. However, there was a knowledge gap in pharmacy students concerning disease-specific interactions because only 66.3% identified hypertension. This contradicts a study that showed a virtually universal level of awareness amongst pharmacy interns, which indicates that continuous reinforcement through the curriculum at a young age is needed (Arifin, Wedhatami, & Alkadri, 2021).

Despite their better understanding, their attitudes remained suboptimal in both groups, with 72% of pharmacy students and 67% of non-pharmacy students having negative and apprehensive views about DFIs and DDs. Their lack of clinical experience may contribute to this apprehension, as reported by Bautista, C. L., & Teng, E. J. (2022) (Bautista & Teng, 2022). However, the pharmacy students took more initiative in this area, with 91.9% wanting to learn more, compared with 65.3% in non-pharmacy students. Similarly, it agrees with Collier *et al.*, because it supports that self-directed education is a positive contributor to safe practices (Collier, 2022). Only 42.8% of students followed faithfully nutritional recommendations, showing the gap between theory and practice. The result is consistent with what exists in studies. In fact, research suggests that students hardly ever apply skills to real-world situations but always hold theoretical concepts (Fantinelli, Cortini, Di Fiore, Iervese, & Galanti, 2024).In regression analysis, females of both groups had better knowledge and practices, consistent with Zaidi, S. F *et al.* (2021), who attributed this to greater health-seeking behavior in women (Zaidi *et al.*, 2021). Gender differences in DDI, DFIs, and DDs awareness can be looked at through several lenses. Females showed higher knowledge and practices, as Embabo, A., Jimma *et al.*'s (2022) findings propose, as females in general tend to show higher health-seeking practices and healthcare safety awareness (Embabo, Jimma, & Diriba, 2022). This can be attributed to overall societal dynamics in which females tend to be more careful about health issues and more attentive towards healthcare professionals' advice. Only postgraduates showed

Table 2: Knowledge among the Pharmacy and Non-Pharmacy Students regarding Diabetes Drug, Drug Food, and Drug Disease Interaction.

Questions	Pharmacy Students n (%)	Non-Pharmacy Students n (%)
Have you heard about drug-drug interactions?		
Yes	232 (81.4)	153 (53.7)
No	53 (18.6)	132 (46.3)
Have you heard about drug-disease interactions?		
Yes	243 (85.3)	156 (54.7)
No	42 (14.7)	129 (45.3)
Have you heard about drug-food interactions?		
Yes	258 (90.5)	158 (55.4)
No	27 (9.5)	127 (44.6)
What do you think happens when two or more medications interact?		
Medications may lose effectiveness	107 (37.5)	50 (17.5)
Side effects may increase	136 (47.7)	163 (57.2)
Medications may work better together	24 (8.4)	19 (6.7)
I don't know	18 (6.3)	53 (18.6)
Which of the following is true about taking multiple medications?		
They can always be taken together	24 (8.4)	31 (10.9)
They can always be taken after being advised by a doctor/ pharmacist	244 (85.6)	208 (73.0)
I am not sure	17 (6.0)	46 (16.1)
Have you ever been informed by a healthcare professional about drug-drug interactions?		
Yes	191 (67.1)	116 (40.7)
No	94 (32.9)	169 (59.3)
If you suspect a drug interaction, what do you do?		
Consult a doctor or pharmacist	199 (69.8)	184 (64.6)
Stop taking the medication immediately	76 (26.7)	70 (24.6)
I don't know what to do	10 (3.5)	31 (10.9)
Do you know that certain medications can worsen diabetes or its complications?		
Yes	229 (80.4)	159 (55.8)
No	56 (19.6)	126 (44.2)
Which conditions can influence diabetes treatment when combined with certain medications?		
I don't know	28 (9.8)	94 (33.0)
Hypertension	189 (66.3)	139 (48.8)
Heart disease	28 (9.8)	19 (6.7)
Kidney disease	34 (11.9)	24 (8.4)
Liver disease	6 (2.1)	9 (3.2)
Have you ever been informed that your general health condition could interact with your diabetes medications?		
Yes	149 (52.3)	74 (26.0)
No	136 (47.7)	211 (74.0)

Questions	Pharmacy Students n (%)	Non-Pharmacy Students n (%)
Do you know that certain foods can reduce or enhance the effectiveness of medications?		
Yes	253 (88.8)	166 (58.2)
No	32 (11.2)	119 (41.8)
Which of the following foods might interact with diabetes medications?		
I don't know	27 (9.5)	103 (36.1)
Alcohol	206 (72.3)	128 (44.9)
Leafy green vegetables	3 (1.1)	9 (3.2)
Grapefruit juice	37 (13.0)	18 (6.3)
Fatty foods	12 (4.2)	27 (9.5)
Who is your primary source of information about medicines?		
Pharmacist	204 (71.7)	115 (40.4)
Doctor	54 (18.9)	112 (39.3)
Friends or family	5 (1.8)	27 (9.5)
Internet or Social Media	21 (7.8)	31 (10.9)

Table 3: Sociodemographic Influences on Diabetes Drug, Drug Food, and Drug Disease Interaction among Pharmacy Students.

Variables	Knowledge			
	Univariate Logistic		Multivariate Logistic	
	OR (95%CL)	*p*-value	AOR (95%CL)	*p*-value
Gender				
Male	1		1	
Female	0.1 (0.3-1.1)	0.6	-	
Age (Years)				
Below 20	1		1	
20-25	0.1 (0.1-1.7)	0.3	-	
Above 25	1.0 (1.1-1.5)	0.01	1.2 (1.3-1.9)	0.01
Education				
Undergraduate	1		1	
Postgraduate	0.1 (0.1-0.9)	0.02	0.2 (0.4-0.9)	0.01
Residence				
Urban	1		1	
Rural	0.1 (0.1-1.3)	0.8	-	
Marital Status				
Married	1		1	
Unmarried	0.1 (0.1-2.1)	0.5	-	

significant awareness related to critical DF interactions, such as metformin and alcohol causing lactic acidosis or warfarin and vitamin K-rich foods impacting anticoagulation. Similarly, it was claimed that pharmacy students could enumerate common DDIs, such as NSAIDs and CKD, but few remembered DF interactions, like grapefruit and statins (Beirão, Costa, & Ferreira-Pêgo, 2024). Postgraduates displayed paradoxically lower knowledge (AOR=0.2, 95% CI:0.4-0.9, p=0.05) than undergraduates. Possible explanations have been explored, including differences in academic focus, reduced engagement with foundational coursework, variability in curriculum exposure, and potential differences in sample characteristics. The students outside of

Table 4: Sociodemographic Influences on Diabetes drug, drug food, and drug disease interaction Non-Pharmacy Students.

Variables	Knowledge			
	Univariate Logistic		Multivariate Logistic	
	OR (95%CL)	*p*-value	AOR (95%CL)	*p*-value
Gender				
Male	1		1	
Female	1.0 (1.1–1.2)	0.001	0.4 (0.2-0.9)	0.02
Age (Years)				
Below 20	1		1	
20-25	0.1 (0.1-1.7)	0.3	-	
Above 25	1.0 (1.1-1.5	)0.01	0.5 (0.2-2.2)	0.3
Education				
Undergraduate	1		1	
Postgraduate	0.1 (0.1-0.9)	0.02	0.2 (0.4-0.9)	0.05
Residence				
Urban	1		1	
Rural	0.1 (0.1-1.3)	0.8	-	
Marital Status				
Married	1		1	
Unmarried	0.1 (0.1-2.1)	0.5	-	

pharmacy classes rarely inquired about either form (18.2% of non-pharmacy students "never" screened DDIs, and 11.9% disregarded dietary recommendations). This is in contrast with a study by Spadaro, G. *et al*., (2023) that found no significant difference by gender, possibly explainable by the characteristics of their study setting or by how variables were operationalized (Spadaro, Jin, & Balliet, 2023). The study has various important strengths that allow it to have increased validity in the findings it produces. The large sample size makes the findings generalizable to a greater extent, while the comparative study performed in the study draws important inferences regarding the awareness of drug interactions from an educational point of view.

CONCLUSION

This study highlights significant differences in knowledge, and awareness regarding drug–drug, drug–food, and drug–disease interactions between pharmacy and non-pharmacy students. Although pharmacy students demonstrated superior knowledge, both groups showed deficiencies in attitudes and practical application. Sociodemographic factors influenced awareness, with female students exhibiting better knowledge and practices, male pharmacy students showing more positive attitudes, and students aged 20–25 years demonstrating improved attitudes and practices, likely due to greater maturity and exposure. The findings emphasize the need for targeted educational interventions, including case-based learning in pharmacy curricula and basic medication safety education for non-pharmacy students, to bridge the gap between knowledge and practice and promote safer medication use.

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