Original Article

Knowledge, Attitude, and Practices Regarding Proton Pump Inhibitors among Community Pharmacists and Pharmacy Students

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Abstract

Background: There are concerns about inappropriate use and insufficient knowledge of proton pump inhibitors (PPIs) use among medical staff. **Aims:** This study was designed to examine pharmacy students' and community pharmacists' knowledge, attitude, and practices toward PPIs and their relationship with specific sociodemographic characteristics. **Subjects and Methods:** This descriptive study was conducted on the pharmacy students (first and last year) at Eastern Mediterranean University and community pharmacists in North Cyprus Data were collected by a validated questionnaire, which assessed knowledge, attitude, and practices regarding PPI use. Students were included without sampling in a volunteer-based manner. Registered community pharmacists were selected randomly. **Results:** First-year pharmacy students (n = 77) showed significantly lower knowledge levels than last-year students (12.00 vs. 13.65; $P < 0.001$); however, there was no significant difference between last-year students (n = 111) and community pharmacists (n = 59). First-year pharmacy students were significantly less aware of PPIs' "dosage and administration" than the other two groups. Last-year students and community pharmacists exhibited significantly higher attitude scores regarding PPI use (24.7 and 24.6 vs. 22.7; $P < 0.001$). Omeprazole was found to be the most preferred PPI among the three studied populations. Community pharmacists used PPIs mainly to treat acid reflux. Gender, nationality, and pharmacy education program type did not influence pharmacy students' knowledge, attitude, or practices. **Conclusions:** There was not a significant difference regarding knowledge and attitude between the last-year pharmacy students and community pharmacists. The practices of community pharmacists were significantly different from the pharmacy students. It was concluded that certain essential topics regarding PPI use should be emphasized in pharmacy education and during pharmacy practice. Further, it is essentially important for community pharmacists to continue their education through training programs after graduation to enhance their knowledge of PPI use.

Keywords: *Attitude, community pharmacist, knowledge, pharmacy student, practices, proton pump inhibitor*

Introduction

Proton pump inhibitors (PPIs) are very commonly used in hospital and outpatient settings due to their high efficacy. PPI use in the United Kingdom has doubled from 32.6 million in 2008 to 60 million in 2018.[1] A study in Hungary[2] revealed an upward trend in the use of PPIs from 2014 to 2018 with approximately half of the hospitalized patients having used PPIs. The increase in the use of PPIs could be due to their inappropriate use. Several previously published data revealed the inappropriate uses of these agents.[3-6]

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Another major factor contributing to the overuse of PPIs is the unnecessarily prolonged usage of these drugs. PPI usage can persist for up to 5 years, and approximately 20% of inpatients have been reported to use PPIs for even longer than 5 years.[2,7,8]

Although PPIs are generally considered safe medications, they have been linked to some clinically significant adverse outcomes in various meta-analyses and observational studies. Among these, intestinal microbiota changes, hypomagnesemia, bone fractures, and formation of fundic gland polyps have been related to relatively more substantial evidence.[9-12] Additionally, PPIs can cause several clinically critical drug–drug interactions.[13,14]

Pharmacists play an important role in proper medicine use, prevention of adverse drug reactions, improving health outcomes in geriatric care, and better management of chronic diseases.[15-17] Pharmacy care services have been found to significantly improve patient outcomes.[18] However, it requires sufficient education and experience to demonstrate proper practices regarding the use of PPIs. A recent study[19] examined the attitudes of community pharmacists regarding managing drug misuse and found they lacked knowledge, education, and training on drug misuse-related topics. Another study conducted in Southwest China[20] found low levels of PPI knowledge among Chinese medical staff; pharmacists, however, scored statistically significantly higher in knowledge levels than nurses and doctors.

This study mainly aimed to assess knowledge, attitude, and practices regarding PPIs among pharmacy students of a pharmacy faculty and community pharmacists working in North Cyprus This study was designed to identify possible gaps and improve educational and health strategies to minimize the inappropriate use of PPIs in North Cyprus.

Subjects and Methods

Study population and design

The study was conducted on three different groups. a) First-year pharmacy students (registered in the first or second academic semester in the faculty of pharmacy). The courses of these groups of students did not include any course outline including PPIs. b) Last-year pharmacy students (students at graduation status who would be the prospective graduates of the spring semester of the 2020–2021 academic year, studying their last semester in the faculty and finished all courses including subjects related to PPIs), c) Community pharmacists (actively working in North Cyprus, both graduates of Eastern Mediterranean University and other pharmacy faculties).

According to the list of the first-and last-year pharmacy students obtained from the Registrar's office, 77 first-year and 123 last-year pharmacy students were enrolled in the study. All students were included without sampling and data were not received from those who declined to participate in this total population study. The list of registered community pharmacists was obtained from the https://www.kteb.org/?lang = tr Cyprus Turkish Pharmacists Association) website. A total number of 101 community pharmacists were selected randomly by using a simple randomization method among all community pharmacists registered in North Cyprus. To prevent the balance between the numbers of community pharmacists who are Eastern Mediterranean University, graduates and graduates from the other universities, 51 community pharmacists were selected from the Eastern Mediterranean University, graduates and 50 community pharmacists were selected from the ones who are not Eastern Mediterranean University, graduates.

Following the approval of the Research and Publication Ethics Board (No: ETK00-2021-0190), a validated questionnaire was administered to the participants both online and in person. Two separate groups were formed in Microsoft Teams® for first-year pharmacy students and pharmacy students at graduation status. The questionnaire was uploaded to Microsoft Teams® as a Google Form®. The questionnaires were distributed and collected in person from 25 community pharmacists who were Eastern Mediterranean University graduates working in North Cyprus, For the 26 pharmacists who were Eastern Mediterranean University but did not work in North Cyprus a Facebook® group was created, the Google Form® was uploaded, and anonymous responses were collected. The questionnaires were delivered to and collected in person from randomly selected non-…… university graduate pharmacists. Participants were informed of the study's purpose and that it was volunteer-based. It also was noted that while filling out the form, checking reference books, related materials, and consulting colleagues were strictly prohibited. Researchers received the completed forms anonymously without information about participants' identities.

Questionnaire

This study used an already published questionnaire from Luo *et al*'s study conducted in China, with a Cronbach's alpha value of 0.78.[20] The initial section of the questionnaire included questions regarding the demographic and educational characteristics of the participants. Students were asked about gender, nationality, program type (B. Pharm./Pharm.

D), cGPA (cumulative grade point average) (for last-year students), and their academic year in the faculty. Additionally, pharmacists were asked about their gender, country of graduation, and years of experience as community pharmacists. Because the faculty of pharmacy where the study was conducted is an English-medium institution and most community pharmacists in ……. are fluent in English, the questionnaires were distributed exclusively in English. The questionnaire had three main sections and 33 questions.

The first part included 20 questions inquiring about the participants' knowledge level of PPIs where the answers were arranged as "Yes" and "No" and graded as 1 point for the correct answer and 0 points for the wrong answer. The analysis of the knowledge level points was revised by relating the questions in the first section to the topics in the FDA's "full prescribing information of PPIs" (https://www.accessdata.fda.gov). The second part analyzed participants' attitudes toward PPI use. Each question was graded on a 5-point Likert scale: 5 for "completely agree," 4 for "almost agree," 3 for "indifferent," 2 for "almost disagree," and 1 for "completely disagree." In the third section, seven questions focused on participants' practices regarding PPI use. Participants who answered "Yes" to the first question should have continued with the next six questions. The second question investigated the PPI member used by the respondent. The last five questions were graded as follows: 5 points for "Always," 4 points for "Often," 3 points for "Sometimes," 2 points for "Seldom," and 1 point for "Never."

Participants' knowledge levels and attitudes were positively correlated with their scores. However, lower scores in the third section indicated a lower dependence on PPIs.

Statistical analysis

Statistical analysis was performed using JASP and R programs. Descriptive statistics are expressed with mean and standard deviation (SD) values for quantitative variables. Additionally, categorical variables are expressed as frequency and percentage. Shapiro–Wilk test was used for the normality test. One of the outcome measures of the study was to compare the frequency of correct responses to each item as well as the total average knowledge level regarding PPIs between the three studied groups: first-year pharmacy students, last-year pharmacy students, and community pharmacists. Additionally, we aimed to compare the calculated attitude scores of each item, average attitude score, and practices on PPI use between the three studied groups. For the statistical analysis to determine these outcomes, Pearson's Chi-square and Kruskal–Wallis tests were used to compare the percentages and median values between the studied groups, respectively. Another outcome measure was to determine and compare the used PPI members among the three studied groups where the Fisher–Freeman–Halton Chi-square test was used for this analysis. Also, the influencing sociodemographic factors regarding knowledge level, attitude scores, and practices regarding PPI use were evaluated for each studied group. Kruskal–Wallis test was used for three or more independent group comparisons, and Bonferroni corrected Mann–Whitney *U* test was used for post hoc comparisons for the statistical analysis of influencing factors. P values < 0.05 were considered statistically significant.

Table 1: Demographic characteristics of participants

	n (%)		
	First-year	**Last-year**	**Comm. Phar.**
Gender			
Male	28 (36.4)	43 (38.7)	14 (23.7)
Female	49 (63.6)	68 (61.3)	45 (76.3)
Nationality			
North Cyprus	11 (14.3)	6 (5.4)	N/A
Turkey	34 (44.2)	15 (13.5)	
Iran	10 (13.0)	63 (56.8)	
Others	22 (28.6)	27 (24.3)	
Education			
Pharm.D.	25 (32.5)	78 (70.3)	N/A
B. Pharm	52 (67.5)	33 (29.7)	
cGPA (out of 4)			
<2.5	N/A	33 (29.7)	N/A
2.5 - 3		53 (47.7)	
>3		25 (22.5)	
Country of graduated university			
North Cyprus	N/A	N/A	48 (81.4)
Turkey			7 (11.9)
Iran			1 (1.7)
Others			3 (5.1)
Years of experience as a community pharmacist			
<1	N/A	N/A	2 (3.4)
1 - 5			39 (66.1)
6 - 10			12 (20.3)
>10			6 (10.2)

First – Year: First Year Students, Last – Year: Last Year Students, Comm. Phar.: Community Pharmacists; cGPA: cumulative grade point average, N/A: not assessed

Table 2: Frequency of correct responses, average, and total scores regarding PPI knowledge in different groups. (correct answers to the questions are given as statements)

	n (%)			*P*
	First-year	Last-year	Comm. Phar.	
Clinical pharmacology				
PPI is an inactive prodrug.	60 (77.9)	80 (72.1)	42 (71.2)	0.591
PPIs include omeprazole, pantoprazole, lansoprazole, rabeprazole, and esomeprazole.	64 (83.1) *	109 (98.2)	59 (100)	<0.001
PPIs cure acid-related diseases by suppressing hydrochloric acid secretion.	58 (75.3)	96 (86.5)	48 (81.4)	0.149
Omeprazole has the largest individual difference compared with other PPIs.	51 (66.2)	74 (66.7)	27 (45.8) *	0.017
Esomeprazole has the longest acid inhibition time compared with other PPIs.	51 (66.2)	76 (68.5)	43 (72.9)	0.705
The more expensive or newer PPI will NOT produce a better and safer effect.	33 (42.9)	63 (56.8)	33 (55.9)	0.139
It is advisable to increase the dose frequency rather than a single dose to improve the effect.	30 (39.0)	42 (37.8)	32 (54.2)	0.095
Clinical pharmacology score mean (SD)	4.51 (1.08)	4.86 (1.27)	4.81 (1.24)	0.108
Dosage and administration				
PPI should usually be taken at breakfast.	36 (46.8)	68 (61.3)	36 (61.0)	0.106
PPI should NOT be taken after the meal.	45 (58.4) *	92 (82.9) *	58 (98.3) *	<0.001
PPI should be swallowed as a whole piece.	64 (83.1)	105 (94.6) *	52 (88.1)	0.039
Patients should NOT take PPI for only 7 days in the *Helicobacter pylori* eradication therapy.	33 (42.9) *	63 (56.8) *	41 (69.5) *	0.008
PPI treatment of gastric ulcer DOES NOT take 2 weeks to 4 weeks.	19 (24.7)	25 (22.5)	12 (20.3)	0.835
The duration of PPI prophylaxis is until no high-risk factors, or ability to tolerate enteral feeding.	40 (51.9)	75 (67.6)	32 (54.2)	0.064
Dosage and administration score mean (SD)	3.08 (1.32) *	3.86 (1.12)	3.92 (0.93)	<0.001
Indications and usage				
PPI can be used to prevent stress ulcers.	55 (71.4) *	103 (92.8)	51 (86.4)	<0.001
PPI can be used to treat acute pancreatitis.	47 (61.0)	68 (61.3)	17 (28.8) *	<0.001
Indications and usage score mean (SD)	1.32 (0.72)	1.54 (0.57)	1.15 (0.58)[a]	<0.001
Use in specific populations				
Omeprazole can be selected for pediatric patients.	34 (44.2)	61 (55.0)	26 (44.1)	0.238
Rabeprazole SHOULD NOT be selected for pregnant patients.	58 (75.3)	83 (74.8)	37 (62.7)	0.185
Use in specific populations score mean (SD)	1.19 (0.69)	1.30 (0.68)	1.07 (0.74)	0.137
Drug interactions				
Omeprazole has the largest individual difference compared with other PPIs.	51 (66.2)	74 (66.7)	27 (45.8)[a]	0.017
Omeprazole DOES NOT have the largest interaction compared with other PPIs.	17 (22.1)[a]	43 (38.7)	25 (42.4)	0.021
Drug interactions score mean (SD)	0.88 (0.65)	1.05 (0.63)	0.88 (0.65)	0.111
Adverse reactions				
Long-term use of PPI may cause adverse reactions such as osteoporosis, pneumonia, etc.	64 (83.1)	97 (87.4)	37 (62.7) *	<0.001
Dosage forms and strengths				
PPI is usually available as enteric-coated capsules or tablets.	65 (84.4)	92 (82.9)	45 (76.3)	0.438
Total average score of knowledge on PPI use mean (SD)	12.00 (2.49)[a]	13.65 (2.33)	12.76 (2.66)	<0.001

* Statistically significant compared with the other two groups; [a]statistically significant compared with the last-year pharmacy students. First-Year: First-Year Students, Last-Year: Last-Year Students, Comm. Phar.: Community Pharmacists

Results

Sociodemographic characteristics of the respondents

Participation rates of first- and last-year pharmacy students and community pharmacists were 100%, 90.24%, and 58.42%, respectively (first-year students: 77, last-year students: 111, and community pharmacists: 59). Female participation was higher in all three groups. The majority of pharmacy students were from countries other than North Cyprus, with 85.8% for the first year and 94.6% for last-year students. Further, 81.4% of community pharmacists graduated from North Cyprus universities, and only 3.4% had less than a year of experience as community pharmacists [Table 1].

Knowledge level regarding the use of PPIs

The total average knowledge level score of first-year pharmacy students was significantly lower than that of

Table 3: Respondents' attitude on using PPI, and average scores

	First-year Mean (SD)	Last-year Mean (SD)	Com. Phar. Mean (SD)	*P*
Overuse of PPI is common at present in North Cyprus.	3.19 (0.76) *	3.72 (0.95) *	4.32 (0.82) *	<0.001
The main cause of PPI overuse is doctors' or patients' abuse of PPI.	3.83 (0.91)	3.98 (0.77)	3.83 (0.97)	0.572
The main purpose of PPI overuse is stress ulcer prophylaxis (SUP).	3.48 (0.99)	3.73 (0.84)	3.63 (0.93)	0.194
Overuse of PPI will cause an increase in adverse drug reactions and medical costs.	3.86 (1.05)	4.30 (0.87) *	3.88 (1.02)	0.002
Necessary to carry out large-scale education on the rational use of PPI for medical staff and the public.	4.06 (1.03)[a]	4.56 (0.64)	4.27 (0.78)	0.001
Necessary to strengthen the management of community pharmacies.	4.26 (0.86)	4.44 (0.79)	4.14 (0.71)[a]	0.008
Average score of attitude on PPI use	22.7 (3.35) *	24.7 (2.86)	24.1 (3.36)	<0.001

* Statistically significant compared with the other two groups; [a] statistically significant compared with the last-year pharmacy students. First-Year: First-Year Students, Last-Year: Last-Year Students, Comm. Phar.: Community Pharmacists

Table 4: PPIs used by the respondents in the past one year, and their practices on using PPI

	First-year		Last-year		Comm. Phar.		*P*
	Mean (SD)	*n* (%)	Mean (SD)	*n* (%)	Mean (SD)	*n* (%)	
PPIs used by respondents							
Omeprazole	11 (64.7)	-	15 (40.5)	-	11 (35.5)	-	0.065
Pantoprazole	4 (23.5)	-	10 (27.0)	-	4 (12.9)	-	
Lansoprazole	2 (11.8)	-	9 (24.3)	-	8 (25.8)	-	
Rabeprazole	-	-	-	-	-	-	
Esomeprazole	-	-	3 (8.1)	-	8 (25.8)	-	
PPIs used when							
Abdominal pain	-	3.22 (1.44)	-	3.48 (1.01)	-	2.31 (1.11) *	<0.001
Ventosity	-	3.89 (1.02)	-	3.96 (1.21)	-	1.86 (1.09) *	<0.001
Nausea	-	4.17 (1.04)	-	4.30 (1.09)	-	1.74 (1.22) *	<0.001
Vomiting	-	4.22 (1.22)	-	4.28 (1.11)	-	1.69 (1.28) *	<0.001
Acid reflux	-	2.89 (1.71)	-	2.24 (0.95)	-	4.09 (0.92) *	<0.001
Average score of practices on PPI use	-	3.68 (0.74)	-	3.64 (0.97)	-	2.34 (0.76) *	<0.001

* Statistically significant compared with the other two groups. First – Year: First-Year Students, Last-Year: Last-Year Students, Comm. Phar.: Community Pharmacists

Table 5: Influencing factors regarding knowledge of PPI use and average scores

Mean (SD)	First-year Mean (SD)	*P*	Last-year Mean (SD)	*P*	Comm. Phar. Mean (SD)	*P*
Gender						
Male	12.68 (2.39)	0.098	13.16 (2.09)	0.114	12.71 (2.81)	0.795
Female	11.61 (2.48)		13.96 (2.44)		12.78 (2.64)	
Nationality						
N. Cyprus	10.73 (1.90)	0.059	14.17 (2.40)	0.745	-	N/A
Turkey	12.76 (2.51)		13.80 (2.27)		-	
Iran	11.70 (2.00)		13.70 (2.43)		-	
Others	11.59 (2.65)		13.33 (2.22)		-	
Education						
Pharm. D	12.02 (2.59)	0.926	13.94 (2.12)	0.429	-	N/A
B. Pharm	11.96 (2.32)		13.53 (2.42)		-	
cGPA						
<2.5	-	N/A	14.18 (1.86)	0.017	-	N/A
2.5-3	-		13.00 (2.53) *		-	
>3	-		14.32 (2.15)		-	

* Statistically significant compared with the other two cGPA values. N. Cyprus: North Cyprus, N/A: not assessed, First – Year: First Year Students, Last – Year: Last Year Students, Comm. Phar.: Community Pharmacists

last-year students ($P < 0.001$); however, there was no statistically significant difference between students and community pharmacists [Table 2]. The three groups did not show any statistically significant differences in their level of knowledge regarding "*Clinical Pharmacology*." With a 45.8% correct response rate, community

Table 6: Influencing factors regarding attitude on PPI use and average scores

	First-year Mean (SD)	*P*	Last-year Mean (SD)	*P*	Comm. Phar. Mean (SD)	*P*
Gender						
Male	22.96 (3.25)	0.523	24.51 (2.83)	0.376	21.93 (3.10)	0.009
Female	22.53 (3.42)		24.87 (2.89)		24.73 (3.18)[b]	
Nationality						
N. Cyprus	22.27 (4.34)	0.392	24.83 (3.87)	0.959	-	N/A
Turkey	23.29 (2.82)		24.67 (1.80)		-	
Iran	21.20 (3.71)		24.67 (3.24)		-	
Others	22.64 (3.37)		24.89 (2.19)		-	
Education						
Pharm. D	22.08 (2.53)	0.272	24.69 (3.11)	0.896	-	N/A
B. Pharm	22.98 (3.24)		24.82 (2.19)		-	
cGPA						
<2.5	-	N/A	24.94 (2.55)	0.013	-	N/A
2.5-3	-		24.00 (2.94)		-	
>3	-		26.00 (2.66)[a]		-	

[a]Statistically significant compared with cGPA value of 2.5-3; [b] Statistically significant compared with males. N. Cyprus: North Cyprus, N/A: not assessed, First – Year: First Year Students, Last – Year: Last Year Students, Comm. Phar.: Community Pharmacists

Table 7: Influencing factors regarding practices on PPI use and average scores

	First-year Mean (SD)	*P*	Last-year Mean (SD)	*P*	Comm. Phar. Mean (SD)	*P*
Gender						
Male	3.51 (0.87)	0.479	3.79 (0.62)	0.316	2.10 (0.40)	0.483
Female	3.78 (0.66)		3.54 (0.78)		2.43 (0.85)	
Nationality						
N. Cyprus	3.85 (0.79)	0.119	-	0.829	-	N/A
Turkey	2.80 (0.72)		3.65 (0.34)		-	
Iran	3.96 (0.59)		3.69 (0.75)		-	
Others	3.77 (0.64)		3.53 (0.85)		-	
Education						
Pharm. D	3.88 (0.62)	0.122	3.58 (0.80)	0.534	-	N/A
B. Pharm	3.43 (0.83)		3.82 (0.43)		-	
cGPA						
<2.5	-	N/A	3.61 (0.67)	0.622	-	N/A
2.5-3	-		3.76 (0.76)		-	
>3	-		3.52 (0.77)		-	

N. Cyprus: North Cyprus, N/A: not assessed, First-Year: First-Year Students, Last – Year: Last Year Students, Comm. Phar.: Community Pharmacists

Table 8: Correlation analysis between knowledge, attitude, and practices

Variables	Knowledge		Attitude		Practices	
	Correlation Coefficient (*r*)	*P*	Correlation Coefficient (*r*)	*P*	Correlation Coefficient (*r*)	*P*
Knowledge	1		0.353	<0.001	0.087	NS
Attitude	0.353	<0.001	1		0.241	NS
Practices	0.087	NS	0.241	NS	1	

NS: Not Significant

pharmacists showed relatively low knowledge concerning "*omeprazole has the largest individual difference compared with other PPIs*." First-year pharmacy students' knowledge of "*PPIs* including *omeprazole, pantoprazole, lansoprazole, rabeprazole, and esomeprazole*" was significantly lower than that of last-year students and community pharmacists ($P < 0.001$). Furthermore, community pharmacists' knowledge regarding "*omeprazole had the largest individual difference compared with other PPIs*," which was significantly lower than that of first- and last-year students ($P = 0.017$). First-year pharmacy students scored significantly lower on "*Dosage and Administration*" awareness than last-year students and community pharmacists ($P < 0.001$). All

three groups had low knowledge levels regarding the duration of PPI treatment for gastric ulcers (24.7%, 22.5%, and 20.3%). Additionally, first-year students were not sufficiently aware of the duration of PPI therapy in *Helicobacter pylori* eradication. The knowledge level of the following items, "*PPI should NOT be taken after meal*" and "*Patients should NOT take PPI for only 7 days in the H. pylori eradication therapy*" significantly increased from first-year to last-year pharmacy students and community pharmacists ($P < 0.001$ and $P = 0.008$, respectively). Last-year students scored significantly higher than the two other groups regarding "*PPIs should be swallowed as a whole piece*" ($P = 0.039$). The correct response rate for community pharmacists regarding the use of PPIs in acute pancreatitis was significantly lower than both first and last-year students (28.8%; $P < 0.001$). First-year pharmacy students were the least knowledgeable about the use of PPIs to prevent stress ulcers ($P < 0.001$). Community pharmacists demonstrated significantly lower knowledge levels of the following item than both first and last-year students "*Long-term use of PPI may cause adverse reactions such as osteoporosis and pneumonia*" ($P < 0.001$).

Attitude on PPI use

First-year students revealed significantly lower attitude scores on PPI use than the other groups ($P < 0.001$). Belief regarding PPI overuse in North Cyprus significantly increased from first-year to last-year students and community pharmacists ($P < 0.001$). Additionally, last-year pharmacy students showed significantly higher attitudes regarding the need to strengthen community pharmacy management compared to the pharmacists ($P = 0.008$) [Table 3].

PPIs used by respondents in the past 1 year

The most used PPI among all three groups was omeprazole. PPI usage increased from first-year to last-year students and community pharmacists (22%, 33.3%, and 52.5%, respectively) over the past year. However, this finding was not statistically significant ($P = 0.065$) [Table 4].

Practices on PPI use

Compared to the other two groups, community pharmacists scored significantly lower on practices regarding PPI use ($P < 0.001$). Community pharmacists used PPIs more often for acid reflux ($P < 0.001$), whereas pharmacy students used PPIs more often for abdominal pain, nausea, and vomiting ($P < 0.001$) [Table 4].

Influencing factors regarding knowledge, attitude, and practices on PPI use

This study found that gender, nationality, or program type of first- and last-year pharmacy students did not affect their knowledge levels, attitude, or practices toward PPI use [Tables 5-7]. However, cGPA affected last-year students' knowledge and attitude scores ($P = 0.017$, and $P = 0.013$, respectively). None of the questioned sociodemographic characteristics influenced community pharmacists' knowledge, attitude, and practices scores except that, female pharmacists scored significantly higher on attitude toward PPI use ($P = 0.009$).

Statistical analysis showed a significant correlation between knowledge levels and the attitude of the participants ($r = 0.353$, $P < 0.001$). A correlation was not observed between knowledge and practices as well as attitude and practices [Table 8].

Discussion

Total knowledge scores regarding PPI use among pharmacy students showed a statistically significant difference between first- and last-year students, with the latter having a higher knowledge level. Our pharmacy curriculum states that PPIs are studied in the sixth and seventh semesters of both programs; therefore, last-year pharmacy students should have higher knowledge scores than first-year students. Based on the results of this study, the total knowledge scores of pharmacy students were very similar to those of pharmacists in Luo *et al*.[20] and Asdaq *et al*.[21] studies. Similarly, this study showed that last-year pharmacy students' average knowledge scores were higher than those of all health professions (doctors, nurses, and pharmacists) in Luo *et al*.[20] Nevertheless, some critical points must be considered. Firstly, last-year pharmacy students were not sufficiently aware that "*increasing the dose frequency rather than a single dose is advised to improve the PPI effect*." Because not all proton pumps are active during the initial phase of the treatment, a twice-daily dose of PPI may result in faster gastric acid inhibition.[22] Secondly, last-year students were not adequately aware of the *"duration of PPI treatment in gastric ulcers."* Generally, for duodenal ulcers, the treatment duration is 4 weeks, whereas, for gastric ulcers, it is 8 weeks.[23] These issues may arise because PPI dosage and duration are the prescriber's responsibility, and pharmacists may not be responsible for commenting on physicians' prescriptions. However, one of the roles of a pharmacist is to implement protocols in collaboration with prescribers to reduce hospital visits and healthcare costs.[24,25] Thirdly, last-year pharmacy students had the misconception that "*omeprazole is the PPI with the largest interaction.*" However, increased pH-related changes in the oral bioavailability of concomitant drugs are not specific to one PPI member but common to all of them.[13] It should be stressed to pharmacy students that

all PPIs may affect the oral bioavailability of some drugs, potentially causing clinically significant drug interactions, especially in elderly patients with polypharmacy and narrow therapeutic indices.

This study showed that students' knowledge level of PPI use improved significantly as their pharmacy education progressed, with the most noticeable improvement in "*Dosage and Administration*" of PPIs. The overall knowledge score of community pharmacists in this study was similar to those reported by Luo *et al*.[20] and Asdaq *et al*.[21] studies. This study found no statistically significant difference between pharmacy students and pharmacists in terms of total knowledge scores. Although 96.6% of pharmacists had 1 year or more experience, it does not seem to have led to a higher PPI knowledge. Further, compared to last-year students, pharmacists were significantly less aware of "*adverse reactions of PPIs,*" "*individual differences of omeprazole,*" and "*use of PPIs in acute pancreatitis.*" PPI use in acute pancreatitis and the duration of treatment in gastric ulcers were associated with the lowest scores, 28.8% and 20.3%, respectively. However, the use of PPIs in acute pancreatitis is controversial because several observational and cohort studies failed to demonstrate their effectiveness.[26-28] This controversy may explain doctors' low percentage (<45%) of correct responses to this question in Luo *et al*.[20] and Asdaq *et al*.[21] studies.

According to this study, last-year pharmacy students' total attitude scores were similar to those of community pharmacists but significantly higher than those of first-year students. The increasing attitude during pharmacy education and relatively high scores of community pharmacists may be attributable to students' practical implementations during their internships and their experiences after graduation. Further, the increased knowledge gained during pharmacy education can also explain the significant attitude shift from first- to last-year students. From first-year to last-year students and pharmacists, the belief that "*overuse of PPIs is common in North Cyprus*" significantly increased. Despite the lack of data regarding the prevalence and use of PPIs in North Cyprus, this finding is consistent with the overuse and rising prevalence of PPIs globally, as reported by Kantor *et al*.[29] and Zhang *et al*.[30] studies. Last-year pharmacy students in this study scored significantly higher than the other groups, indicating that the overuse of PPIs increases adverse effects and costs, in line with Savarino *et al*.[27] and Forgacs and Loganayagam[31] studies. All three studied groups, particularly last-year pharmacy students, agreed on the need for education on rational PPI use for the public, medical staff, and community pharmacists, in agreement with previous studies.[27,32,33] Overall, our study showed a similar pattern regarding knowledge and attitude between the three studied groups, which can also be attributed to the observed significant correlation between knowledge and attitude regarding PPI use.

The use of PPIs increased steadily from 22.2% to 52.5% among first-year students to community pharmacists in the past year. This may be due to the self-medication of the participants because their knowledge regarding PPI indications grew during their pharmacy education and work experience. This study found that omeprazole was the most preferred PPI among the three groups, confirming Luo *et al*.[20] and Asdaq *et al*.[21] findings.

According to this study, community pharmacists used PPIs for acid reflux significantly more than pharmacy students. However, for pharmacy students, the most common reasons for taking PPIs were abdominal pain, nausea, and vomiting. In conclusion, respondents' PPI usage practices shifted from non-specific gastrointestinal symptoms to gastroesophageal reflux from pharmacy students to community pharmacists. A lack of experience among pharmacy students may explain their high reliance on PPIs, emphasizing their inappropriate use of these agents.

Both B. Pharm (5 years pharmacy education) and Pharm D (6 years pharmacy education) programs offered in the faculty where the study was conducted contain PPI chapter in pharmaceutical chemistry-2 and pharmacotherapy-1 courses, which are given in the sixth and seventh academic semesters; respectively. There are no differences regarding the semesters, content, and total hours of study in PPI lectures between B. Pharm. and Pharm. D. programs. However, the majority of Pharm. D. program students are from Iran and Nigeria, whereas students registered for B. Pharm. program are mainly composed of Turkish and Cypriot students. This study found that among first- and last-year pharmacy students, type of pharmacy program (B. Pharm. or Pharm. D.), gender, and nationality did not influence knowledge levels, attitude, and practices." However, there was no homogeneity in the number of participants within each sociodemographic parameter. In contrast, community pharmacists' attitude was significantly influenced by gender, with females scoring higher. According to previously published data,[21] knowledge of PPI use was found good in healthcare professionals who had experience between 6 and 10 years in practice. Our raw data demonstrated that 9 out of 12 participants who had experience in practice between 6 and 10 years were females. We assume that this female dominance in this experience range might explain the role of gender regarding attitude on PPI use in the case that knowledge level was obtained as correlated with the attitude of

the respondents. However, more detailed and specific studies should be performed in the future to demonstrate the effect of gender on the attitude toward PPI use.

This study had several limitations; most notably, the authors were unable to comment on the detailed use of PPIs due to the lack of data on PPI prescription characteristics in North Cyprus, including indications, patient specifications, members, dosage, and duration. Furthermore, it was impossible to determine the number of prescribed and over-the-counter PPIs, which would have clarified the self-medication characteristics. Another limitation was the relatively low number of participants enrolled in the study; particularly, the community pharmacists due to the lower response rates to the delivered questionnaires. Additionally, the study design was composed of a self-administered questionnaire, which prevented the researchers to observe the participants were not checking related materials while filling out the questionnaire.

This study demonstrated that knowledge and attitudes regarding PPI use increased during pharmacy education. Nevertheless, there are significant concerns that must be addressed during pharmacy education to improve the knowledge and practice gaps. Furthermore, community pharmacists' low scores on essential items and their total knowledge scores indicate the need for their post-graduate continuing education. These strategies are critical to reducing the misuse and overuse of PPIs. This study is the first to evaluate pharmacy students' knowledge, attitude, and practices regarding PPI use and compare it with community pharmacists. To provide further insight into this condition, additional research with detailed and specific questions among a larger number of community pharmacists and students with a multi-center study is required.

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Conflicts of interest

There are no conflicts of interest.

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