Practice of Pharmacogenomic Services by Physicians in Saudi Arabia

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Abstract

Purpose: In this study, we aimed to illustrate the practice of pharmacogenomic services by the physicians in the Kingdom of Saudi Arabia.

Methods: This is a cross-sectional survey conducted to evaluate the practice of pharmacogenomic services by physicians in Saudi Arabia. We used a self-reported electronic survey and distributed it to physicians from internship to consultant, physician specialties in Saudi Arabia. The survey collected demographic information of the physicians and implemented pharmacogenomics in medical care, frequently of the pharmacogenomics items reported in medical care, medications executed the pharmacogenomics. The 5-point Likert response scale system with closed-ended questions to obtain responses. The data were collected using the Survey Monkey system. The Statistical Package of Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP), and Microsoft excel sheet version 16 were used to analyze the data.

Results: A total of 247 physicians responded to the survey. Of them, 156 (64.73%) were female and 84 (35.27%) were male, 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's 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 average score of items "Physician's practice of pharmacogenomic services" was 2.99 with high score obtained for the elements pharmacogenomic services in the pharmacy (3.16) and pharmacogenomics services competency (3.08). Most of the pharmacogenomics tests requested or observed with the following medications: antiplatelet medications (125 (50.61%)), followed by antidepressants (113 (46.31%)), and antipsychotics 101 (40.06%). The scores of single-test reliability analysis for McDonald's ω was 0.843, Cronbach's α was 0.809, Gutmann's $\lambda 2$ was 0.845, and Gutmann's $\lambda 6$ was 0.848.

Conclusion: The practice of pharmacogenomic services by physicians was insufficient in the Kingdom of Saudi Arabia. Therefore, we highly recommend the implementation of the pharmacogenomics practice in medical care. Pharmacogenomics services can help to prevent drug-related side effects and improve the safety and efficacy of medication in Saudi Arabia.

Keywords: Pharmacogenomic, Practice, Physicians, Saudi Arabia.

INTRODUCTION

Recently, pharmacogenomic services has become an essential practice in medical care worldwide [1-6]. It is needed to prevent any drug-related problems [1,7]. The international guidelines recommend the implementation of pharmacogenomic services for necessary medicines such as anti-HIV medications, oral anticoagulant medications, and antineoplastic medications [3,4,8,9]. There are various questions that need further exploration, for example, are the pharmacogenomics tests available when required. What should be the ideal qualification of a physician who can request the pharmacogenomics test? Does the pharmacogenomics test express a high economic burden on the healthcare system? In addition to the basic information about pharmacogenomics

practice, the vision, mission, annual plan, and policies and procedures need to be further explored. So far, several studies have explored the practice of pharmacogenomics services and others have discussed the perception and attitudes of the pharmacist [10-13]. Furthermore, there are studies that have examined the practice of pharmacogenomics by the physician [5,6,9,14,15,16]. However, to the best of our knowledge, there are no studies conducted on the practice of pharmacogenomic services by physicians. In this study, we aimed to declare the physician's practice of pharmacogenomic services in the Kingdom of Saudi Arabia.

Methods

This is a 6-month cross-sectional analysis conducted to evaluate the practice of pharmacogenomic services by physicians in the Kingdom of Saudi Arabia. In this study, we used an electronic self-reported survey, which was distributed to the physicians from interns to consultants and all specialists located in Saudi Arabia. All nonphysicians and students and incomplete surveys were excluded from this study. The survey collected demographic information of the responders. Moreover, the implemented pharmacogenomics in medical care, frequently of the pharmacogenomics items reported in medical care, medications executed the pharmacogenomics. The pharmacogenomics (to authorities) responsibility of healthcare professionals and pharmacogenomics reporting practice. We used 5-point Likert response scale system and close-ended questions to obtain responses. According to the previous literature with unlimited population size, the sample for this cross-sectional study was calculated with a population percentage of 50%, a confidence level of 95%, a z score of 1.96, margin of error of 5–6.5%, and drop-out rate of 10%. Based on these criteria, the sample size was calculated to be around 251 to 432 with a power of study value of 80% [17-19]. The response rate required for the calculated sample size was around 60–70% [19,20]. The survey was distributed through social media such as WhatsApp and Telegram. A reminder message was once every 2-3 weeks. The survey was validated through the revision of expert reviewers and pilot testing. Moreover, the test of reliability Gutmann's λ6, Gutmann's λ2, McDonald's ω, and Cronbach's α were calculated. The data were collected through the Survey Monkey system and analyzed using the Statistical Package of Social Sciences (SPSS), Microsoft excel sheet version 16, and Jeffery's Amazing Statistics Program (JASP) with description and frequency analysis, goodness of fit analysis, correlation analysis, and inferential analysis of factors affect physician practice of pharmacogenomic services. The STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guided the reporting of this study [21,22].

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 most of them coming from the central region (143 (58.13%)), with statistically significant differences between different regions ($p<0.01$). Of them, 156 (64.73%) were female and 85 (35.27%) 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's 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 majority of the responders were supervisors (81 (32.93%)) and physicians (73 (29.67%)), with statistically significant differences between them ($p<0.01$). There was a medium positive relationship between age (years) and qualification of the physicians 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 is a medium positive relationship between age (years), and physician experiences Kendall's tau_b (0.390) or Spearman's rho (0.434) with statistically significant difference between them ($p<0.05$). Most of the physicians had work experience of ≤ 6 years (204 (82.93%)), with almost one-quarter of physicians (57 (23.36%)), with statistically significant differences between them ($p=0.003$) (Tables 1 and 2).

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: Do you have the following items for Pharmacogenomics?

	76-100 % implemented		**51-75 %**		**25-50 %**		**< 25 %**		**We do not have it**		**Total**	**Weighted Average**	**p-value**
1- The vision of Pharmacogenomic services	23.98%	59	22.36%	55	26.02%	64	17.48%	43	10.16%	25	246	2.67	0.001
2- Mission of Pharmacogenomic services	13.82%	34	23.58%	58	30.49%	75	23.17%	57	8.94%	22	246	2.90	0.000
3- The strategic plan of Pharmacogenomic services	12.20%	30	26.83%	66	25.61%	63	21.54%	53	13.82%	34	246	2.98	0.000
4- The annual plan of Pharmacogenomic services	16.26%	40	25.61%	63	25.20%	62	17.48%	43	15.45%	38	246	2.90	0.016
5- Policy and procedure of Pharmacogenomic services	16.19%	40	20.65%	51	24.29%	60	21.46%	53	17.41%	43	247	3.03	0.267
6- Pharmacogenomics services competency	14.69%	36	22.04%	54	21.63%	53	23.67%	58	17.96%	44	245	3.08	0.168
7- Pharmacogenomics services quality management	16.19%	40	19.43%	48	23.48%	58	23.48%	58	17.41%	43	247	3.06	0.227
8- Pharmacogenomic	14.17%	35	14.57%	36	32.79%	81	18.22%	45	20.24%	50	247	3.16	0.000

services in the pharmacy													
9- Pharmacogenomics and patients' satisfaction	14.17%	35	25.10%	62	23.89%	59	20.65%	51	16.19%	40	247	3.00	0.025
10- Pharmacogenomics and adverse drug reactions system	13.77%	34	24.70%	61	24.29%	60	20.24%	50	17.00%	42	247	3.02	0.028
11- Pharmacogenomics and medications errors system	17.55%	43	22.86%	56	23.67%	58	18.37%	45	17.55%	43	245	2.96	0.349
12- Pharmacogenomic and education and training program	13.01%	32	25.20%	62	23.58%	58	22.76%	56	15.45%	38	246	3.02	0.006
13- Pharmacogenomics and research	12.60%	31	21.54%	53	27.64%	68	22.36%	55	15.85%	39	246	3.07	0.002
14- Pharmacogenomics and cost analysis	14.29%	35	24.08%	59	23.67%	58	19.59%	48	18.37%	45	245	3.04	0.090
Answered											**247**		
Skipped											**0**		

Table 4: Most Pharmacogenomics tests requested or observed with the following medications

	Yes		**No**		**I do not know if they need for pharmacogenomics test**		**Total**
Antiplatelet	50.61%	125	28.74%	71	23.08%	57	247
Anti-seizure	35.10%	86	36.33%	89	32.65%	80	245
Anticoagulant	40.98%	100	31.56%	77	29.51%	72	244
NSAIDs or Pain killer	30.74%	75	40.16%	98	30.33%	74	244
Anti-emetics	34.02%	83	39.34%	96	28.28%	69	244
Antineoplastic medications	32.38%	79	33.20%	81	35.25%	86	244
Anti-HIV medication	38.93%	95	37.30%	91	25.00%	61	244
Anesthesia medications	40.33%	98	36.63%	89	23.87%	58	243
Anti-thrombosis	40.41%	99	30.61%	75	29.80%	73	245
Anti-Depressant	46.31%	113	31.56%	77	25.41%	62	244
General Anti-viral	37.86%	92	36.63%	89	25.93%	63	243
Anti-Psychotics	41.06%	101	33.74%	83	27.24%	67	246
Answered							**247**
Skipped							**0**

Table 5: The Pharmacogenomics services (to authorities) is the responsibility of

	Strongly agree		**Agree**		**Uncertain**		**Disagree**		**Strongly Disagree**		**Total**	**Weighted Average**	**p-value**
Doctors	24.70%	61	38.06%	94	22.67%	56	11.74%	29	2.83%	7	247	3.7	0.000

Pharmacist	29.15%	72	20.65%	51	28.74%	71	18.62%	46	2.83%	7	247	3.55	0.000
Pharmacy technicians	17.55%	43	23.67%	58	27.35%	67	21.22%	52	10.20%	25	245	3.17	0.000
Nurses	12.65%	31	18.78%	46	28.57%	70	29.39%	72	10.61%	26	245	2.93	0.000
Pharm. company	23.67%	58	25.71%	63	28.16%	69	15.92%	39	6.53%	16	245	3.44	0.000
Patients	13.01%	32	26.02%	64	29.67%	73	17.07%	42	14.23%	35	246	3.07	0.000
											Ans.	**247**	
											Skipped	**0**	

Table 6: Pharmacogenomics reporting practice

Have you ever requested any Pharmacogenomics test?	Response Count	Response Percent	p-value (X2)
Yes	100	40.65%	0.000
No	107	43.50%	
I do not know	39	15.85%	
Answered question	**246**		
Skipped question	**1**		
Are Pharmacogenomic tests available at your institution?	**Response Count**	**Response Percent**	**p-value (X2)**
Yes	79	31.98%	0.040
No	100	40.49%	
I do not know	68	27.53%	
Answered question	**247**		
Skipped question	**0**		
Does the institution have an association with a Pharmacogenomic tests site?	**Response Count**	**Response Percent**	**p-value (X2)**
Yes	101	40.89%	0.034
No	77	31.17%	
I do not know	69	27.94%	
Answered question	**247**		
Skipped question	**0**		
The number of Pharmacogenomics tests observed/requested daily?	**Response Count**	**Response Percent**	**p-value (X2)**
1-5	66	26.72%	0.000
6-10	35	14.17%	
11-15	26	10.53%	
16-20	22	8.91%	
21-25	19	7.69%	
26-30	5	2.02%	
I do not know, can not specify	34	13.77%	
Nothing	40	16.19%	
Answered question	**247**		
Skipped question	**0**		

Direction of sending the Pharmacogenomic results?	Response Count	Response Percent	p-value (X2)
The Ministry of Health (MOH).	84	34.15%	
The Saudi food and drug Authority	62	25.20%	
Drug company	96	39.02%	
Prescriber	48	19.51%	
Pharmacist	70	28.46%	
Pharmaceutical company	64	26.02%	
Answered question	**246**		
Skipped question	**1**		

Table 7. Factors (average scores) influencing the physician's pharmacogenomics practice

		Physician's pharmacogenomics practice						
	Factors	**N**	**Average scores**	**Std. D**	**Median**	**Lower Bound**	**Upper Bound**	**P-value**
Region	Central	139	2.9523	.81396	2.9286	2.8158	3.0888	0.429
	North	23	3.0266	.93645	2.7857	2.6216	3.4315	
	South	28	2.8336	.81196	2.7143	2.5187	3.1484	
	East	24	3.2042	.88380	2.9286	2.8310	3.5774	
	West	18	3.2421	.84520	3.1071	2.8218	3.6624	
	Total	232						
Site of works	MOH Hospitals	51	3.1404	1.10213	3.0000	2.8304	3.4504	0.136
	Military hospitals	13	2.9129	.80531	2.6429	2.4263	3.3996	
	National Guard Hospital	17	2.3403	.69736	2.5000	1.9818	2.6989	
	Security forces hospitals	12	3.3027	.75660	2.8874	2.8219	3.7834	
	University hospital	35	2.9771	.81711	2.7857	2.6964	3.2578	
	MOH primary care centres	10	3.2813	.86147	2.9643	2.6651	3.8976	
	Private hospitals	84	2.9789	.64069	2.9286	2.8398	3.1179	
	Private ambulatory care clinics	4	2.8530	.13364	2.8489	2.6404	3.0657	
	Private primary healthcare centre	6	3.0815	1.01224	3.0357	2.0192	4.1438	
	Total	232						
Age	24–35	154	2.9718	.82642	2.8571	2.8402	3.1033	0.377
	36–45	51	2.9020	.75159	2.9286	2.6906	3.1133	
	46–55	20	3.3786	.94792	3.1429	2.9349	3.8222	
	> 55	7	3.0510	1.18932	2.7857	1.9511	4.1510	
	Total	232						
Gender	Male	82	3.0575	.90653	2.8571	2.8583	3.2567	0.396

	Female	150	2.9591	.79726	2.8571	2.8305	3.0878	
	Total	232						
Physician Qualification	Intern	52	2.8173	.70649	2.8929	2.6206	3.0140	0.491
	Resident	60	3.1349	.90969	2.9286	2.8999	3.3699	
	General Practitioner	48	2.8536	.82045	2.8159	2.6154	3.0918	
	Specialist	52	3.0843	.82514	2.8571	2.8546	3.3140	
	Consultant	20	3.1316	.93420	2.9643	2.6944	3.5688	
	Total	232						
Physician specialties	Critical Care	26	2.8324	1.05790	2.6429	2.4051	3.2597	0.263
	Emergency	30	3.2141	.79899	3.0000	2.9158	3.5124	
	Medical	57	2.8288	.73637	2.7857	2.6334	3.0242	
	Surgical	29	2.8740	.71012	2.8462	2.6039	3.1441	
	Paediatrics	32	3.1511	.92612	2.9286	2.8172	3.4850	
	Anaesthesia	16	3.0124	.74276	2.7060	2.6166	3.4081	
	Psychiatry	16	2.7232	.38233	2.8214	2.5195	2.9269	
	Obstetrics and Gynaecology	4	2.6429	1.26974	2.7857	.6224	4.6633	
	Family medicine	20	3.1006	.92992	2.9286	2.6654	3.5358	
	Ambulatory care	11	3.4471	.89359	3.4286	2.8467	4.0474	
	Total	241						
Position	Director of medical departments	40	2.7411	.77956	2.7500	2.4918	2.9904	0.066
	Assistant director of the medical department	49	2.8844	.72873	2.7857	2.6751	3.0937	
	Supervisor	81	2.9812	.82366	2.9286	2.7991	3.1633	
	Physician staff	76	3.2065	.92988	3.0714	2.9940	3.4190	
	Total	246						
Experiences	< 1	48	3.0361	.79186	3.0000	2.8061	3.2660	0.018
	1-3	95	2.9426	.81776	2.7857	2.7760	3.1092	
	4-6	51	2.9128	.82189	2.7857	2.6817	3.1440	
	7-9	23	2.9303	.82155	2.8571	2.5750	3.2855	
	> 9	15	3.5571	1.04568	3.5714	2.9781	4.1362	
	Total	232	3.0361	.79186	3.0000	2.8061	3.2660	

Table 8: Multiple regression of Factors with the physician's Pharmacogenomics practice [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)	.237 [b]	.056	1.566	.111 [b]	2.520	0.313		8.062	0.000	1.904	3.136		
	Location					0.048	0.041	0.078	1.177	0.241	-0.033	0.129	0.959	1.043

	Site of work					-0.013	0.023	-0.041	-0.585	0.559	-0.059	0.032	0.880	1.137
	Age (years)					0.047	0.084	0.043	0.557	0.578	-0.118	0.211	0.702	1.425
	Physician gender					-0.127	0.116	-0.073	-1.093	0.276	-0.356	0.102	0.958	1.044
	Physician Qualifications					0.034	0.050	0.051	0.676	0.500	-0.064	0.131	0.737	1.357
	Physician Specialties					0.020	0.022	0.061	0.893	0.373	-0.024	0.064	0.895	1.118
	Current Position					0.142	0.051	0.184	2.804	0.005	0.042	0.242	0.979	1.021
	Years of experiences					0.007	0.058	0.010	0.122	0.903	-0.108	0.122	0.696	1.436

[a]: Dependent Variable: physician's Pharmacogenomics practice, 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)	2.520	-0.020	0.318	0.001	1.904	3.128
	Location	0.048	-0.004	0.043	0.254	-0.049	0.128
	Site of work	-0.013	-0.001	0.026	0.594	-0.065	0.038
	Age (years)	0.047	0.004	0.093	0.613	-0.127	0.246
	Physician gender	-0.127	0.006	0.123	0.306	-0.362	0.121
	Physician Qualifications	0.034	0.002	0.045	0.440	-0.058	0.121
	Physician Specialties	0.020	0.000	0.024	0.405	-0.027	0.062
	Current Position	0.142	0.005	0.054	0.007	0.038	0.253
	Years of experiences	0.007	-0.001	0.060	0.896	-0.116	0.128

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

The average score of the item "Physician's practice of pharmacogenomic services" was 2.99, with high scores obtained for the element pharmacogenomics services in the pharmacy (3.16), with statistically significant differences between the responses ($p<0.001$). Moreover, the score for the item pharmacogenomics services competency was 3.08, with statistically significant differences between the responses ($p=0.135$). In contrast, the lowest score was obtained for the vision of pharmacogenomic services (2.67) and mission of pharmacogenomic services (2.90), with statistically significant differences between responses ($p<0.001$) (Table 3). Most of the pharmacogenomic services were requested for the following medications: antiplatelet (125 (50.61%)), followed by antidepressants (113 (46.31%)), and antipsychotics (101 (40.06%)) (Table 4). Most of the responses of Pharmacogenomic Services aspects were statistically significant ($p<0.05$). However, four items, including policies and procedures of pharmacogenomic services ($p=0.229$), competencies of pharmacogenomics services ($p=0.135$), quality management of pharmacogenomics services ($p=0.194$), and pharmacogenomics and medications errors system element ($p=0.136$) (Table 3). The highest score for the element pharmacogenomics (to authorities) is the responsibility of healthcare professionals was obtained for doctors (3.7) and pharmacists (3.55). In contrast, the lowest score was obtained for nurses (2.93), with statistically significant differences between responses ($p<0.05$) (Table 5). Despite pharmacogenomics test observed/requested daily was (1–5) 66 (26.72%)) and (6–10) was 35 ((14.17%)); less than half 100 (40.65%) only of physicians requested pharmacogenomics test, only 79 (31.98%) of pharmacogenomics tests available at their institution, and 101 (40.89%) if the institution has an association with a pharmacogenomics tests site with statistically significant differences between answers ($p<0.05$). Most reports of the pharmacogenomics results were sent to drug company (96 (39.02%)) and Ministry of Health (84

(34.15%)) (Table 6). The scores obtained for single-test reliability analysis of McDonald's ω was 0.843, Cronbach's α was 0.809, Gutmann's λ2 was 0.845, and Gutmann's λ6 was 0.848.

Factors influencing the physician's pharmacogenomics practice

Numerous factors might affect the pharmacogenomics practice by physicians. Using independent samples, the Kruskal-Wallis test and Bonferroni correction for multiple tests adjusted for significant values, and the results are as follows. All factors such as location, worksite, physician age, physician gender, physician qualifications, and position held in medical career did not influence the physician's pharmacogenomics practices, or the barriers prevent implementing pharmacogenomics in medical care with non-statistically significant differences ($p>0.05$). However, five levels of work experience affected the pharmacogenomics practice by physicians, with statistically significant differences ($p=0.018$), there is no group of experiences affected more than others with further analysis due to low sample size (Table 7).

The relationship between the physician's pharmacogenomics practice and factors affecting it such as the location, worksite, age (years), gender, qualifications, specialties, years of experience in the medical career, and position held. According to the results of multiple regression analysis and measured the physician's pharmacogenomics practice dependent variable, and factors were measured as an expletory variable. There was a weak relationship ($R = 0.237$; $p=0.111$) between physician's pharmacogenomics practice and aforementioned factors. All the aforementioned factors were nonsignificant ($p>0.05$). However, only a single factor that is, physician's current position explained an 18.4% positive relationship to the variation in the physician's pharmacogenomics practice with a statistically significant difference ($p=0.005$) through multiple regression analysis and Bootstrap model. The relationship was verified by the nonexistence of multi-collinearity with the physician's current position with factor Variance Inflation Factor (VIF=1.021) less than 3 or 5 [23-25] (Table 8).

Discussion

The practice of pharmacogenomics services reflected the knowledge background of physicians [5,6,9,14,26,27,28]. Therefore, it is necessary to analyze the practice of pharmacogenomics services from the various perspectives. The general aspect of pharmacogenomics such as vision, mission, policies, and procedures. Moreover, the type of medications needed for pharmacogenomics services. In this study, we conducted an electronic survey of pharmacogenomics practice. Most of the responders were physicians from different regions, emphasizing the central region because data collectors practice in the same area [9]. Most of the responders were residents or interns with less work experience as they had time to participate in research. The results of this study showed that there was medium positive correlation between age and physician's qualification and work experience. This result was expected because physicians are getting older positive for age ratio by increasing qualifications and experience.

Like previous studies, the average score of pharmacogenomics practice in this study was found to be insufficient at various healthcare organizations [5,6,9]. The elements with highest score were implementation of pharmacogenomics practice at pharmacy services and pharmacogenomics competency. This is reflected by clinicians who have conducted pharmacogenomics through pharmacy services. However, most of the physicians were unaware of the foundation of pharmacogenomic services, including the vision, mission, or annual and strategic plans of the services. In addition, most of the physicians requested pharmacogenomics tests for those medications that were unnecessary or controversial, for example, antiplatelet medications, antidepressants, and antipsychotics, which is different from the results of previous study [9].

On the contrary, the physicians did not request the essential medicines required of pharmacogenomics tests such as anti-HIV and anticoagulant drugs [3,9]. They might be unfamiliar with the medications needed for pharmacogenomics tests or the medications are not practiced at their specialty. This study showed a statistically significant difference between the responses, either positive or negative. However, four aspects of pharmacogenomics practice did not show any difference between the responses. For instance, pharmacogenomics policies and procedures, pharmacogenomics competencies, pharmacogenomics quality management, and medications errors. Therefore, Physicians may not be aware of the questions or accurately reflect the weakness of practice among physicians practicing or not practicing pharmacogenomics. Despite conflicting among physicians practicing pharmacogenomics answers. They insisted that pharmacogenomics services be held accountable by physicians first and then responsibility was followed by pharmacists, which was the same as in previous studies [5]. Suppose the well-trained pharmacist on pharmacogenomics services should be accountable for it. Almost one-third of the responders did not request a pharmacogenomics test. Moreover, one-third of the healthcare institutions had pharmacogenomics test available at their facility. In addition, one-third of the physicians collaborated with other healthcare organizations to make pharmacogenomics tests. This is reflected in the fact that most clinicians have insufficient practices or conflicting answers to the practice of

pharmacogenomics. More than one-third of the responders send the results of pharmacogenomics test to the drug company, whereas one-third of the responders send the results to Ministry of Health because there are no clear policies and procedures for the practice of pharmacogenomics services. All factors, including geographic location, worksite, physician's age, specialties, years of experience, and career positions in medical practice did not affect the pharmacogenomics services practice. However, only positions might change the pharmacogenomics practice positively, and this is related to the healthcare leaders encourage and lead positive changes in the medical practice.

Limitations

This study has some benefits; however, it also has some limitations. First, the study had a small sample size that did not reach optimal size. There were differences in location, age group, gender, and number of years of experience. Therefore, we highly recommend future studies to fill this gap.

Conclusion

The physician's practice of pharmacogenomics services was inadequate in the Kingdom of Saudi Arabia. There were no factors that affected or changed the physician's practice. The review of the foundations of pharmacogenomics services. We suggest that the vision, mission, and policies and procedures of pharmacogenomics should be revised. Moreover, pharmacist involvement in pharmacogenomics services is highly recommended in the Kingdom of Saudi Arabia.

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REFERENCES

1. Haidar CE, Hoffman JM, Johnson SG. ASHP statement on the pharmacist's role in clinical pharmacogenomics. Am J Heal Pharm. 2015;72(7):579–81.
2. Sheean. Facilitating Clinical Implementation of Pharmacogenomics. Bone. 2013;23(1):1–7.
3. Shastry BS. Pharmacogenetics and the concept of individualized medicine. Pharmacogenomics J. 2006;6(1):16–21.
4. Lee SY, McLeod HL. Pharmacogenetic tests in cancer chemotherapy: What physicians should know for clinical application. J Pathol. 2011;223(1):15–27.
5. Daniel E Shumer NJNNPS. Clinician Perspectives on Using Pharmacogenomics in Clinical Practice. Physiol Behav. 2017;176(12):139–48.
6. Sauver JLS, Bielinski SJ, Olson JE, Bell EJ, Greeb MEM, Jacobson DJ, et al. Integrating pharmacogenomics into clinical practice: promise vs. reality. Am J Med. 2016;129(10):1093–9.
7. American Society of Health-System Pharmacists. ASHP guidelines on a standardized method for pharmaceutical care. Am J Heal Pharm [Internet]. 1996;53(14):1713–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8827240
8. Topol EJ. Pharmacy benefit managers, pharmacies, and pharmacogenomic testing: Prescription for progress? Vol. 2, Science Translational Medicine. 2010.
9. Johansen Taber KA, Dickinson BD. Pharmacogenomic knowledge gaps and educational resource needs among physicians in selected specialties. Pharmgenomics Pers Med. 2014;7(1):145–62.
10. Algahtani M. Knowledge, perception, and application of pharmacogenomics among hospital pharmacists in Saudi Arabia. Risk Manag Healthc Policy. 2020; 13:1279–91.
11. Jarrar Y, Mosleh R, Hawash M, Jarrar Q. Knowledge and attitudes of pharmacy students towards pharmacogenomics among universities in Jordan and west bank of Palestine. Pharmgenomics Pers Med. 2019; 12:247–55.
12. Karas Kuželički N, Prodan Žitnik I, Gurwitz D, Llerena A, Cascorbi I, Siest S, et al. Pharmacogenomics education in medical and pharmacy schools: Conclusions of a global survey. Pharmacogenomics. 2019;20(9):643–57.
13. Muzoriana N, Gavi S, Nembaware V, Dhoro M, Matimba A. Knowledge, Attitude, and Perceptions of Pharmacists and Pharmacy Students towards Pharmacogenomics in Zimbabwe. Pharmacy. 2017;5(4):36.
14. Alzoubi A, Kanaan H, Alhazaimeh D, Gharaibeh S, Mukattash TL, Kheirallah K. Knowledge, attitude, future expectations and perceived barriers of medical students and physicians regarding pharmacogenomics in Jordan. Int J Clin Pract [Internet]. n/a(n/a):e13658. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/ijcp.13658
15. Peterson JF, Field JR, Shi Y, Schildcrout JS, Denny JC, McGregor TL, et al. Attitudes of clinicians following large-scale pharmacogenomics implementation. Pharmacogenomics J. 2016;16(4):393–8.

16. Gallipani A, Cope R, Fischetti B, Abraham S, Ankireddypalli A. Prescriber Attitudes Toward Implementation of Pharmacogenomic Testing in a Family Medicine Residency Program. PRiMER. 2018; 2:1–6.
17. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Vol. 35, Indian Journal of Psychological Medicine. 2013. p. 121–6.
18. Pourhoseingholi MA, Vahedi M, Rahimzadeh M. Sample size calculation in medical studies. Gastroenterol Hepatol from Bed to Bench. 2013;6(1):14–7.
19. G.Ezhumalai. How big a sample do I need require? Ann SBV. 2017;6(1):39–41.
20. Johnson TP, Wislar JS. Response rates and nonresponse errors in surveys [Internet]. Vol. 307, JAMA - Journal of the American Medical Association. 2012. p. 1805–6. Available from: http://www.aapor.org/Standard_Definitions2.htm.
21. Erik von Elm, Douglas G. Altman, Matthias Egger, Stuart J. Pocock, Peter C. Gøtzsche JPV. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. PLoS Med [Internet]. 2007;4(10):1623–7. Available from: http://www.epidem.com/
22. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies [Internet]. Vol. 370, www.thelancet.com. 2007. Available from: www.plosmedicine.org
23. Liao D, Valliant R. Variance inflation factors in the analysis of complex survey data. Surv Methodol. 2012;38(1):53–62.
24. Akinwande MO, Dikko HG, Samson A. Variance Inflation Factor: As a Condition for the Inclusion of Suppressor Variable(s) in Regression Analysis. Open J Stat. 2015;05(07):754–67.
25. Thompson CG, Kim RS, Aloe AM, Becker BJ. Extracting the Variance Inflation Factor and Other Multicollinearity Diagnostics from Typical Regression Results. Basic Appl Soc Psych. 2017;39(2):81–90.
26. Abdela OA, Bhagavathula AS, Gebreyohannes EA, Tegegn HG. Ethiopian health care professionals' knowledge, attitude, and interests toward pharmacogenomics. Pharmgenomics Pers Med. 2017; 10:279–85.
27. Rahma AT, Elsheik M, Elbarazi I, Ali BR, Patrinos GP, Kazim MA, et al. Knowledge and attitudes of medical and health science students in the united arab emirates toward genomic medicine and pharmacogenomics: A cross-sectional study. J Pers Med. 2020;10(4):1–13.
28. Kim WY, Kim HS, Oh M, Shin JG. Survey of physicians' views on the clinical implementation of pharmacogenomics-based personalized therapy. Transl Clin Pharmacol. 2020;28(1):34–42.