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**KNOWLEDGE, ATTITUDES AND AWARENESS ABOUT FOOD AND DRUG  
INTERACTIONS (FDI) AMONG PHARMACISTS IN NORTHERN BORDER  
REGION OF SAUDI ARABIA**

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**ABSTRACT**

**Introduction:** Interactions between the food and drugs can have profound influence on the compliance and success of drug treatment. Certain foods and specific nutrients in foods, may affect the overall bioavailability, pharmacokinetics, pharmacodynamics and therapeutic efficacy of medications.

**Objectives:** To evaluate the knowledge, attitude and awareness regarding the common FDI among pharmacists in northern border region of Saudi Arabia.

**Method:** This is a cross-sectional study, which involved a sample of 81 pharmacists working hospital, community and primary care pharmacies in Northern Border Region of Saudi Arabia. A self-administered questionnaire consisted of 29 questions was used to assess pharmacists' knowledge, awareness and attitude towards the most common and clinically significant interactions between food and medicines. Assessment was done through FDI's Questionnaire and data processed using MS excel by descriptive statistics.

**Results:** The mean scores (%) on the pharmacist knowledge about FDI was (53%) and the mean score (%) on pharmacists attitude was (83%), about one fifth (21%) of pharmacists

reported that they came across FDI. The pharmacists surveyed in this study have demonstrated good knowledge of some interactions; but poor knowledge of others.

**Conclusion:** Pharmacists' knowledge about the FDI was not satisfactory but they mostly had positive attitude regarding patient counseling about FDI. This requires regulatory bodies to include structured training schedule about FDIs for practicing pharmacists.

**Keywords: Food and Drug Interactions (FDI), Bioavailability, Pharmacokinetics, Pharmacodynamics**

## INTRODUCTION

Interactions between the food and drugs can have profound influence on the compliance and success of drug treatment. In the health care setting, adverse drug reactions (ADR) and drug interactions (DI) present a growing concern. Food–drug interactions (FDIs) are one of the sources of Medication errors [1]. Food may have positive or negative effects on the drug bioavailability, which may lead to therapeutic failure or drug toxicity. FDIs are of important concern in the medical practice; they may adversely affect the drug's effectiveness and prolong the patient's hospitalization and be life threatening [2]. Food can alter drug's bioavailability by introducing changes in the GI physiology such as; gastric emptying, gastric pH, GI motility, the activity of the metabolizing enzymes and the transport proteins such as P-glycoprotein. Furthermore, food components may bind or chelate to the active pharmaceutical ingredient [3].

Certain foods and specific nutrients in foods, if ingested concurrently with some

drugs, may affect the overall bioavailability, pharmacokinetics, pharmacodynamics and therapeutic efficacy of the medications [4]. Furthermore, the therapeutic efficacy of many drugs depends on the nutritional status of the individual. In other words, the presence or absence of some nutrients in the gastrointestinal tract and/or in the body's physiological system, such as in the blood, can enhance or impair the rate of drug absorption and metabolism. Drug food interactions can happen with both prescription and over-the-counter medicines, including antacids, vitamins and iron pills. Foods containing active substances that interact against certain medications can produce unexpected or adverse effects. Pharmacist can give the information of such interactions to the patients [5]. Nutrients include food, beverages and dietary supplements. Consumption of these substances may alter the effects of drugs in the patient.

High-risk patients taking three or more medications for chronic conditions like

diabetes, hypertension, depression or congestive heart failure should be particularly monitored for FDI [6]. Timing of food intake does affect the efficacy of certain medicines. Thus, food may either delay or decrease the absorption of the drug when taken with meals or some drugs are better tolerated when taken with food. Therefore, it's always advised to consult the physician regarding the timing of food consumption and the medicine [7]. Doctors and pharmacists in every practice setting need to be vigilant and counsel the patients for potential FDIs.

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has developed standards regarding drug-nutrient interactions and mandate healthcare professionals to counsel their patients on these interactions [8]. FDIs per se are very complex, varying in nature and there is a need for greater attention from the health care community. In Saudi Arabia, no study has been found focusing on the knowledge, attitude and awareness regarding the common FDI among the pharmacist or healthcare in their day to day practice.

To investigate this type of interactions and alertness, we conceptualized this study with an objective to evaluate the knowledge, attitude and awareness regarding the common FDI among the pharmacist in their day to day practice.

## **METHODS**

### **Study participants and data collection**

A cross sectional study design in a period of two months from 1<sup>st</sup> January 2018 to 28<sup>th</sup> February 2018 in Northern Border Area. The data collected by a self-created questionnaire in English language especially designed for the study purpose after revising related literature. The questionnaire contained twenty nine questions and divided into three main sections: the first section includes socio-demographic data and the second part to assess pharmacists' knowledge and awareness about FDIs and the third part to assess pharmacist's attitudes toward FDIs.

Inclusion criteria included: licensed and currently practicing pharmacist or clinical pharmacist and agree to participate and answer the questionnaire. The objective of the study explained to the pharmacists, they had all the right not to be involved in the study or not to answer any question. Only the pharmacists who agreed to fill the questionnaire were included after being consented before answering the questionnaire. They were also informed that all of their responses will be confidential.

All data categorized, tabulated and analyzed using Microsoft excel program by means of descriptive statistics. Frequency and percentage calculated for each variable with representation by figures. Mean and

standard deviation calculated for age of participants. Also, the mean score calculated for the knowledge and attitude of pharmacists regarding food and drug interactions.

## RESULTS

### Socio-demographics of pharmacists

This study included 81 licensed and currently practicing pharmacists in different pharmacies in Northern Border region of Saudi Arabia. Their Socio-demographic characteristics are presented in Table 1. The mean age of participants were  $33.6 \pm 4.2$  years with minimum 28 years and maximum 48 years and the male pharmacists represent 55% (60/81) of the study sample. Nearly two thirds 60% (49/81) of the study participants was bachelor's degree holders and 79% (64/81) were Saudi national. In our study 51% (41/81) of the included pharmacists were hospital pharmacists and 60% (49/81) were married.

### Pharmacists' knowledge and awareness regarding FDIs

Majority 89% (72/81) of pharmacists in the study know that food and beverage can interfering with drug in the body and also the same percentage 89% (72/81) of pharmacists know that food can speed up or slow down the action of a drug. Table 2 represents details of pharmacists' knowledge regarding FDIs. 81% (66/81) knew that Impact of FDI depends on a

various factors like drug dosage, person's age, & health status. 63% (51/81) of pharmacists knew that potassium rich foods (e.g banana, leafy vegetables) should be avoided with ACE inhibitors but only 60% (49/81) of pharmacists knew that food/drug interaction can include fruit juice, alcohol, vitamins, iron and the same percentage of pharmacists also knew that acidic foods and beverages-such as tomato sauce, tea, coffee, and citrus juices effect on drug absorption and may cause food/drug interaction. 59% (48/81) knew that OTC drugs are safe and don't cause any interactions with herbals drugs or supplements. 59% (48/81) knew that glipizide, isoniazid, antacids should be taken after meal, 57% (47/81) knew that NSAIDs, steroids are advised after meal, 53% (43/81) knew that milk & dairy products should be avoided with tetracyclines, 53% (43/81) knew that drugs should be always taken after meal, 51% (41/81) knew that patient on theophylline should avoid large amount of caffeine containing beverage like tea and coffee, 51% (41/81) knew that a patient on thyroid supplements for hypothyroidism must avoid foods like cauliflower and cabbage.

48% (39/81) knew that grape fruit may cause serious and lethal food/drug interactions, 47% (38/81) knew that Spironolactone must be avoided with potassium rich foods, 42% (34/81) knew

that Patients on Heparin / Warfarin should avoid foods like Spinach, broccoli and cauliflower in large quantities, 44% (36/81) knew that Patients on Warfarin should avoid foods like garlic and ginger for long period and also the same percentage of pharmacists knew that a patients on MAO Inhibitors should avoid cheese, processed meats and fermented products, 39% (32/81) knew that omeprazole / ranitidine, antihistamines-should be taken before meal, 33% (27/81) knew that geriatrics are at a greater risk for FDI, 33% (27/81) knew that Lopinavir / Ritonavir must be taken with food, 32% (26/81) knew that drugs like griseofulvin, ketoconazole and albendazole should be taken with fatty diet, Only 20% (16/81) knew that acarbose, voglibose should be taken with meal, 17% (14/81) knew that propranolol, ACE Inhibitors must be taken on empty stomach.

### Pharmacists' attitude toward FDI

88% (71/81) of the pharmacists in the study agreed that it is imperative for pharmacist to update knowledge on potential FDI of medications, so as to counsel the patients and 85% (71/81) of the pharmacists agreed that each patient require counseling regarding interactions of drug with food and beverages (Table 3).

### Experiences of pharmacists with FDI

21% of the pharmacists reported that they came across FDI and the reported types of FDI represented in (Table 4).

### Suggestions for improving awareness regarding the FDI

The pharmacists suggested improving awareness regarding the FDI through social media 71% (58/81), counseling from pharmacists 65% (53/81) and awareness campaigns 35% (29/81). (Table 5).

Table 1: Socio-demographics of pharmacists (n=81)

| Variable       | Categories  | Frequency | Percentage (%) |
|----------------|---|-----------|----------------|
| Sex            | Male  | 60        | 55%            |
|                | Female  | 21        | 74%            |
| Education      | B.Sc. in pharmacy   | 49        | 60%            |
|                | Pharm. D  | 21        | 26%            |
|                | Masters or American board   | 11        | 14%            |
| Site of work   | Community (private)   | 13        | 16%            |
|                | Primary health care Clinic (private or public)                                | 27        | 33%            |
|                | Hospital (private or public)  | 41        | 51%            |
| Nationality    | Saudi   | 64        | 79%            |
|                | Non Saudi   | 17        | 21%            |
| Monthly income | 5000-10000  | 24        | 30%            |
|                | >10000  | 57        | 70%            |
| Marital status | Married   | 49        | 60%            |
|                | Non married   | 32        | 40%            |
| Age (years)    | 20-30 years   | 23        | 28%            |
|                | 31-40 years   | 47        | 58%            |
|                | 41-50 years   | 11        | 14%            |
|                | Maximum= 48 years<br>Minimum = 28 year<br>Mean $\pm$ (SD)= 33.6 $\pm$ ( 4.2 ) |           |                |

Table 2: Pharmacists' knowledge regarding FDIs (n=81)

| Knowledge items   | (n=81)    |     |           |     |
|---|-----------|-----|-----------|-----|
|   | Good      |     | Poor      |     |
|   | Frequency | %   | Frequency | %   |
| Food and beverage can interfere with drug in the body?  | 72        | 89% | 9         | 11% |
| Food can speed up or slow down the action of a drug   | 72        | 89% | 9         | 11% |
| Food/drug interaction can include fruit juice, alcohol, vitamins, iron  | 49        | 60% | 32        | 40% |
| Impact of FDI depends on a various factors like drug dosage, person's age, & health status?   | 66        | 81% | 15        | 19% |
| Acidic foods and beverages-such as tomato sauce, tea, coffee, and citrus juices effect on drug absorption and may cause food/drug interaction | 49        | 60% | 32        | 40% |
| Drugs should be always taken after meal   | 43        | 53% | 38        | 47% |
| OTC drugs are safe and don't cause any interactions with herbals drugs or supplements   | 48        | 59% | 33        | 41% |
| Grape fruit may cause serious and lethal food/drug interactions   | 39        | 48% | 42        | 52% |
| Potassium rich foods (e.g. banana, leafy vegetables) should be avoided with ACEIs   | 51        | 63% | 30        | 37% |
| Geriatrics are at a greater risk for FDI  | 27        | 33% | 54        | 67% |
| Milk & dairy products should be avoided with tetracyclines  | 43        | 53% | 38        | 47% |
| Patients on warfarin should avoid foods like garlic and ginger for long period  | 36        | 44% | 45        | 56% |
| A patients on MAO Inhibitors should avoid cheese, processed meats and fermented products  | 36        | 44% | 45        | 56% |
| Drugs like griseofulvin, ketoconazole and albendazole should be taken with fatty diet   | 26        | 32% | 55        | 68% |
| Patient on theophylline should avoid large amount of caffeine containing beverage like tea and coffee   | 41        | 51% | 40        | 49% |
| Omeprazole / ranitidine, antihistamines- should be taken before meal  | 32        | 39% | 49        | 61% |
| Glipizide, isoniazid, antacids should be taken after meal   | 48        | 59% | 33        | 41% |
| Acarbose, voglibose should be taken with meal   | 16        | 20% | 65        | 80% |
| NSAIDs, steroids are advised after meal   | 46        | 57% | 35        | 43% |
| Propranolol, ACE Inhibitors must be taken on empty stomach.   | 14        | 17% | 67        | 83% |
| Spirolactone must be avoided with potassium rich foods  | 38        | 47% | 43        | 53% |
| A patient on thyroid supplements for hypothyroidism must avoid foods like cauliflower and cabbage   | 41        | 51% | 40        | 49% |
| Lopinavir / Ritonavir must be taken with food   | 27        | 33% | 54        | 67% |
| Patients on Heparin / Warfarin should avoid foods like Spinach, broccoli and cauliflower in large quantities                                  | 34        | 42% | 47        | 58% |
| Mean score for pharmacists knowledge  | 43        | 53% | 38        | 47% |

Table 3: Pharmacists' attitude toward FDI

| Attitude items   | (n=81)   |     |          |     |
|--|----------|-----|----------|-----|
|  | Positive |     | Negative |     |
|  | No.      | %   | No.      | %   |
| Each patient require counseling regarding interactions of drug with food and beverages                             | 69       | 85% | 12       | 15% |
| It is imperative for pharmacist to update knowledge on potential FDI of medications, so as to counsel the patients | 71       | 88% | 10       | 12% |
| Mean score for pharmacists attitude  | 70       | 86% | 22       | 27% |

Table 4: Experiences of pharmacists with FDI (n=81)

| Experiences                   | Categories                        | Frequency | %   |
|-------------------------------|-----------------------------------|-----------|-----|
| Have you come across any FDI? | Yes                               | 17        | 21% |
|                               | No                                | 64        | 79% |
| Type of Interaction           | Cauliflower with hypothyroidism   | 1         | 1%  |
|                               | Iron with calcium containing food | 1         | 1%  |
|                               | Tetracycline with milk            | 3         | 4%  |
|                               | MAOIs with fermented products     | 1         | 1%  |
|                               | NSAID on empty stomach            | 2         | 2%  |

Table 5: Suggestions for improving awareness regarding the FDI

| Item  | Categories                  | Frequency | Percentage (%) |
|---|-----------------------------|-----------|----------------|
| Suggestions for improving awareness regarding the FDI | Counseling from pharmacists | 53        | 65%            |
|   | Through social media        | 58        | 71%            |
|   | Awareness campaigns         | 29        | 35%            |

## DISCUSSION

Many problems in pharmacotherapy result due to drug interactions. Drug interactions (DI) are consequences in which the effects of one drug are altered by prior or concurrent administration of another drug. The concept of DI is also extended to include: food drug interactions, herb drug interactions, laboratory drug interactions etc. [9]. Food and drug interactions might reveal more difficulties than a drug - drug interaction [10]. Food induced changes in drug bioavailability determine the majority of FDI and relate the clinical consequences of most of the drugs [1]. Specific foods greatly affect drug therapy, resulting in serious side effects, or reduced absorption of a drug i.e. therapeutic failure [11] or increase bioavailability [12]. The clinical consequence of FDI depends on various factors like particular food consumed, drug dosage, herbs, patient's age and state of health [13]. In the present scenario, drug

approval occurs with increasing speed, therefore less information is available about a new drug ADRs and DI, as and when the drug reaches market [14]. Various studies in the past have tried to evaluate the effect of food on drugs. Previous studies have reported gaps in the knowledge of clinicians about the FDI [15, 16].

The present study conducted to evaluate the pharmacist's knowledge and attitude toward FDIs. The pharmacists scored less in certain fields of FDIs like food and antihypertensive drugs, anticoagulants, antibiotics and appropriate time of drug administration in relation to food. Vitamin K rich food stuffs like broccoli, spinach and other green leafy vegetables promote blood clot formation and oppose the effects of the anticoagulants like warfarin, heparin, etc. [17, 18]. A study showed deficiencies of the healthcare team with regard to warfarin-vitamin K interactions which can lead to disruption in anticoagulant outcomes [16].

Similar deficiencies were seen in the present study, pharmacists had less information about vitamin K containing foods and their interaction with anticoagulants like warfarin. They were also not sufficiently aware of interactions of dairy products with tetracyclines, as earlier studies revealed tetracyclines to be taken one hour before or two hours after meals and avoided with milk as it forms insoluble chelates by binding with calcium and iron, affecting its bioavailability [19, 20]. Similarly casein and calcium present in milk decrease the absorption of ciprofloxacin [21, 22] and the absorption of angiotensin converting enzyme inhibitors is increased when taken on an empty stomach [23, 24].

In the present study, all pharmacists didn't have the sufficient knowledge about FDI with relation to timings of drugs and food intake. The pharmacists were not sufficiently aware about NSAIDs and PPIs but lacked knowledge regarding the FDIs involving commonly used drugs like antidiabetics such as glipizide and acarbose, antithyroid, antacids, antiviral for HIV, isoniazid, etc. Earlier studies have shown that food greatly decreases isoniazid bioavailability [25], therefore must be taken on empty stomach in the early morning for maximum benefit. Glipizide, a sulfonylurea should be taken 30 minutes before meals. The maximum effectiveness of acarbose, an

alpha-glucosidase inhibitor for diabetes is attained when the drug is taken just before ingesting the first portion of each meal [26]. PPIs must be taken 30 minutes before breakfast as proton pumps are maximally active, than after meals [27]. Fatty meal improves bioavailability for griseofulvin [14].

Pharmacists showed poor performance in overall FDI questions, which could be due to lack of knowledge, awareness and clinical exposure. Our study revealed that pharmacists were not aware of cheese reaction. Cheese reaction is seen in depressive disorder patients on monoamine oxidase inhibitors (MAOIs) [28, 29]. Only one fifth of pharmacists (21%), reported FDI during their practice. The reasons for such low incidence among pharmacists could be due to lack of awareness, clinical exposure or need of proper history and follow up of patients, etc. Our results are similar to the previous studies [15, 16] who have also reported lack of knowledge about FDI among health care professionals.

#### **Limitations of the study**

Smaller sample size is one of the limitations of this study. Multicenter study with larger samples will be beneficial. Regional specificity of food, culture and even the individual specificity need to be considered. Therefore, additional training and integration of knowledge and expertise about FDI among pharmacists is needed to

improve the therapeutic efficacy, patient's drug compliance and patient's safety.

## CONCLUSION

The outcomes of this survey showed that pharmacists' knowledge about the FDIs was not satisfactory but they mostly had positive attitude regarding patient counseling about FDI and only one fifth among all the study participants had recorded FDIs during their clinical practice. Lack of knowledge of FDIs may lead to inappropriate patient counselling and the occurrence of adverse effects. There is a need to improve the knowledge and to raise the level of awareness of pharmacists about the potential FDIs that are clinically relevant. Therefore, pharmacists still need more education and training campaign about FDIs in order to be more qualified to provide better pharmaceutical care and improve their patient's therapeutic outcome.

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