Nurses' Knowledge of Pharmacogenomics Services in Saudi Arabia

Mohamed Soliman Imam, Bcs. Pharm, MSc. Clin Pharm
Department of Clinical Pharmacy, College of Pharmacy, Shaqra University, Shaqra, SAUDI ARABIA.
Department of Clinical Pharmacy, National Cancer Institute, Cairo University, Fom El Khalig Square, Kasr Al-Aini Street, Cairo, EGYPT.

Yousef Ahmed Alomi*, BSc. Pharm, MSc. Clin Pharm, BCPS, BCNSP, DiBA, CDE,
Critical Care Clinical Pharmacists, TPN Clinical Pharmacist, Freelancer Business Planner, Content Editor and Data Analyst, Riyadh, SAUDI ARABIA.

Manar Alzahrani, Pharm D
College of Pharmacy, Princess Nourah bint Abdulrahman University, Riyadh, SAUDI ARABIA.

Hatim Thamer Awad Alotibi, Pharm D
College of Pharmacy, Shaqra University, Shaqra, SAUDI ARABIA.

Salem Fahad Alanazi, Pharm D
College of Pharmacy, Shaqra University, Shaqra, SAUDI ARABIA.

Meshari Abdullah Saad Alosaimi, Pharm D
College of Pharmacy, Shaqra University, Shaqra, SAUDI ARABIA.

Abdulmjeed Sweed Alosimi, Pharm D
College of Pharmacy, Shaqra University, Shaqra, SAUDI ARABIA.

Correspondence:
Dr. Yousef Ahmed Alomi, BSc. Pharm, MSc. Clin Pharm, BCPS, BCNSP, DiBA, CDE Critical Care Clinical Pharmacists, TPN Clinical Pharmacist, Freelancer Business Planner, Content Editor and Data Analyst, P.O.BOX 100, Riyadh 11392, SAUDI ARABIA.

E-mail: yalomi@gmail.com

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ABSTRACT

Objectives: To explore the nurse's basic knowledge of Pharmacogenomics services in Saudi Arabia. **Materials and Methods:** It analyzes a cross-sectional survey discussing the nurses' basic knowledge of some items for pharmacogenomics services in Saudi Arabia. The survey consisted of respondents' demographic information about the assessment of pharmacogenomics services knowledge of nurses and the resources of Pharmacogenomics used by nurses. The 5-point Likert response scale system was used with closed-ended questions. The survey was validated through the revision of expert reviewers and pilot testing. Besides, various tests of the reliability of McDonald's ω, Cronbach alpha, Gutmann's λ2 and Gutmann's λ6 been done with the study. Furthermore, the data analysis of the nurses' basic knowledge of some items for pharmacogenomics services is done through the Survey Monkey system. Besides, the Statistical Package of Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP) and Microsoft Excel sheet version 16. **Results:** A total number of 396 nurses responded to the questionnaire. Of those, almost one-third responded from the central region (138 (34.85%)) and one-fifth responded from the northern region (79 (19.95%)) and Southern area (79 (19.95%)), with statistically significant differences between the provinces (p=0.000). Most of the respondents were from private hospitals (227 (57.32%)) and university hospitals (59 (14.90%)), with a statistically significant difference between working sites (p=0.000). Males responded more than females (251 (63.54%)) versus 144 (36.46%)), with statistically significant differences between all levels (p=0.000). One-quarter of responders107 (27.02%) worked at an organization with pharmacogenomics test services or associated with a Pharmacogenomics tests site 105 (26.52%). Only 103 (26.01%) had cared for any Pharmacogenomics test and 92 (23.29%) had a Pharmacogenomics request or reporting form at your institution or pharmacy, with statistically significant differences between all answers (p=0.000). The average score of basic knowledge of pharmacists about Pharmacogenomics services was (2.86). The element "interpret Pharmacogenomics testing" obtained the highest score (3.06). The aspect is "know to make treatment recommendations based on Pharmacogenomics results" (3.02). In contrast, the lowest score was obtained for "Have you ever heard about the concept of Pharmacogenomics" (2.55). The score for the element "Have you ever had a course/ attended a workshop about Pharmacogenomics" (was 2.73) and for the part "Legal provisions in the medicines act that provide for Pharmacogenomics activities" was (2.74), with a statistically significant difference between the responses (p<0.000). The most resources for Pharmacogenomics were the Colleagues/ other nurses 343 (86.84%), General Internet 311 (78.73%) and Saudi Food and Drug Authority 112 (28.35%) (Table 4). **Conclusion:** There needs to be more than just nursing knowledge of pharmacogenomics. Only a quarter of responder nurses worked with pharmacogenomics services at their healthcare facilities. The nursing knowledge required education and training plus legality provision of the pharmacogenomics services. The nursing pharmacogenomics resource was Colleagues/ other nurses. Targeting the nursing knowledge of the pharmacogenomics services foundation should be renewed thoroughly with under and post-guarded nurse staff.

Keywords: Nurses, Knowledge, Pharmacogenomics, Gene Therapy, Saudi Arabia.

INTRODUCTION

Pharmaceutical science has expanded and developed day by day with an emphasis on hospital and community pharmacy services. The old pharmacy was inpatient and outpatient pharmacy services. Besides, the intravenous administration services. Nowadays, you will find clinical pharmacy services, automated drug distribution systems, electronic prescriptions, pharmacy informatics, pharmacy artificial intelligence and pharmacogenomics. Pharmacogenomics is a new concept established in the 2000s in the United States of America.[1] It started to appear in the 2005s with epidemic infections during test investigations of the virus and oncology services and it has continued to grow in healthcare facilities.[2,3] Pharmacogenomics highly demands appropriate and effective medicines for patients without potential complications in various diseases such as infectious diseases, oncology and cardiovascular diseases.[4] In the pharmacogenomics services provided by physicians request the laboratory test for medication, the nurse withdraws the blood sample for the concerned medicines and the clinical pharmacist determines the medication needs for pharmacogenomics test and defining, avoiding and monitoring the drug-related problems before requesting the pharmacogenomics test and after receiving the medication.[5] All pharmacogenomics services team members aimed to improve patient clinical outcomes and

quality of life. Various studies have been done on the pharmacogenomics knowledge of teams, including physicians and pharmacists.[2,3,5-20] However, nursing knowledge about pharmacogenomics services is rarely found in Saudi Arabia or Arabic countries.[5,20-24] The current research aims to declare the knowledge of pharmacogenomics by nursing staff in healthcare facilities in Saudi Arabia.

MATERIALS AND METHODS

It analyzes a cross-sectional survey that discussed the nurses' basic knowledge of some items for Pharmacogenomics services in Saudi Arabia. It self-reported an electronic survey of the nurses, including nurses from internship to consultant, nurses' specialties and Saudi Arabia. Non-nurses or students, as well as non-completed, non-qualified surveys, will be excluded from the study. The survey consisted of respondents' demographic information about the Assessment of Pharmacogenomics services knowledge of nurses and the resources of Pharmacogenomics used by nurses.[1-20] The 5-point Likert response scale system was used with closed-ended questions. According to the previous literature with unlimited population size, the sample was calculated as a cross-sectional study, with a confidence level of 95% with a z score of 1.96 and a margin of error of 5%, a population percentage of 50% and a drop-out rate of 10%. As a result, the sample size will equal 380-420 with a power of study of 80%.[25-27] The response rate required for the calculated sample size is 60-70% and above.[28] The survey was distributed through social media, including applications and telegram groups of nurses. The reminder message had been sent every 1-2 weeks. The survey was validated through the revision of expert reviewers and pilot testing. Besides, various tests of the reliability of McDonald's ω, Cronbach alpha, Gutmann's λ2 and Gutmann's λ6 been done with the study. The data analysis of the nurses' knowledge of some items for pharmacogenomics services at the institution is done through the Survey Monkey system. Besides, the Statistical Package of Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP) and Microsoft Excel sheet version 16. It included a description and frequency analysis, good of fitness analysis and correlation analysis. Besides, inferential analysis of factors affecting the nurse's essential knowledge of some items for Pharmacogenomics services at institutions with linear regression. The STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guided the reporting of the current study.[29]

RESULTS

A total number of 396 nurses responded to the questionnaire. Of those, almost one-third responded from the central region (138 (34.85%)) and one-fifth responded from the northern region (79 (19.95%)) and Southern area (79 (19.95%)), with statistically significant differences between the provinces (p=0.000). Most of the respondents were from private hospitals (227 (57.32%)) and university hospitals (59 (14.90%)), with a statistically significant difference between working sites (p=0.000). Males responded more than females (251 (63.54%)) versus 144 (36.46%)), with statistically significant differences between all levels (p=0.000). Most of the responders were in the age group of 24-35 years (319 (80.76%)), with statistically significant differences between all age groups (p=0.000). Most of the nurses had bachelor nursing (306 (77.66%)) with statistically significant differences between all levels (p=0.000). Most of the responders worked as nursing staff (277 (70.66%)), with a statistically significant difference between positions (p=0.000). Most nurses had a work experience of 4-6 years (209 (52.91%)) and 6-9 years (101 (25.57%)), with a statistically significant difference between years of experience (p=0.000). Most of nurses's specialties was pediatrics (57 ((14.50%)), surgery (54 ((13.74%)) and emergency (53 ((13.49%)) with statistically significant differences between all specialties (p=0.000). One-quarter of responders107 (27.02%) worked at an organization with pharmacogenomics test services or associated with a Pharmacogenomics tests site 105 (26.52%). Only 103 (26.01%) had cared for any Pharmacogenomics test and 92 (23.29%) had a Pharmacogenomics request or reporting form at your institution or pharmacy, with statistically significant differences between all answers (p=0.000). There was a medium positive correlation between age (years) and nurse's qualifications based on Kendall's tau_b (0.572) and Spearman's rho (0.588) correlation coefficients, with a statistically significant difference between the two factors (p<0.01). There was a medium positive correlation between age (years) and years of experiences based on Kendall's tau_b (0.422) and Spearman's rho (0.449) correlation coefficients, with a statistically significant difference between the two factors (p<0.01). There was a medium negative correlation between age (years) and position held based on Kendall's tau_b (0.537) and Spearman's rho (0.562) correlation coefficients, with a statistically significant difference between the two factors (p<0.01). There was a medium negative correlation between the nurse's qualifications and positions held based on Kendall's tau_b (0.593) and Spearman's rho (0.619) correlation coefficients, with a statistically significant difference between the two factors (p<0.01). (Tables 1 and 2).

Table 1: Demographic, social information.

Nationality	Response Count	Response Percent	*p*-value (X2)
Central area	138	34.85%	0.000
North area	79	19.95%	
South area	79	19.95%	
East area	68	17.17%	
West area	32	8.08%	
Answered question	396		
Skipped question	0		
Site of work	**Response Count**	**Response Percent**	***p*-value (X2)**
MOH Hospitals	18	4.55%	0.000
Military Hospitals	41	10.35%	
National Guard Hospital	5	1.26%	
Security Forces Hospitals	30	7.58%	
University Hospital	59	14.90%	
MOH Primary Care Centers	6	1.52%	
Private Hospitals	227	57.32%	
Private Ambulatory Care Clinics	6	1.52%	
Private Primary Healthcare Center	4	1.01%	
Answered question	396		
Skipped question	0		
Gender	**Response Count**	**Response Percent**	
Male	251	63.54%	0.000
Female	144	36.46%	
Answered question	395		
Skipped question	1		

Age	Response Count	Response Percent	
24–35	319	80.76%	0.000
36–45	60	15.19%	
46–55	11	2.78%	
> 55	5	1.27%	
Answered question	395		
Skipped question	1		

Table 2: Demographic, social information.

Nurses Qualifications	Response Count	Response Percent	*p*-value (X2)
Diploma	17	4.31%	0.000
Bachelor nursing	306	77.66%	
Master	52	13.20%	
Ph D	19	4.82%	
Answered question	394		
Skipped question	2		
Position Held	**Response Count**	**Response Percent**	
Director of the Nursing Department	25	6.38%	0.000
Assistant director of nursing department	27	6.89%	
Supervisor	63	16.07%	
Nursing staff	277	70.66%	
Answered question	392		
Skipped question	4		
Years of experience in a nursing career	**Response Count**	**Response Percent**	
<1	6	1.52%	0.000
1-3	59	14.94%	
4-6	209	52.91%	
6-9	101	25.57%	
>9	20	5.06%	
Answered question	395		
Skipped question	1		
The practice area	**Response Count**	**Response Percent**	
Critical Care	32	8.14%	0.000
Emergency	53	13.49%	
Medical	42	10.69%	
Surgical	54	13.74%	
Pediatrics	57	14.50%	
Anesthesia	47	11.96%	
Psychiatry	39	9.92%	
Obstetric and Gynecology	27	6.87%	
Family medicine	25	6.36%	
Ambulatory care	16	4.07%	
General	1	0.25%	
Answered question	393		
Skipped question	3		
Have you ever cared any Pharmacogenomics test?	**Response Count**	**Response Percent**	***p*-value (X2)**
Yes	103	26.01%	0.000
No	216	54.55%	
I do not know	77	19.44%	
Answered question	396		
Skipped question	0		
Are Pharmacogenomics tests available at your institution?	**Response Count**	**Response Percent**	
Yes	107	27.02%	0.000
No	198	50.00%	
I do not know	91	22.98%	
Answered question	396		
Skipped question	0		
Does your institution have an association with a Pharmacogenomics test site?	**Response Count**	**Response Percent**	
Yes	105	26.52%	0.000
No	200	50.51%	
I do not know	91	22.98%	
Answered question	396		
Skipped question	0		
Do you have a Pharmacogenomics request or reporting form at your institution or pharmacy?	**Response Count**	**Response Percent**	
Yes	92	23.29%	
No	219	55.44%	
I do not know	84	21.27%	
Answered question	395		
Skipped question	1		

The average score of basic knowledge of pharmacists about Pharmacogenomics services was (2.86). The element "interpret Pharmacogenomics testing" obtained the highest score (3.06). The aspect is "know to make treatment recommendations based on Pharmacogenomics results" (3.02). The element "know the ethical tool of Pharmacogenomics testing" was (2.96). In contrast, the lowest score was obtained for "Have you ever heard about the concept of Pharmacogenomics" (2.55). The score for the element "Have you ever had a course/attended a workshop about Pharmacogenomics" (was 2.73) and for the part "Legal provisions in the medicines act that provide for Pharmacogenomics activities" was (2.74), with a statistically significant difference between the responses ($p<0.000$). All aspects of Pharmacogenomics assessment of knowledge were statistically significant between responses ($p<0.000$) (Table 3). The most resources for Pharmacogenomics were the Colleagues/ other nurses 343 (86.84%), General Internet 311 (78.73%) and Saudi Food and Drug Authority 112 (28.35%) (Table 4). The score for single-test reliability analysis of McDonald's ω was 0.930, Cronbach's α was 0.930, Gutmann's was λ2, 0.931, Gutmann's λ6 was 0.938 and Greater Lower Bound was 0.960 with statistically significant ($p<0.05$).

Table 4: Pharmacogenomics assessment of knowledge.

No		76-100% of knowledge		51-75%		25-50%		< 25%		We do not have it		Total	Weighted Average	*p*-value (X2)
1	Have you ever heard about the concept of Pharmacogenomics?	8.59%	34	40.40%	160	42.42%	168	5.05%	20	3.54%	14	396	2.55	0.000
2	Have you ever had a course/attended a workshop about Pharmacogenomics?	5.81%	23	32.83%	130	47.73%	189	9.60%	38	4.04%	16	396	2.73	0.000
3	In Saudi Arabia, are there legal provisions in the Medicines Act providing Pharmacogenomics activities?	7.07%	28	30.30%	120	48.48%	192	10.10%	40	4.04%	16	396	2.74	0.000
4	In Saudi Arabia, is there a Pharmacogenomic services center?	7.09%	28	28.35%	112	48.86%	193	11.39%	45	4.30%	17	395	2.77	0.000
5	Is there an official standardized form for reporting or documenting Pharmacogenomics in Saudi Arabia?	8.12%	32	26.65%	105	48.22%	190	12.18%	48	4.82%	19	394	2.79	0.000
6	Do you know where you can get the Pharmacogenomics reporting form?	4.81%	19	22.78%	90	57.22%	226	9.62%	38	5.57%	22	395	2.88	0.000
7	How can you access, interpret and use pharmacogenomics international guidelines?	3.79%	15	24.49%	97	50.51%	200	16.41%	65	4.80%	19	396	2.94	0.000
8	Do you know the indications of Pharmacogenomics testing?	3.79%	15	24.75%	98	52.02%	206	14.90%	59	4.55%	18	396	2.92	0.000
9	Are you familiar with the medications required for Pharmacogenomics testing?	4.30%	17	23.54%	93	52.15%	206	15.95%	63	4.05%	16	395	2.92	0.000
10	Do you know how to recommend alternative drug therapy or dose change when required based on Pharmacogenomics results?	3.54%	14	25.00%	99	50.76%	201	15.66%	62	5.05%	20	396	2.94	0.000
11	Do you know how to make treatment recommendations based on Pharmacogenomics results?	3.28%	13	21.46%	85	51.26%	203	17.68%	70	6.31%	25	396	3.02	0.000
12	Do you know how to interpret Pharmacogenomics testing?	2.78%	11	18.94%	75	53.79%	213	18.18%	72	6.31%	25	396	3.06	0.000
13	Do you know the ethical tool of Pharmacogenomics testing?	3.04%	12	23.29%	92	53.92%	213	14.18%	56	5.57%	22	395	2.96	
	Answered											396		
	Skipped											0		

Table 5: The resources of the Pharmacogenomics knowledge.

No		Responses	
1	Pharmacogenomics international guidelines	86	21.77%
2	Genetic testing laboratory	72	18.23%
3	Colleagues/ other nurses	343	86.84%
4	Pharmacogenomics services inside the institution	35	8.86%
5	Healthcare institution administration guidelines	34	8.61%
6	Saudi Food and Drug Authority	112	28.35%
7	Medications package insert	40	10.13%
8	General internet	311	78.73%
9	Pharmaceutical companies	58	14.68%
10	Drug information resources (Micromedex, Lexi-comp, Epocrate,...)	188	
	Answered	395	
	Skipped	1	

Factors affecting the nurses' basic knowledge of Pharmacogenomics services

Factors affecting the perception were analyzed. We adjusted the significant values using the independent samples Kruskal–Wallis test and the Bonferroni correction for multiple tests. ***The nurse's basic knowledge about pharmacogenomics services***

Includes location, work site, age, gender and qualifications. Nurses practice area, years of experience, position held, you cared any pharmacogenomics test, pharmacogenomics tests available at your institution, The institution has an association with a pharmacogenomics tests site, presence of pharmacogenomics request or reporting form at your institution or pharmacy, The number of pharmacogenomics test. Three factors only (Site of work, Nurse qualification and the institution have an association with a Pharmacogenomics tests site) out of thirteen were statically significant released ($p<0.05$). The highest scores (3.5192) were obtained from private primary healthcare centers, with statistically significant differences among all sites ($p=0.000$). Four levels of academic qualifications affected the ***nurses' basic knowledge about Pharmacogenomics services, with the lowest score (2.5911)*** obtained for Ph. D nurses with a statistically significant difference

between all levels (p=0.000). The institution's presence is associated with a Pharmacogenomics test site with the highest score (2.9967), which affected nurses' basic knowledge about Pharmacogenomics services, with a statistically significant difference between all answers (p=0.000) (Table 5).

The relationship between the nurses' basic knowledge about Pharmacogenomics services and factors such as location, work site, Age, gender and qualifications. Nurses practice area, years of experience, position held, you cared any pharmacogenomics test, pharmacogenomics tests available at your institution, The institution has an association with a pharmacogenomics tests site, Presence of pharmacogenomics request or reporting form at your institution or pharmacy, The number of pharmacogenomics test. The multiple regression analysis considered perception as the dependent variable and factors affecting it as an expletory variable. There was a medium relationship (R=0. 491 with p=0.000) between the nurses' basic knowledge of Pharmacogenomics services and its factors. Three (Site of work, Nurse qualification and the institution have an association with a Pharmacogenomics tests site) out of thirteen were significant differences (p<0.05). The multiple regression analysis confirmed that two factors (Site of work and the institution have an association with a Pharmacogenomics tests site) explained 17.9% and 34.2%, respectively, of the positive relationship to the variation in knowledge, with a statistically significant difference (p=0.001) and (p=0.024). At the same time, one factor (Nurse qualification) explained a 39.3% negative relationship to the variation in knowledge, with a statistically significant difference (p=0.000). The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with the location factor with a Variance Inflation Factor (VIF) of 0.017, 0.074 and 0.136, respectively less than three or five as a sufficient number of VIF (Table 6).

DISCUSSIONS

Pharmacogenomics is one of the most recent and potential services for healthcare professionals and facilities.[5] That can help in the early diagnosis of certain diseases, prevent them and help choose the most cost-effective drug therapy.[4] Besides, various medication manufacturers are built based on genetic engineering.[4] Therefore, implementing pharmacogenomics requires several things, including knowledge and best practices. The pharmacogenomics services team comprises physicians, nurses and pharmacists.[5] The current research emphasizes nursing knowledge of pharmacogenomics services. It was a cross-sectional study with convenience sampling methods due to the difficulty in random sampling and the uncertainty documented in nursing distribution. The sample size is suitable based on requirements calculation with a high-reliability validation test that is better than the previous study[20,23,30] and lower than others.[24] The nursing geographic distribution was significantly different, with a higher percentage of the central area, the number of hospitals was higher than in other locations and pharmacogenomics services were probably viable. However, it might be good for various geographical regions to reflect the actual situation of pharmacogenomics nursing knowledge among multiple areas in Saudi. The majority of nurses from private hospitals have unclear reasons. The male nursing gender is higher than the female, similar to a previous study.[23] This was not expected because the number of female nurses is higher than that of male nurses due to nursing males working at private hospitals. Most nurses were young with bachelor's degrees and working staff, which was expected because new graduate nurses were more willing to participate in the survey than old graduates. However, despite being young nurses, most had more than four years of experience in previous studies,[21,24,30] which can give a more accurate picture of pharmacogenomics services with a low number of years of experience. There, nurses worked with various medical departments with statistical significance but not clinically significant and it was good to show the nurse's specialty and knowledge of pharmacogenomics. One-third of nurses cared for pharmacogenomics services, worked at healthcare institutions with pharmacogenomics tests, or associated with other hospitals with pharmacogenomics services. That is expected because pharmacogenomics services have not yet been widely implemented in healthcare organizations.

The average pharmacogenomics nursing knowledge needed to be increased, similar to previous healthcare professional studies[21,24,30] and lower than other studies.[20] However, the nursing responders had a high understanding of pharmacogenomics test interpretation, made recommendations based on the test results and were familiar with the ethical considerations of pharmacogenomics services. All previous knowledge is essential to start or continue the implementation of pharmacogenomics services. At the same time, the responders needed a better understanding of education courses on pharmacogenomics or the legal aspects of pharmacogenomics standards practice similar to previous studies.[20] That is expected because the full implementation of pharmacogenomics services is uncompleted. Besides, the nursing responses had poor knowledge of indications of pharmacogenomics tests and medicine that's required for pharmacogenomics tests and there was no standardized form of pharmacogenomics tests. Therefore, most nurses use colleagues and the general internet as initial resources for pharmacogenomics information, similar to previous studies.[24]

A few factors might affect the knowledge nursing of pharmacogenomics, such as the Site of work and institutions associated with pharmacogenomics services with other healthcare facilities affect the nursing knowledge of pharmacogenomics positively and that is expected because the results showed that private primary healthcare centers have the highest organization had high nursing knowledge. However, the conflict results from unavailable pharmacogenomics services with high knowledge scores. It was unexpected because the nurse tried to read too much and it might have been education courses despite the unavailable complete services. Nursing academic qualifications hurt nursing knowledge, as the higher degree of not practicing pharmacogenomics services and sequencing lowers knowledge of pharmacogenomics services, which is different from previous studies.[20]

Due to changes in healthcare services and new drug therapy, pharmacogenomics services are required for all healthcare facilities. However, nursing pharmacogenomics knowledge is insufficient and nurses cannot cope with new treatments and modalities. Therefore, education and training in pharmacogenomics services are highly recommended to complete the implementation of fully serviced pharmacogenomics facilities in Saudi Arabia.[20,24]

LIMITATIONS

The cross-sectional study, with a calculated appropriate sample size, various nursing qualifications and geographic nursing population distribution, provides information about nursing knowledge of pharmacogenomics. However, some limitations include unequal geographic nursing distribution, non-randomized sampling techniques and unequal nursing qualifications. Overcoming previous challenges is future targeting and further research on the same topic is warranted.

CONCLUSION

The nursing knowledge of pharmacogenomics needed to be more appropriate by cross-sectional survey with proper sample size and high-reliability test validations and only one-quarter of nursing responders participated in pharmacogenomics services. The pharmacogenomics services needed to be improved in education and training, as well as a regal aspect involved in the policy and procedures. Various demographic factors affect passive nursing responses to the survey, such as the work site and the institution's association with a pharmacogenomics

Table 6: Multiple regression of Factors with the nurses' basic knowledge of Pharmacogenomics Services.

Model						Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		R	R Square	F	Sig.	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.491[b]	.242	9.016	.000[b]	3.183	.322		9.880	.000	2.549	3.816	3.183	.322
	Location					-.036	.024	-.076	-1.534	.126	-.083	.010	-.036	.024
	Site of work					.057	.017	.179	3.308	.001	.023	.092	.057	.017
	Age (years)					.145	.069	.129	2.083	.038	.008	.281	.145	.069
	Nurses gender					-.050	.063	-.037	-.785	.433	-.174	.074	-.050	.063
	Nurses qualification					-.430	.074	-.393	-5.795	.000	-.576	-.284	-.430	.074
	Nurses specialties					.016	.012	.063	1.356	.176	-.007	.039	.016	.012
	Years of experience in a medical career					-.001	.043	-.001	-.025	.980	-.086	.083	-.001	.043
	Position Held					-.100	.047	-.137	-2.136	.033	-.192	-.008	-.100	.047
	Do you care about any Pharmacogenomics tests?					.070	.098	.075	.720	.472	-.122	.262	.070	.098
	Pharmacogenomics tests available at your institution					-.211	.134	-.236	-1.573	.117	-.475	.053	-.211	.134
	The institution is associated with a pharmacogenomics test site.					.308	.136	.342	2.269	.024	.041	.575	.308	.136
	Presence of Pharmacogenomics request or reporting form at your institution or pharmacy					.029	.070	.031	.418	.676	-.108	.166	.029	.070
	The number of Pharmacogenomics test					.025	.017	.110	1.518	.130	-.007	.058	.025	.017

a. Dependent Variable: Nurses' basic knowledge about Pharmacokinetics services, Predictors: (Constant), Location,), Site of work, Age (years, Nurses gender, Nurses qualification. Nurse practice area, Years of experience, Position Held, You cared any Pharmacogenomics test, Pharmacogenomics tests available at your institution, The institution has an association with a Pharmacogenomics tests site, Presence of Pharmacogenomics request or reporting form at your institution or pharmacy, The number of Pharmacogenomics test

Bootstrap for Coefficients							
Model		Bootstrap					
		B	Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	3.183	.032	.441	.001	2.403	4.128
	Location	-.036	.001	.024	.138	-.085	.011
	Site of work	.057	.001	.020	.006	.018	.097
	Age (years)	.145	-.003	.075	.058	-.013	.290
	Nurses gender	-.050	-.002	.064	.419	-.187	.078
	Nurses qualification	-.430	-.003	.113	.001	-.641	-.195
	Nurses specialties	.016	.000	.014	.260	-.011	.042
	Years of experience in a medical career	-.001	-.003	.054	.990	-.114	.097
	Position Held	-.100	-.003	.055	.062	-.209	.004
	Do you care about any Pharmacogenomics test	.070	-.009	.099	.456	-.134	.251
	Pharmacogenomics tests available at your institution	-.211	.006	.163	.168	-.541	.094
	The institution has an association with a Pharmacogenomics test site	.308	-.005	.147	.027	.022	.609
	Presence of Pharmacogenomics request or reporting form at your institution or pharmacy	.029	.001	.059	.598	-.087	.139
	The number of Pharmacogenomics test	.025	.001	.015	.094	-.004	.057

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

test site. However, nursing qualification had adverse effects because pharmacogenomics knowledge is new. Most nursing respondents utilized nursing colleagues and friends as resources of pharmacogenomics knowledge, which were inappropriate references. The targeting of undergraduate and postgraduate education in pharmacogenomics knowledge is warranted.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Consent for Publications

Informed consent was obtained from all the participants

Ethical Approval

This research was exempted from research and ethical committee or an institutional review board (IRB) approval.
https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html

ABBREVIATIONS

MOH: Ministry of Health; **K.S.A.:** Kingdom of Saudi Arabia; **SPSS:** Statistical Package of Social Sciences; **JASP:** Jeffery's Amazing Statistics Program; **STROBE:** Strengthening the Reporting of Observational studies in Epidemiology statement: guidelines for reporting observational studies; **VIF:** Variance Inflation Factor.

ORCID ID

https://orcid.org/0000-0003-1381-628X

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