Physician's Knowledge of Pharmacogenomics Services in Saudi Arabia

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Abstract

Objective: In this study, we aimed to assess physician's knowledge of pharmacogenomics services in the Kingdom of Saudi Arabia.

Methods: This is a cross-sectional survey conducted to assess the knowledge of physicians about pharmacogenomics services in the Kingdom of Saudi Arabia. This is a self-reported electronic survey of physicians. We included physicians from interns to consultants to specialists employed in Saudi Arabia. The survey collected demographic information of the responders and their knowledge of selected pharmacogenomics elements employed in medical care. The resources of pharmacogenomics in medical care. We used 5-point Likert response scale system with close-ended questions to obtain responses. The data were captured through the Survey Monkey system and analyzed using the Statistical Package of Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP), and Microsoft Excel (version 16) software.

Results: A total of 247 physicians responded to the questionnaire. Of them, 156 (65.00%) were female and 85 (35.00%) were male responders, with statistically significant differences between them ($p<0.01$). Most of the responders were in the age group of 24–35 years (162 (65.85%)), with statistically significant differences between all age groups ($p<0.01$). Most of the physicians were residents (61 (24.70%)), followed by interns (56 (22.67%)) and specialists (55 (22.27%)). The total average score of physician's knowledge of pharmacogenomics was 3.06, with high scores obtained for the element's knowledge of the concept of pharmacogenomics (3.42), the medications required the pharmacogenomics testing (3.20), and indications of pharmacogenomics testing (3.14). The pharmacogenomics international guidelines were the most used resource for the medication safety by physicians (97 (39.92%)) and colleagues/other physicians (65 (26.75%)).

Conclusion: In this study, knowledge of physicians about pharmacogenomics services was found to be inadequate. Training and education on pharmacogenomics are highly recommended during the undergraduate and postgraduate courses for the best utilization and practice implementations pharmacogenomics services in the Kingdom of Saudi Arabia.

Keywords: Pharmacogenomic, Knowledge, Physicians, Saudi Arabia.

INTRODUCTION

During the past 20 years, the job of pharmacists has changed from drug care to patient care. Pharmaceutical care was founded in the 2000s emphasizing drug therapy and prevent drug-related problems [1]. The response of drug therapy or exposure to drug-related dependence on various factors. External factors such as drug–drug interaction, drugs without indication, and indications without medications [2]. Moreover, endogenous factors such as pharmacokinetics, pharmacogenetics, or pharmacogenomics [3]. The term pharmacogenomics is responsible for enhancing drug therapy and stimulating aspect or vice

versa due to the patient's genes. [4]. The term pharmacogenomics has been established more than 15 years ago and since then, a number of publications have discussed it [5,6]. Furthermore, the School of Pharmacy started a curriculum that included pharmacogenomics [5]. Pharmacogenomics consists of various elements including the medications affecting the genes, the human genes responsible for decreasing or increasing the drug effects. Furthermore, the genes responsible for drug distribution within the human body and population differences in pharmacogenomics. [7]. The healthcare professionals emphasize that physicians need to be familiar with the knowledge elements needed. Most of the investigation discussed pharmacist knowledge, practice, and perception of pharmacogenomics services [8-12]. So far, various studies have focused their research on physician's knowledge of pharmacogenomics [13-19]. However, to the best of our knowledge, there are studies that investigated the knowledge of physicians' knowledge of pharmacogenomics in local or in Middle Eastern countries. Therefore, in this study, we aimed to explore the physician's knowledge of pharmacogenomics services in Saudi Arabia.

Methods

This is a 6-month cross-sectional study conducted to assess the knowledge of physicians about pharmacogenomics services in Saudi Arabia. We used a self-reported electronic survey, including physicians from interns to consultants, and specialists in the Kingdom of Saudi Arabia. All non-physicians or students and incomplete surveys were excluded from the survey. The survey collected demographic information of the responders and their knowledge of selected pharmacogenomics elements in medical care. Sources of knowledge of pharmacogenomics in medical care. We used 5-point Likert response scale system with close-ended questions in order to obtain responses. According to the previous literature with unlimited population size, the sample size was calculated for a cross-sectional study. The confidence level was 95%, with a z score of 1.96, a margin of error of 5-6.5%, a population percentage of 50%, and a drop-out rate of 10%. With these criteria, the sample size was calculated as 251 to 432 with a power of study of 80% [20-22]. The response rate required of calculated sample size at least 60–70% and above [22,23]. The survey was distributed through social media such as Telegram and via face-to-face contact. A reminder message was sent once every 1-2 weeks. The survey was validated through the revision of expert reviewers and pilot testing. Moreover, various tests of reliability such as McDonald's ω, Cronbach's α, Gutmann's λ2, and Gutmann's λ6 were calculated. The data analysis of the physician's knowledge of pharmacogenomic was collected through the Survey Monkey system. Moreover, Microsoft excel sheet version 16, the Statistical Package of Social Sciences (SPSS) and Jeffery's Amazing Statistics Program (JASP). We performed descriptive and frequency analysis, goodness of fit analysis, correlation analysis, and inferential analysis on the factors affecting physician's knowledge of pharmacogenomics. The STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guided the reporting of the results of this study [24,25].

Ethical Approval

The research protocol was approved by research ethics committee, Pharmacy College, Shaqra University, Saudi Arabia.

Results

A total of 247 physicians responded to the survey, with the majority of them coming from the central region (143 (58.13%)), with statistically significant differences between the regions ($p<0.01$). Of them, 156 (65.00%) were female and 85 (35.00%) were male responders, with statistically significant differences between them ($p<0.01$). Most of the responders were in the age group of 24–35 years (162 (65.85%)), with statistically significant differences between the age groups ($p<0.01$). Most of the physicians were residents (61 (24.70%)), followed by interns (55 (22.36%)) and specialists (55 (22.36%)). With respect to jobs, the majority of the responders were supervisors (81 (32.93%)) followed by physicians (73(29.67%)), with statistically significant differences between them ($p<0.01$). There was a medium positive relationship between age (years) and physician's qualifications based on Kendall's tau_b (0.413) or Spearman's rho (0.477) correlation, with a statistically significant difference between the two factors ($p<0.05$). Moreover, there was a medium positive relationship between age (in years), and work experience based on Kendall's tau_b (0.390) or Spearman's rho (0.434) correlation, with statistically significant differences between the two factors ($p<0.05$). Most physicians had work experience of ≤ 6 years (204 (82.93%)), with almost one-quarter of them being physicians (57 (23.36%)) and with statistically significant difference between them ($p=0.003$) (Tables 1 and 2). The total average score for the element physician's knowledge of pharmacogenomics was 3.06, with high scores obtained for the element's knowledge of the concept of pharmacogenomics (3.42), the medications required for the pharmacogenomics testing (3.20), and indications of pharmacogenomics testing (3.14). In contrast, the lowest scores were obtained for the elements where you could get the pharmacogenomics reporting form (2.96), with statistically significant differences between the answers. In contrast, the second-lowest scores were obtained for the element how to access, interpret, and use international pharmacogenomics guidelines (2.97), with non-statistically significant differences between the answers ($p>0.05$). However, all

elements showed statistically significant differences between the responses ($p<0.05$), except for one (Table 3). The international pharmacogenomics guidelines were the most used resource for the pharmacogenomics by physicians (97 (39.92%) and colleagues/other physicians (65 (26.75%)). They were followed by Genetic Testing Laboratory (62 (25.51%)) pharmacogenomics services inside the institution (47 (19.34%)) (Table 4). The score for single-test reliability analysis of McDonald's ω was 0.885, Cronbach's α was 0.886, Gutmann's λ2 was 0.887, and Gutmann's λ6 was 0.888.

Table 1: Demographic, social information

Locations	Response Count	Response Percent	p-value (X2)
Central area	143	58.13%	0.000
North area	23	9.35%	
South area	33	13.41%	
East area	26	10.57%	
West area	21	8.54%	
Answered question	**246**		
Skipped question	**1**		
Site of work	Response Count	Response Percent	p-value (X2)
MOH Hospitals	57	23.08%	0.000
Military hospitals	14	5.67%	
National Guard Hospital	18	7.29%	
Security forces hospitals	12	4.86%	
University hospital	38	15.38%	
MOH primary care centres	10	4.05%	
Private hospitals	87	35.22%	
Private ambulatory care clinics	5	2.02%	
Private primary healthcare centre	6	2.43%	
Answered question	**247**		
Skipped question	**0**		
Gender	Response Count	Response Percent	
Male	85	35.27%	0.000
Female	156	64.73%	
Answered question	**241**		
Skipped question	**6**		
Age	Response Count	Response Percent	
24–35	162	65.85%	0.000
36–45	54	21.95%	
46–55	23	9.35%	
> 55	7	2.85%	
Answered question	**246**		
Skipped question	**1**		

Table 2: Demographic, social information

Physicians Qualifications	Response Count	Response Percent	p-value (X2)
Intern	56	22.67%	0.002
Resident	61	24.70%	
General Practitioner	51	20.65%	
Specialist	55	22.27%	

Consultant	24	9.72%	
Answered question	**247**		
Skipped question	**0**		
Position Held	Response Count	Response Percent	
Director of medical departments	40	16.26%	0.000
Assistant director of the medical department	49	19.92%	
Supervisor	81	32.93%	
Physician staff	73	29.67%	
Intern	3	1.22%	
Answered question	**246**		
Skipped question	**1**		
Years of experience	Response Count	Response Percent	
> 1	52	21.14%	0.000
1-3	98	39.84%	
4-6	54	21.95%	
7-9	26	10.57%	
> 9	16	6.50%	
Answered question	**246**		
Skipped question	**1**		
Physicians Specialties	Response Count	Response Percent	
Critical Care	26	10.74%	0.000
Emergency	30	12.40%	
Medical	57	23.55%	
Surgical	29	11.98%	
Paediatrics	32	13.22%	
Anaesthesia	16	6.61%	
Psychiatry	16	6.61%	
Obstetrics and Gynaecology	4	1.65%	
Family medicine	20	8.26%	
Ambulatory care	11	4.55%	
Laboratory	1	0.41%	
Answered question	**242**		
Skipped question	**5**		

Table 3: Pharmacogenomics assessment of knowledge

	76-100 % of knowledge		**51-75%**		**26-50%**		**1-25%**		**No knowledge**		**Total**	**Weighted Average**	**p-value**
1- Have you ever heard about the concept of Pharmacogenomics?	16.60%	41	35.22 %	87	26.72 %	66	16.60 %	41	4.86 %	12	247	3.42	0.000
2- Have you ever had a course/attended a workshop about Pharmacogenomics?	12.96%	32	24.70 %	61	27.94 %	69	19.84 %	49	14.57 %	36	247	3.02	0.000
3- In Saudi Arabia, are there legal provisions in the medicines act that	15.79%	39	19.43 %	48	28.34 %	70	23.48 %	58	12.96 %	32	247	3.02	0.001

provide for Pharmacogenomics activities?													
4- In Saudi Arabia, is there a Pharmacogenomics services center?	16.33%	40	19.18 %	47	26.94 %	66	22.86 %	56	14.69 %	36	245	3.00	0.017
5- In Saudi Arabia, is there an official standardized form for reporting or document Pharmacogenomics?	15.51%	38	22.04 %	54	27.76 %	68	18.37 %	45	16.33 %	40	245	3.02	0.015
6- Do you know from where you can get the Pharmacogenomics reporting form?	11.38%	28	25.61 %	63	26.42 %	65	21.14 %	52	15.45 %	38	246	2.96	0.000
7- Do you know how to access, interpret, and use international pharmacogenomics guidelines?	16.67%	41	19.51 %	48	24.80 %	61	21.95 %	54	17.07 %	42	246	2.97	0.219
8- Do you know the indications of Pharmacogenomics testing?	16.33%	40	24.49 %	60	28.16 %	69	18.78 %	46	12.24 %	30	245	3.14	0.001
9- Do you familiar with the medications required the Pharmacogenomics testing?	19.59%	48	21.22 %	52	29.39 %	72	19.18 %	47	10.61 %	26	245	3.20	0.000
10- Do you know to recommend alternative drug therapy or dose change when required based on pharmacogenomics results?	15.45%	38	24.39 %	60	28.05 %	69	18.70 %	46	13.41 %	33	246	3.10	0.001
11- Do you know to make treatment recommendations based on Pharmacogenomics results?	16.33%	40	24.08 %	59	18.78 %	46	27.35 %	67	13.47 %	33	245	3.02	0.003
12- Do you can interpret Pharmacogenomics testing?	15.92%	39	20.00 %	49	26.94 %	66	23.27 %	57	13.88 %	34	245	3.01	0.008
13- Do you know the ethical tool of Pharmacogenomics testing?	13.47%	33	25.31 %	62	24.90 %	61	19.18 %	47	17.14 %	42	245	2.99	0.013
14- Do you know the cost or the process of	15.51%	38	25.31 %	62	27.35 %	67	16.73 %	41	15.10 %	37	245	3.09	0.002

Pharmacogenomics testing?													
Answered												**247**	
Skipped												**0**	

Table 4: The most resources used for Pharmacogenomics assessment of knowledge in medical care

Answer Choices	Responses	
1- Pharmacogenomics international guidelines	97	39.92%
2- Genetic testing laboratory	62	25.51%
3- Colleague/another physician	65	26.75%
4- Pharmacogenomics services inside the institution	47	19.34%
5- Healthcare institution administration guidelines	41	16.87%
6- Saudi Food and Drug Authority	41	16.87%
7- Medication's package insert	36	14.81%
8- General internet	45	18.52%
9- Pharmaceutical companies	46	18.93%
10- Drug information resources (Micromedex, Lexi-comp, Epocrates...,)	50	20.58%
Answered	243	
Skipped	4	

Table 5: Factors (average scores) influencing the physician's pharmacogenomics assessment of knowledge

		Physician's pharmacogenomics assessment of knowledge						
	Factors	N	Average scores	Std. D	Median	Lower Bound	Upper Bound	P-value
Region	Central	139	3.0936	.76548	3.1429	2.9652	3.2219	0.106
	North	23	2.9472	.92913	3.0000	2.5454	3.3490	
	South	28	3.3230	.73759	3.4643	3.0370	3.6090	
	East	24	2.8966	.77123	3.0000	2.5709	3.2222	
	West	18	2.7976	.93429	2.8214	2.3330	3.2622	
	Total	232						
Site of works	MOH Hospitals	51	3.0902	.99297	3.1429	2.8109	3.3695	0.092
	Military hospitals	13	3.2549	.79499	3.2143	2.7745	3.7353	
	National Guard Hospital	17	3.6471	.73907	3.5000	3.2671	4.0271	
	Security forces hospitals	12	2.8036	.84632	3.0000	2.2658	3.3413	
	University hospital	35	3.0807	.83750	3.0714	2.7930	3.3684	
	MOH primary care centres	10	2.7071	.74112	2.9643	2.1770	3.2373	
	Private hospitals	84	3.0047	.56403	3.0357	2.8823	3.1271	
	Private ambulatory care clinics	4	2.8929	.27664	2.9643	2.4527	3.3331	

	Private primary healthcare centre	6	2.7152	1.33207	3.3214	1.3173	4.1131	
	Total	232						
Age	24–35	154	3.0574	.84613	3.1429	2.9227	3.1922	0.922
	36–45	51	3.0585	.64890	3.0000	2.8760	3.2410	
	46–55	20	3.0582	.73458	3.0357	2.7144	3.4020	
	> 55	7	3.2449	1.02008	3.2857	2.3015	4.1883	
	Total	232						
Gender	Male	82	3.0689	.78371	3.1429	2.8967	3.2412	0.927
	Female	150	3.0604	.80922	3.1131	2.9298	3.1909	
	Total	232						
Physician Qualification	Intern	52	3.2303	.71512	3.1429	3.0313	3.4294	0.084
	Resident	60	2.8298	.84853	3.0000	2.6106	3.0490	
	General Practitioner	48	3.2952	.73623	3.2857	3.0814	3.5090	
	Specialist	52	3.0648	.77814	3.1429	2.8482	3.2814	
	Consultant	20	2.7703	.83938	2.8214	2.3775	3.1632	
	Total	232						
Physician specialties	Critical Care	26	3.2718	.92734	3.2857	2.8972	3.6463	0.222
	Emergency	30	3.0634	.93589	3.1786	2.7139	3.4128	
	Medical	57	3.2244	.69676	3.1429	3.0395	3.4093	
	Surgical	29	3.0625	.72439	3.1429	2.7870	3.3381	
	Paediatrics	32	2.8973	.65865	3.0357	2.6599	3.1348	
	Anaesthesia	16	3.1399	.58511	3.1429	2.8282	3.4517	
	Psychiatry	16	3.2325	.51403	3.1786	2.9586	3.5064	
	Obstetrics and Gynaecology	4	2.8750	1.61874	2.7143	.2992	5.4508	
	Family medicine	20	2.9668	.84503	3.0357	2.5713	3.3622	
	Ambulatory care	11	2.4805	1.00056	2.6429	1.8083	3.1527	
	Total	241						
Position	Director of medical departments	40	3.3019	.73509	3.1786	3.0668	3.5370	0.244
	Assistant director of the medical department	49	3.1454	.70844	3.1429	2.9419	3.3489	
	Supervisor	81	3.0898	.72328	3.0833	2.9299	3.2498	
	Physician staff	76	2.8651	.92436	3.0000	2.6539	3.0763	
	Total	246						
Experiences	< 1	48	2.9749	.80349	3.0000	2.7416	3.2082	0.202
	1-3	95	3.0629	.84391	3.1429	2.8910	3.2348	
	4-6	51	3.0929	.72524	3.0714	2.8889	3.2968	
	7-9	23	3.2817	.79393	3.3571	2.9383	3.6250	
	> 9	15	2.9151	.75717	3.0833	2.4958	3.3344	

	Total	232							

Table 6: Multiple regression of Factors with the physician's Pharmacogenomics assessment of knowledge [a]

Model		R	R Square	F	Sig.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
						B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.264 [b]	.069	2.080	.039[b]	3.708	0.296		12.520	0.000	3.124	4.291		
	Location					-0.048	0.039	-0.082	-1.241	0.216	-0.125	0.028	0.959	1.043
	Site of work					-0.021	0.022	-0.066	-0.964	0.336	-0.064	0.022	0.880	1.137
	Age (years)					0.017	0.079	0.017	0.218	0.828	-0.139	0.173	0.702	1.425
	Physician gender					0.016	0.110	0.010	0.147	0.883	-0.201	0.233	0.958	1.044
	Physician Qualifications					-0.053	0.047	-0.085	-1.133	0.258	-0.146	0.039	0.737	1.357
	Physician Specialties					-0.029	0.021	-0.095	-1.390	0.166	-0.071	0.012	0.895	1.118
	Current Position					-0.137	0.048	-0.186	-2.843	0.005	-0.231	-0.042	0.979	1.021
	Years of experiences					0.058	0.055	0.082	1.055	0.292	-0.051	0.168	0.696	1.436

[a]: Dependent Variable: physician's Pharmacogenomics assessment of the knowledge, Predictors [b]: (Constant), Location, Site of work, Age (years), Physician gender, Physician Qualifications, Physician Specialties, and Your Current Position

Bootstrap for Coefficients

Model		B	Bootstrap [a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	3.708	-0.010	0.308	0.001	3.082	4.310
	Location	-0.048	0.002	0.041	0.249	-0.126	0.035
	Site of work	-0.021	0.000	0.025	0.397	-0.069	0.028
	Age (years)	0.017	-0.003	0.091	0.827	-0.171	0.184
	Physician gender	0.016	0.000	0.116	0.898	-0.201	0.245
	Physician Qualifications	-0.053	0.000	0.043	0.223	-0.140	0.030
	Physician Specialties	-0.029	0.001	0.024	0.224	-0.075	0.018
	Current Position	-0.137	-0.002	0.050	0.015	-0.235	-0.040
	Years of experiences	0.058	0.004	0.057	0.305	-0.054	0.175

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Factors influencing the physician's pharmacogenomics assessment of knowledge

Various factors might affect the physician's assessment of pharmacogenomics knowledge. Using independent samples Kruskal–Wallis test and the Bonferroni correction for multiple tests, we adjusted the significant values. All factors such as location, worksite, age (years), gender, qualifications, years of experience, and position held in the medical career of the

physician did not affect the pharmacogenomics assessment of knowledge by physicians in medical care. There were no statically significant differences ($p>0.05$) (Table 5).

The relationship between pharmacogenomics assessment of knowledge by physicians and the aforementioned factors affecting it was revealed via a multiple regression model. We considered the pharmacogenomics assessment of knowledge as the dependent variable and factors affecting it as the expletory variable. According to the results, there was a weak association ($R=0.264$ with $p=0.039$) between the physician's pharmacogenomics assessment of knowledge and factors. All factors showed non-significant differences ($p>0.05$), whereas only a single factor (physician's current position) explained an 18.6% negative association for the variation in the physician's pharmacogenomics assessment of knowledge with a statistically significant differences ($p=0.005$) through multiple regression model and confirmed by Bootstrap model. The relationship was verified by the non-existence of multi-collinearity with the physician's current position with factor variance inflation factor ($VIF=1.021$) less than three or less than five [26-28] (Table 6).

Discussion

The physicians need various updated information in their practice, including medications safety, pharmacogenomics, and applied pharmacokinetics. This knowledge can have positive or negative influence on the healthcare system. As a result, the assessment of pharmacogenomics knowledge of the physician is. In this study, we explored the physician's knowledge of pharmacogenomics assessment from different areas in Saudi Arabia. Most of the responders were from the central region relevant to co-authors of the data collectors in the study [17]. Therefore, it was easy for them to contact the physicians in their areas. Moreover, the responders were young and recent graduates with less than 6 years of experience. Furthermore, most of the respondents were female, of the same gender as the data collectors, so it was easy to contact them. In this study, we covered all age groups and number of years of experience as reported in the previous study [17]. Furthermore, the method of sampling was a convenient sample, but the representative sample did not reach an optimal level, which was difficult to generalize to all of those physicians which is similar to the previous study [17,18]. Nevertheless, the study finding showed a medium positive correlation between age and qualifications and years of experience of the physician. This is expected as the older physicians become positive through increased qualifications and experience.

Like previous studies, in this study, the physicians showed inadequate knowledge of pharmacogenomics in the Kingdom of Saudi Arabia [14,15,17,18,19]. The highest score of knowledge elements was the concept of pharmacogenomics, indication for usage, and medications needed for pharmacogenomics testing. This result is expected due to an increase in basic knowledge of pharmacogenomics over the previous study [14]. On the contrary, the physicians had the lowest understanding of where to look for the forms required for pharmacogenomics services, the knowledge of testing interpretation, and international guidelines pharmacogenomics knowledge that was better than previous studies [14]. The utilization of pharmacogenomics services was found to be inadequate in medical care provided in Saudi Arabia. Some elements of pharmacogenomics knowledge did not reach the optimal level, for instance ethical tool of pharmacogenomics. It is a critical element during pharmacogenomics practice. Some vital aspects of knowledge were found to be insufficient. For example, non-availability of educational courses of pharmacogenomics, making recommendations for pharmacogenomics tests, and medicine act of pharmacogenomics. All previous elements are in great demand in the medical practice [7,16,17,19]. Most physicians obtain the knowledge of pharmacogenomics from pharmacogenomics guidelines, colleagues, or laboratories of healthcare organizations [17]. This means there is proper learning but improper utilization of the pharmacogenomics knowledge. For example, the pharmacist or the drug information center is not a common resource for pharmacogenomics knowledge for physicians, or the pharmacist might not be involved in the pharmacogenomics services. In this study, various factors did not affect physician's knowledge of pharmacogenomics such as geographic location, age, gender, years of experience, or position held. Moreover, there was no factor that depended on increasing or decreasing pharmacogenomics knowledge. However, only one factor might have affected the decrease in pharmacogenomics knowledge, which was position held by the physician. That's related not much practice of supervisors or higher directors of medical care at healthcare institutions.

Limitations

The study had various information related to physician's assessment in pharmacogenomics knowledge. However, it had multiple limitations. For instance, the sample size does not reach a number that obstacles in external validity. In addition, there are differences in demographic data of physician's age, location, gender, and practice experiences.

Conclusion

In this study, the knowledge of pharmacogenomics was not sufficient. There are not many factors that can affect the knowledge of physicians regarding pharmacogenomics services. However, the position of the physician adversely affects knowledge Pharmacist was not a source of pharmacogenomics for physicians Therefore, we recommend education and training during undergraduate and postgraduate courses on pharmacogenomics in Saudi Arabia.

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Conflict of interest:

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