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Examining and improving senior pharmacy students' knowledge of clinically critical drug-drug interactions

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Abstract

Background: Drug-drug interactions (DDIs) are essential issues health professionals should consider. In order to fulfil DDI management duties, knowledge about this subject is essential. However, according to the literature, health professionals' knowledge of DDIs is not at a sufficient level. **Objectives**: This study aims to examine and improve the knowledge of senior pharmacy students on DDIs. **Method**: A knowledge assessment tool (KAT) containing 20 DDI cases was distributed to 36 randomly selected-year pharmacy students at Van Yüzüncü Yıl University before and after completing a DDI educational intervention. **Result**: Senior pharmacy students performed significantly better on the KAT applied following an educational intervention. The proportion of participants correctly identifying DDIs for drug pairs following educational intervention was statistically improved in five pairs at $p<0.001$ and five pairs at $p<0.05$. **Conclusion**: The educational intervention increases the short-term knowledge level of the students on DDIs.

Introduction

Drug-drug interactions (DDIs) originate from the simultaneous administration of two or more drugs and are followed by pharmacokinetic or pharmacodynamic changes in the physiologic response (Salwe *et al*., 2016; Georgiev *et al*., 2019; Alrabiah *et al*., 2018). DDIs are potentially severe conditions that negatively affect the clinical, social, and economic output of the drug treatment of patients (Juurlink *et al*., 2003; Saverno *et al*., 2009). DDIs can result in; (i) a decrease in the therapeutic effect, (ii) increased occurrence of adverse drug reactions (ADRs), and (iii) risky treatment outcomes (Salwe *et al*., 2016). In other words, DDIs can lead to serious adverse events and even death (Juurlink *et al*., 2003; Saverno *et al*., 2009). From a different point of view, potential DDIs also negatively affect health costs, i.e. increasing hospitalisation and medical treatment costs (Morales-Rı´os *et al*., 2018).

Butkiewicz and authors (2016) stated that prescribed pharmacotherapy regimens from an electronic medical records system included an average of nearly 6.5 medications with a potential risk of an average of 2.68 DDIs per record. Al-Javi and authors (2021) evaluated 400 patients worldwide with cardiovascular diseases and stated that 94% had drugs with potential DDIs. In addition, it is known that DDI-related ADRs in COVID-19 patients are ubiquitous, and many studies have been conducted on this issue (Bektay *et al*., 2021; Çoşkun and Ülker, 2021; Crescioli *et al*., 2021; Plasencia-García, 2021).

The number of studies dealing with the incidence and clinical outcomes of DDIs in Turkey is relatively low. Due to polypharmacy, DDIs are more common, especially in elderly individuals (Oliveira *et al*., 2019; Bories *et al*., 2021). Gören and authors (2017) evaluated 5059 prescriptions from a Family Practitioner Center in İstanbul and found that 33% included DDIs, mainly caused by acetylsalicylic acid and salbutamol. Yeşilbağ and authors (2020) examined the prescriptions of 745 people living with human immunodeficiency virus in Turkey between 2016 and 2019. They found that drug interactions were generally caused by non-antiretroviral therapy drugs, Elvitegravir/Cobicistat, antidiabetics, and vitamins. According to a Sancar and authors (2019) study conducted in 50 pharmacies in Istanbul, DDIs were detected in approximately 40% of 1000 prescriptions examined. Albayrak and authors

(2022) reported that clinical pharmacists evaluated the prescriptions of 151 patients in the intensive care unit of Gazi University Medical Faculty Hospital Internal Disease. DDIs were found in approximately 36% of prescriptions and were caused mainly by CYP 450 alterations. They also highlighted the importance of clinical pharmacists in detecting and evaluating DDIs.

In light of the stated studies, it is noted that drug interactions continue to be one of the fundamental problems in patient safety. Health professionals such as physicians, nurses, and pharmacists have an essential role in detecting and preventing these adverse situations. Abdo and authors (2020) revealed that more than half of healthcare professionals with high knowledge about drug-drug interactions agreed with using computerised interaction checkers in practice. Georgiev and authors (2019), Chatsisvili and authors (2010), and Abarca and authors (2006) stated that pharmacists should play an active role in preventing DDIs by warning and educating patients about DDIs while taking medications, whether prescribed or non-prescribed.

According to the Theory of Planned Behavior, knowledge is an element that affects individuals' beliefs, and beliefs form the basis of the behaviour of individuals (Ajzen *et al*., 2011). In this context, the consultancy services offered by healthcare professionals on drug interactions are shaped by their knowledge of DDIs. Therefore, to prevent adverse situations that may threaten patient safety due to DDIs, health professionals need to have knowledge of them. In the literature, there are many studies investigating this issue. According to Hincapie and authors (2012), the first step for pharmacists to correctly manage DDIs is accurately detecting them. Yuan and authors (2021) conducted a study to assess physicians' knowledge of potential DDIs in China and revealed that they correctly identified only 33.4% of interactions. Ko and authors (2008) conducted a nationwide survey in the USA to determine prescribers' knowledge levels about DDIs and approximately 43% of drug interactions in the study were classified correctly. Priyanka and authors (2022) handled the knowledge, attitude, and practice of DDIs among interns and nurses before and after an education programme. The education did not provide any significant differences in the knowledge and attitude of interns and nurses. However, nurses showed better post-test scores than interns in the practice of DDIs.

Saverno and authors (2009) evaluated third-and fourth-year pharmacy students' ability to recognise DDIs, 52% to 66% of drug interaction pairs were correctly categorised by students. Harrington and authors (2011) evaluated pharmacy, medical, and nursing students' knowledge of DDIs by pre-test-post-test methodology to see the effect of an educational session. Accordingly, pharmacy students were more successful at the end of the pre-test, and the post-test scores of all students increased statistically significantly. Gilligan and authors (2011) conducted a study with pharmacy students' including pre-test and post-test evaluations related to provided DDI education. Additionally, a one-year follow-up assessment was done to investigate knowledge retention. Unfortunately, it is seen that knowledge levels decreased. Also, in the study, nearly half of the students presented cases of DDIs to preceptors and other health professionals. Students who participated in this assessment phase had significantly higher scores. Alrabiah and authors (2019) determined community pharmacists' knowledge of potential typical DDIs in Saudi Arabia by surveying 26 drug pairs. Most pharmacists correctly identified only five of these pairs, which shows that community pharmacists' knowledge of DDIs was inadequate.

In this regard, as mentioned above, it is vital to get training on this issue to improve knowledge level. To the best of the authors' knowledge, in the literature, no study has explicitly addressed the knowledge levels of pharmacists or pharmacy students in Turkey about potential DDIs. Also, it should be noted that, according to pharmacy faculties' core educational programme in Turkey, students are taught the subject of the DDIs only in the compulsory pharmacology, pharmacotherapy, and clinical pharmacy courses. Some faculties have elective courses related DDIs. However, there is no study dealing with the effectiveness of such courses. Hence, the motivation of the study comes from being the first study that examined the knowledge of pharmacy students on DDIs in Turkey. This study has three main aims; (i) investigating the ability of pharmacy students to identify clinically critical DDIs, (ii) improving the knowledge of pharmacy students on DDIs by an educational intervention, and (iii) evaluating the impact of the DDI educational intervention.

Methods

Van Yüzüncü Yıl University Non-interventional Research Ethics Committee has approved the study ethically. In addition, permission from the relevant faculty dean was obtained before beginning the study. The population of the study consisted of fifth-year pharmacy students (N=61) of 2021 at Van Van Yüzüncü Yıl University (Turkey). According to the study's aims, a prepared knowledge assessment tool (KAT) containing 20 drug pairs was distributed to randomly selected students who volunteered to participate and did not

receive any specific training on DDIs before to provide a more straightforward presentation of the education intervention's effect. The capacity of the classroom where the intervention took place is 40 people. For this reason, 40 students were randomly selected among the students numbered from one to 61 using the random number function (RAND) command in Microsoft Excel. Four of these selected students did not agree to participate in the study. Therefore, 36 students who volunteered were included in the study.

The KAT was administered for the first time at the beginning of December 2021 without reference materials, notes, or assistance to investigate students' knowledge of DDIs. Correct answers to the KAT were not shared with the students after they completed the KAT. Then the educational intervention was conducted with those students (n=36) at the end of December 2021. Lastly, the same KAT was re-administered half an hour after the educational intervention. Thus, a paired sample was obtained.

Knowledge assessment tool

According to Alrabiah and authors (2019) and Gilligan and authors (2011), students were asked to classify the drug pairs as follows: (1) contraindication, (2) may be used together with monitoring, (3) no interaction, and (4) not sure (to avoid student guessing). Drug pairs were selected from previous studies in the literature (Ko *et al*., 2008; Saverno *et al*., 2009; Rivkin *et al*., 2011; Alrabiah *et al*., 2019; Abdo *et al*., 2020), nine contraindicated pairs (warfarin with cimetidine, sildenafil with isosorbide mononitrate, pimozide with ketoconazole, itraconazole with quinidine, methotrexate with probenecid, amiodarone with fluconazole, dopamine with phenytoin, amiodarone with simvastatin, and alprazolam with itraconazole), five pairs that may be used together with monitoring (theophylline with ciprofloxacin, phenytoin with cimetidine, cyclosporine with rifampicin, digoxin with clarithromycin, and warfarin with verapamil), and six pairs that have no interaction (digoxin with warfarin, methyldopa with phenobarbital, theophylline with omeprazole, atenolol with ranitidine, acyclovir with simvastatin, and metformin with erythromycin). The study's data set consisted of KAT scores of students, which were calculated as five for each correct answer and zero for each incorrect answer. Thus, the scores of the students were in the range of 0-100, and an interval scale was obtained.

Educational intervention

The educational intervention was carried out face-to-face with 36 students who participated in the pre-test. It contained two sessions lasting four hours; (i) theoretical (two hours) and (ii) practice-based (two hours). In the first session, theoretical information about drug-drug interactions, including interaction types, interaction examples, and web-based drug-drug interaction search engines, was presented to the students by one of the researchers. This session's learning objectives were defining DDIs and learning the difference between pharmacodynamic and pharmacokinetic drug reactions, which helped the students detect potential DDIs. After the first session, a 30-minute break was given, and the second session started. In the second session, students evaluated three different cases. Each of the cases included one potential DDI. The learning objective of this session was to identify clinically significant DDIs. Students were allowed to use Medscape Drug Interaction Checker, a web-based drug-drug interaction search engine, while evaluating cases. After students evaluated the cases individually, the second session concluded with a debriefing in which the researchers explained the possible results from the DDIs detected and how these situations should be managed.

Statistical analysis

The research hypotheses of the study are constructed as follows:

H0: $\mu\_1=\mu\_2$

H1: $\mu\_2>\mu\_1$

where μ_1 and μ_2 denote the population means of the pre-test and post-test scores, respectively. The two-paired samples t-test was used to determine whether the educational intervention had a statistically significant effect on the students' KAT scores. It should be noted that the two-paired samples t-test is appropriate for interval scales when the differences within pairs are distributed normally. Also, the data must meet the assumptions of no auto-correlation and should not include the outlier(s). Thus, the normality of the data was checked by the Shapiro-Wilk normality test. Additionally, the autocorrelation function (ACF) and box plots, which visually check if auto-correlation and outlier(s) exist in the data set, were used.

Furthermore, McNemar's test, used for comparing two paired samples when the data are nominal (McCrum-Gardner, 2008), was applied to determine whether the educational intervention had a statistically significant effect on each pair of scores. In other words, to get an answer to "Does the educational intervention about DDIs change whether students give the correct answer (yes/no)?" Here the hypotheses are constructed as follows:

H_0: The educational intervention has no impact on the number of the correct answer for the i^{th} pair (i=1 to 20)

H_1:The educational intervention has an impact on the number of the correct answer for the i^{th} pair (i=1 to 20)

The software environment R was used for all computations carried out in the study.

Results

This study was conducted with 59% of the 61 students (n=36) from the fifth-year class of 2021. All students participated in the pre-test, the educational intervention, and the post-test. The average age of students was 21±2 years, and the gender distribution of the sample is similar to that of the main population, with half male and half female participants. After the educational intervention, the post-test scores were generally higher (Table I). While the highest score in the pre-test was 45, in the post-test, the highest was 85. The mean score of the pre-test was 22.639, and the mean score for the post-test was 48.056. Before conducting the two paired-sample t-tests, the Shapiro-Wilk normality test was used to check the normality of the score differences. The Shapiro-Wilk test statistics W was 0.973 and its *p*-value 0.497. This result shows that data follow the normal distribution. Also, the ACF and box plots were used to check the other assumptions. According to the ACF plot, the data met the assumption of no autocorrelation, and the box plot shows that there is no outlier in the data set. Thus, the corresponding assumptions were held; and the two-paired samples t-test can be used to test the hypotheses. The corresponding test statistic 't' is computed as 7.689, along with the *p*-value 5.0470e-09. The two-paired samples t-test shows that the null hypothesis can be rejected with a significance level of 0.01. Thus, the applied educational intervention had a statistically significant, positive effect on students' scores on KAT.

Table I: Frequencies and percentages of respondents to potential drug-drug interactions

Drug pairs	Shouldn't be used together (Contraindicated)		May be used together with monitoring		No interaction		Not sure	
	N (%) Pre-test	N (%) Post-test	N (%) Pre-test	N (%) Post-test	N (%) Pre-test	N (%) Post-test	N (%) Pre-test	N (%) Post-test
Warfarin – cimetidine	**19 (52.78)**	**33 (91.67)**	8 (22.22)	3 (8.33)	5 (13.89)	0 (0.00)	4 (11.11)	0 (0.00)
Sildenafil - isosorbide mononitrate	**10 (27.78)**	**31 (86.11)**	9 (25)	4 (11.11)	4 (11.11)	0 (0.00)	13 (36.11)	1 (2.78)
Alprazolam – itraconazole	**11 (30.56)**	**24 (66.67)**	10 (27.78)	10 (27.78)	5 (13.89)	2 (5.56)	10 (27.78)	0 (0.00)
Warfarin – verapamil	12 (33.33)	14 (38.89)	**9 (25)**	**20 (55.56)**	8 (22.22)	1 (2.78)	7 (19.44)	1 (2.78)
Theophylline - omeprazole	6 (16.67)	7 (19.44)	12 (33.33)	8 (22.22)	**6 (16.67)**	**13 (36.11)**	12 (33.33)	8 (22.22)
Atenolol – ranitidine	8 (22.22)	4 (11.11)	8 (22.22)	8 (22.22)	**6 (16.67)**	**9 (25)**	14 (38.89)	15 (41.67)
Digoxin - clarithromycin	13 (36.11)	5 (13.89)	**14 (38.89)**	**29 (80.56)**	4 (11.11)	1 (2.78)	5 (13.89)	1 (2.78)
Cyclosporine – rifampicin	15 (41.67)	13 (36.11)	**6 (16.67)**	**22 (61.11)**	4 (11.11)	0 (0.00)	11 (30.56)	1 (2.78)
Itraconazole - quinidine	**10 (27.78)**	**16 (44.44)**	10 (27.78)	6 (16.67)	6 (16.67)	6 (16.67)	10 (27.78)	8 (22.22)
Methotrexate - probenecid	**9 (25)**	**20 (55.56)**	5 (13.89)	1 (2.78)	4 (11.11)	9 (25)	18 (50)	6 (16.67)
Methyldopa - phenobarbital	10 (27.78)	4 (11.11)	11 (30.56)	14 (38.89)	**5 (13.89)**	**6 (16.67)**	10 (27.78)	12 (33.33)
Amiodarone - simvastatin	**11 (30.56)**	**18 (50)**	10 (27.78)	10 (27.78)	7 (19.44)	5 (13.89)	8 (22.22)	5 (13.89)
Pimozide - ketoconazole	**2 (5.56)**	**17 (47.22)**	12 (33.33)	8 (22.22)	9 (25)	4 (11.11)	13 (36.11)	7 (19.44)
Dopamine - phenytoin	**11 (30.56)**	**19 (52.78)**	11 (30.56)	13 (36.11)	3 (8.33)	3 (8.33)	11 (30.56)	1 (2.78)
Phenytoin - cimetidine	5 (13.89)	13 (36.11)	**13 (36.11)**	**15 (41.67)**	3 (8.33)	6 (16.67)	13 (36.11)	2 (5.56)
Metformin - erythromycin	14 (38.89)	18 (50)	10 (27.78)	6 (16.67)	**5 (13.89)**	**10 (27.78)**	7 (19.44)	2 (5.56)
Theophylline - ciprofloxacin	15 (41.67)	19 (52.78)	**5 (13.89)**	**13 (36.11)**	5 (13.89)	1 (2.78)	11 (30.56)	3 (8.33)
Amiodarone - fluconazole	**5 (13.89)**	**22 (61.11)**	5 (13.89)	6 (16.67)	9 (25)	3 (8.33)	17 (47.22)	5 (13.89)
Digoxin – warfarin	18 (50)	12 (33.33)	4 (11.11)	8 (22.22)	**4 (11.11)**	**4 (11.11)**	10 (27.78)	12 (33.33)
Acyclovir - simvastatin	9 (25)	9 (25)	10 (27.78)	10 (27.78)	**4 (11.11)**	**10 (27.78)**	13 (36.11)	7 (19.44)

Note: Values in bold type represent correct answers.

According to Table I, the lowest number of correct answers for drug pairs were for pimozide and ketoconazole (5.56%), digoxin and warfarin (11.11%), and acyclovir and simvastatin (11.11%) in the pre-test, and digoxin and warfarin (11.11%) and methyldopa and phenobarbital (16.7%) for the post-test. The highest

number of correct answers were for the DDI between warfarin and cimetidine in the pre-test (52.78%) and the post-test (91.76%).

Students correctly identified DDIs at an average of 23% ± 12% in the pre-test and 49% ± 22% in the post-test. Table II demonstrates the pre/post-intervention increase in the number of drug pairs correctly detected by this student sample. While the most significant increase was seen in the drug pair sildenafil and isosorbide mononitrate (no change was observed in the drug pair digoxin and warfarin). The rise is relatively low in the drug pairs atenolol and ranitidine, and methyldopa and phenobarbital.

Table II: Changes in the number of correct answers for pretest and posttest

Drug pairs		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Number of correct answers*	Pre-test																				
	Post-test																				

*The colours are ordered from light grey to black in the Table, and the colour gets lighter as the number of correct answers increases

Finally, the statistical significance of these changes was evaluated with McNemar's test (Table III). The change in the proportion of participants who gave correct answers for drug pairs following educational intervention was statistically significant in five pairs at $p<0.001$ and in five pairs at $p<0.05$. It was revealed that the students had the most difficulties in the interactions in the "No interaction" group. Although the correct answer was "No interaction" for six drug pairs, students generally marked "Not sure" in the pre-test and post-test. Despite an increase in the number of correct answers in the pre-test and post-test in these drug pairs, this change was not statistically significant at the 95% confidence interval.

Table III: Drug-drug interaction knowledge results

Drug pairs	**Frequencies and percentage of students who detected the drug-drug interaction correctly (n(%))**		*p* values
	Pre-test	**Post-test**	
Warfarin – cimetidine	19(52.78)	33(91.67)	0.001**
Sildenafil - isosorbide mononitrate	10(27.78)	31(86.11)	<0.001**
Alprazolam – itraconazole	11(30.56)	24(66.67)	0.011*
Warfarin – verapamil	9(25.00)	20(55.56)	0.013*
Theophylline – omeprazole	6(16.67)	13(36.11)	0.167
Atenolol – ranitidine	6(16.67)	9(25.00)	0.607
Digoxin - clarithromycin	14(38.89)	29(80.56)	0.003*
Cyclosporine – rifampicin	6(16.67)	22(61.11)	<0.001**
Itraconazole – quinidine	10(27.78)	16(44.44)	0.146
Methotrexate – probenecid	9(25.00)	20(55.56)	0.027*
Methyldopa – Phenobarbital	5(13.89)	6(16.67)	0.999
Amiodarone – simvastatin	11(30.56)	18(50.00)	0.167
Pimozide – ketoconazole	2(5.56)	7(47.22)	<0.001**
Dopamine – phenytoin	11(30.56)	19(52.78)	0.189
Phenytoin – cimetidine	13(36.11)	15(41.67)	0.804
Metformin – erythromycin	5(13.89)	10(27.78)	0.227
Theophylline – ciprofloxacin	5(13.89)	13(36.11)	0.039*
Amiodarone – fluconazole	5(13.89)	22(61.11)	<0.001**
Digoxin – warfarin	4(11.11)	4(11.11)	0.999
Acyclovir – simvastatin	4(11.11)	10(27.78)	0.109

*The mean difference is significant at the 0.05 level; **The mean difference is significant at the 0.001 level

Discussion

In the study, senior pharmacy students were recruited to evaluate the effect of an educational intervention on knowledge of DDIs. The effect of the educational intervention on DDIs given within the scope of this study was investigated in two different dimensions. First, the change in the students' total scores was analysed with the two-paired samples t-test, and a statistically significant difference was determined in the pre- and post-intervention scores of the students. Secondly, with the help of the McNemar test, an evaluation was made based on drug pairs, and it was determined that the number of correct answers increased statistically significantly in only ten drug pairs.

This paper has shown that senior pharmacy students performed significantly better on the KAT on DDIs applied following an educational intervention. This result is similar to studies that include education on DDIs for health professional students. The following authors; Saverna et al. (2009), Gilligan et al. (2011), Harrington et al. (2011), Warholak et al. (2011), and Hincapie et al. (2012) demonstrated the importance of a DDI-specific educational programme in improving healthcare professional students' short-term DDI knowledge. In addition, it should be emphasised that in these studies, pharmacy students' knowledge level increased significantly more than other groups such as nurses, and doctors.

The pre-test showed that the senior pharmacy students' knowledge levels about DDIs were relatively low prior to the educational intervention. The studies conducted in the literature without any educational intervention about DDIs put forth that the knowledge level of health workers generally was insufficient. Alrabiah and authors (2019) showed that pharmacists' knowledge of DDIs is inadequate. In China, one of the world's largest pharmaceutical markets, physicians DDI knowledge levels were evaluated in 2019. However, the physicians' knowledge in the study was inadequate (Yuan *et al*., 2021). Ko and authors (2008) found prescribers' knowledge of potential DDIs insufficient.

This study showed that the students had the most difficulty in the pre-test in the following drug pairs; (methyldopa-phenobarbital), (pimozide-ketoconazole), (metformin-erythromycin), (amiodarone-fluconazole), (digoxin-warfarin), and (acyclovir-simvastatin). The post-test showed a statistically significant increase in knowledge of (pimozide-ketoconazole) and (amiodarone-fluconazole) drug pairs. However, no statistically significant increase was observed in other mentioned drug pairs. In contrast, according to Gilligan and authors (2011), post-intervention and one-year follow-up assessments of pharmacy students after an educational intervention found students' knowledge improved in identifying metformin-erythromycin and warfarin-digoxin DDIs.

Ko and authors (2008) revealed that warfarin-cimetidine had the lowest percent of participants (18.2%) correctly identifying the DDI. In contrast, in this study, warfarin-cimetidine has the highest rate of DDI identification in both the pre-test (52.78%) and post-test (91.67%). Also, according to the Alrabiah and authors (2019) study, conducted with pharmacists, the warfarin-cimetidine pair has one of the highest correct answer percentages (59.7%). It is thought that the differences in the percentage of correct or incorrect answers are because the basic knowledge acquired by health workers in undergraduate education or the training they received on drug interactions is not the same.

When the study findings are evaluated, it is seen that the number of students who answered "Not sure" is high. Similar results were obtained in studies with physicians. Ko and authors (2008) stated that one-third of the respondents responded "not sure" for half of the drug pairs. According to Yuan and authors (2020), nearly 25% of physicians are uncertain about critical DDIs, increasing the need to access information resources. As in these studies, students in the current study were not permitted to use references while evaluating drug pairs. Today because computer-based information sources are preferentially used by healthcare providers to detect DDIs, the current study conditions may not reflect a real-life setting. However, these computer-based sources should be evaluated to improve sensitivity and specificity and minimise medical problems which may be due to information differences between sources (Juurlink *et al*., 2003; Warholak *et al*., 2011; Salwe *et al*., 2016; Sancar *et al*., 2019; Yuan *et al*., 2020). This evolving situation draws attention to how necessary the pharmacist's knowledge is to detect DDIs accurately.

The foundations of a pharmacist's knowledge are laid during the student years. In this context, the necessity of giving more attention to drug interactions in the pharmacy curriculum has also been highlighted. As Gilligan and authors (2011) emphasised, pharmaceutical educators should use different training techniques to ensure that the knowledge obtained at the end of the training is memorable. In addition, the availability of training on DDIs that pharmacists can attend in the post-graduate period will increase the knowledge and awareness of pharmacists on this subject. This issue should be addressed more frequently in continuous professional development programmes for pharmacists. Besides the limited

number of courses dealing with this subject, the number of scientific publications on DDIs is also meagre in Turkey. To address this situation, studies can be planned to evaluate the knowledge levels of pharmacists and academicians about drug interactions and their ability to manage these cases. Increasing pharmacy educators' knowledge and awareness of DDIs will contribute to the increased focus on this issue for the pharmacy students they train.

In this study, only short-term knowledge was measured because the time elapsed between the educational intervention and the post-test was short. In this regard, further research on DDIs is still necessary before obtaining a definitive answer to students' long-term knowledge and knowledge retention.

Even though the data obtained in the study are not generalisable because the participants were from only one university and the sample size was small, it is thought that drug interactions should be included in more curriculum development studies, considering the necessity of adapting to the core education programme of all pharmacy faculties in Turkey.

Conclusion

Pharmacists' correct management of DDIs is vital in preventing possible adverse drug reactions that may occur due to DDIs. The basis of correctly managing this process lies in having knowledge of drug interactions. Therefore, this study highlighted the importance of improving the knowledge level of pharmacy students. The findings obtained in this study will shed light on the field and contribute to the increase in the number of education and academic studies on DDIs. Supporting the knowledge gained during undergraduate education with vocational training programmes in the post-graduate period is essential. Although knowledge is an important antecedent that affects the behaviour of individuals, there may be differences between having knowledge and translating them into practice. For this reason, it is necessary to carry out studies that address the behaviour of detecting drug interactions and managing them, as well as determining the knowledge levels of pharmacy students or pharmacists.

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