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ORIGINAL RESEARCH

Clinical Knowledge, Attitude, and Perceptions of Community Pharmacists Towards Pharmacogenomics - A Cross-Sectional Study from Saudi Arabia

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Background and Aims: It is crucial to provide healthcare personnel with the necessary knowledge and understanding of genetic testing and pharmacogenomics. The purpose of this study is to assess the knowledge, attitudes, views, and considerations of Community pharmacists (CPs) about pharmacogenomics and genetics.

Methods and Materials: A cross-sectional web-based study was conducted among practicing pharmacists Between January and February of 2022. Participants were recruited through a convenient sampling technique. A total of 23 item questionnaires were used to assess the Knowledge Attitudes, Views, and Considerations toward Pharmacogenomics among pharmacists.

Results: The mean age of the CPs were 28.45±7.29(Std). Among the CPs, 38.4% (98 of 255) of them were correctly identified human chromosomes, and the majority of them 73.3% knew that adverse reactions can be caused by genetic changes in the human body. A total of 194 CPs agreed that certain drugs can be affected by genetic changes in the patient. In this study, one-third (33%) of the CPs were found to have good knowledge, while most (66.3%) of the CPs were found poor knowledge of pharmacogenomics and genetics. Furthermore, the knowledge score is significantly different concerning the qualification of the CPs (p=0.0001).

Conclusion: The current findings, demonstrated a majority of the CPs found a lack of knowledge and understanding regarding pharmacogenomics and its perspectives, there is a need to increase awareness among CPs to reduce the knowledge gap of pharmacogenomics and genetics.

Keywords: community pharmacist, pharmacogenomics, chromosomes, genetic changes

Introduction

Pharmacogenomics (PGx) is the study and analysis of how genetic variations affect and how the body reacts to the medication. It entails the application of genetics to pharmacology.[1] The interaction of drugs with their molecular targets is caused by genetic variation, furthermore, pharmacogenomics has the potential to enhance drug dosing and avoid adverse drug reactions.[2,3] More than 350 medications have so far been added to the United States Food and Drug Administration's (USFDA) library and labeled before administration.[4] These mostly comprise potentially toxic medications with a narrow therapeutic index.[5–7]

Despite the known role of genetic differences in drug reactions, clinical implementation has been slow due to health professionals' inadequate understanding and awareness of genomics is one of the reasons only.[7] Education of health professionals is crucial both at the undergraduate level and in continuing education, as pharmacogenomics applications become more widely used. Pharmacy professionals are in a perfect position to play a crucial part in the clinical application of pharmacogenomics because of their considerable knowledge of pharmacology and pharmacotherapy.[7,8] In addition, Pharmacists have the power to encourage trainers, clinical advisors, and medical professionals about the significance of PGx in healthcare.[7,8]

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Pharmacogenetics, in its broadest sense, is the study of how variations in a single gene can affect variability in the body's response to a specific stimulus.[9] Changes in these genes can affect how medicines function, making them more effective or helping to predict which patients are more likely to suffer side effects. Pharmacogenomics, on the other hand, is the study of how a patient's genome can influence how patients respond to medications.[9]

The literature revealed that pharmacists with PGx training have improved medication compliance among patients. They aid in the selection of medication therapy, patient counseling, and genetic testing for better treatment outcomes.[10,11] Although affluent countries like the USA and countries in Europe are implementing PGx training among pharmacists.[11] On the other hand, prior research has confirmed that pharmacists in Australia have inadequate of PGx knowledge[12] and that Zimbabwe has few tools for raising awareness.[13] A systematic review in 2015 revealed that PGx knowledge had increased from 38% in 2005 to more than 50% in several countries by 2013. Furthermore, previous findings showed that pharmacists had a good attitude but insufficient understanding and behavior of PGx.[7] Similarly, another study in the United States, revealed that CPs had a positive attitude toward PGx, and the majority of them believed it would reduce adverse events and improve drug dosing.[3]

Additionally, a recent study in Australia, found that the majority of pharmacists do not think they are qualified to advise patients regarding pharmacogenetics testing.[12] Additionally, a study carried out in Indonesia discovered that CPs had higher awareness levels than those working in hospital settings.[14] Very few studies have been published in the middle east.[9,15] For instance in a study in Qatar, where doctors and pharmacists were unaware of the uses of PGx.[15] However, PGx implementation in daily practice was seen more favorably by pharmacists than by doctors.[15] Similarly, another cross-sectional study among pharmacists working in Saudi Arabia reported a moderate to low level of knowledge of PGx.[9] However, the majority of the pharmacists in Saudi Arabia felt the need to learn more about pharmacogenomics.[9] Nevertheless, half of the hospital pharmacists stated that their hospital management is ignorant of the value of pharmacogenomics in clinical practice.[9]

Significantly, the opinions of CPs regarding PGx testing and informing patients of test results are unclear. CPs are ideal healthcare providers for advising patients about the proper use of their drugs, including the application of PGx information to further individualize patient therapy. This is in contrast to pharmacists operating in hospital settings. The creation of curricula for undergraduate, postgraduate, and pharmacy students, will identify knowledge gaps and help build capacity for PGx training. This study is special since it is one of the few studies to look into these concerns in Saudi Arabia. Therefore, the purpose of this study is to assess the knowledge, attitudes, views, and considerations of CPs about pharmacogenomics and genetics.

Materials and Methods

Study Design and Settings

A cross-sectional, study was conducted among CPs working in the capital of Saudi Arabia, (Riyadh) to assess the knowledge, attitudes, views, and considerations of CPs about pharmacogenomics and genetics. The study was conducted over 6 months, from January to June 2022. A structured, self-administered questionnaire was prepared and distributed among CPs. This study included CPs who are currently working in various community pharmacies in Saudi Arabia and are willing to provide informed consent. Before carrying out the study Ethical approval was obtained from the college of medicine, king Saud University, Riyadh, Saudi Arabia.

Study Questionnaires and Procedure

The questionnaire was adopted after a detailed review of the published literature on this topic[1,2] and was evaluated by a senior colleague with substantial experience in survey design. The questionnaire contained three sets. The first set addressed demographic variables, including age, gender, years of registration as a licensed pharmacist, and current shift or time of pharmacy. The second set consisted of knowledge related to pharmacogenomics questions, with a total of 6 items, assessed on (Yes/No/I do not know) options. The last set of questionnaires was related to Attitude, perception, and thoughts about pharmacogenomics and genomic medicine among CPs, and all these questionnaires were assessed 3- on a point Lickert scale (Agree/ disagree/ neutral). The knowledge score was calculated for each item, by assigning a 1 for the correct answer, and a 0' for the wrong and I do not know answer. Similar to previous findings[16,17] the knowledge score is further categorized into two levels good knowledge, which scores greater than 50%, and poor knowledge considered CPs, who scored less than 50% of the score.

The questionnaires were subjected to a translation procedure through forwarding and backward translation with the help of a native Arabic speaker. The prepared Arabic questionnaires were subjected to a pilot study, which was conducted among randomly selected CPs (n=30) to examine the readability and difficulty of the questionnaire before administering it. The results of the pilot study were not included in the main study. The Cronbach's alpha scores for the knowledge and attitudes, of pharmacogenomics, were 0.66 and 0.79, respectively.

A convenient sampling technique was used to collect the data from the CPs. Data was collected using google forms. Before proceeding to the questionnaire, there was a statement about the objective of the study and informed consent, who agreed and proceed to the survey were included in the study. Furthermore, CPs were given adequate time to complete the questionnaire. For data collection, a researcher (who has extensive experience in data collection) was appointed from the College of pharmacy to follow up with CPs. Moreover, the study protocol and questionnaires were reviewed by an ethical committee from the College of Medicine, King Saud University, before data collection. Written informed consent was obtained from the participants, and the participants were assured that the data would be used only for research and that confidentiality would be maintained throughout the study.

Statistical Analysis

The collected data was analyzed using the IBM SPSS Statistics 22 (IBM Inc., Chicago, IL, USA) software. Descriptive statistics, frequencies, and percentages were used to summarize the data. To examine the difference in the variables, univariate analysis (chi-squared test/Fisher's exact test) was utilized. All statistical tests were conducted using a 0.05 significance level.

Results

The number of questionnaires returned was 300, of which 45 (15%) were excluded from the study due to incomplete responses, leaving a total of 255 valid questionnaires and a response rate of 85%. Of the CPs, the majority of them were males 208 (81.6%) and the majority 158 (62.0%) of them were Saudis and their mean age was 28.45±7.29(Std). Slightly more than one-third of the community pharmacist 84(32.9%) had registered since <1 year as a licensed pharmacist, while most of the CPs 89(34.9%) completed between 1–5 years after their professional registration (Table 1).

Assessment of Knowledge of Pharmacogenomics in Study Subjects

Among the participants, 36.9% (94 of 255) correctly identified human chromosomes, and the majority of them 73.7% knew that adverse reactions can be caused by genetic changes in the human body. A total of 76.1% (n=194) of CPs agreed that certain drugs can be affected by genetic changes in the patient. In addition to this 67.5% of the CPs agreed that (n=172) environmental factors can affect gene expression (Table 2). In this study, the mean knowledge score was 3.717 (SD=1.581) (Range 0–6). Furthermore, one-third (32.5%) of the CPs were found to have good knowledge, while most (67.5%) of the CPs found poor knowledge of pharmacogenomics and genetics as shown in Figure 1.

Attitude, Perception, and Thoughts of Study Subjects About Pharmacogenomics and Genomic Medicine

When we ask CPs in the future, do they consider a genetic test to determine any risk of developing certain genetic diseases 56.5% (n=144) of them agreed about it, while the majority of the CPs 74.1% (n=189) reported that they would consider genetic testing as a means to choose a cancer treatment with fewer side effects if they face a cancer diagnosis (Table 3)?

When we asked to determine the desire of CPs to be involved in genomics and genetics 56.9% wanted to attend pharmacogenetics courses or seminars, while 56.1% of CPs wanted to participate in genetic research. Furthermore, half 49.8% of the CPs are interested in having genetics collected by a biobank. The majority of CPs agreed that genetic testing can be ordered online Table 3 shows the responses of CPs towards thoughts and desire for genetic testing and the availability and accessibility of genetic testing.

Table 1 Participants' Demographic Characteristics

Variables	n(%)	Mean±std
Gender		
Male	208(81.6)	
Female	47(18.4)	
Age group		28.45±7.29
Nationality		
Saudi	158(62.0)	
Non-Saudi	97(38.0)	
Qualification		
Bachelors in pharmacy	170	66.7
Masters	07	2.7
PharmD	68	26.7
Technician	10	3.9
Years have you been registered as a licensed pharmacist?		
<1 year	84(32.9)	
1–5 years	89(34.9)	
6–10 years	28(11.0)	
11–20 years	25(9.8)	
>20 years	19(7.5)	

Table 2 Knowledge of Pharmacogenomics Among Community Pharmacists

Questions	Yes n(%)	No n(%)	I Do not Know n(%)
Humans have 48 chromosomes.	95(37.3)	129(50.6)	31(12.2)*
Adverse reactions can be caused by genetic changes	188(73.7)	31(12.2)	36(14.1)
For several medications, the FDA advises pharmacogenomics testing.	159(62.4)	24(9.4)	72(28.2)
Genetic variations in the patient can have an impact on certain medications.	194(76.1)	26(10.2)	35(13.7)
Every cell of the body contains the whole genome	140(54.9)	56(22.0)	59(23.1)
Environmental factors can affect gene expression, (Nicotine smoke)	172(67.5)	43(16.9)	40(15.7)

Note: *Missing response.

The knowledge score is significantly different concerning qualification (p=0.0001). Although the knowledge score is not significantly associated with the pharmacist's gender and years of experience (p>0.005). The association between the knowledge score and community pharmacist demographics were given in Table 4.

Figure 1 Levels of knowledge.

Table 3 Attitudes, Thoughts, Desire to Participate in Genomic Medicine and PGX Research, and Availability and Accessibility of Genomic Medicine

Questions	Agree n(%)	Neutral n(%)	Disagree n(%)
In the future, I might think about getting a genetic test to find out my likelihood of contracting specific hereditary disorders.	144 (56.5)	67(26.3)	44 (17.3)
I am only interested in knowing my susceptibility to diseases that have current interventions for protection	133 (52.2)	74 (29.0)	48 (18.8)
I would think about genetic testing as a way to pick a cancer treatment that has less adverse effects after receiving a cancer diagnosis.	189(74.1)	37(14.5)	29 (11.4)
I would think about having my genes examined if my family has a history of diabetes so that I can select a therapy that has few negative effects.	157 (61.6)	46(18.0)	52(20.4)
Apart from the physician, CPs should explain genome reports to patients	172 (67.5)	54(21.2)	29(11.4)
Community pharmacists alone can explain genome report	116(45.5)	79(31.0)	55(21.6)
I am interested in attending a genetics (PGX) course or seminar	145 (56.9)	65 (25.5)	45 (17.6)
Interested in having my genetics collected by a biobank	127(49.8)	49 (19.2)	79(31.0)
I am interested in participating in genetic research	143 (56.1)	64 (25.1)	48(18.8)
The availability of genetic tests for insurance companies and the future employer is problematic	152(59.6)	68(26.7)	35(13.7)
I am glad that genetic tests available so that people with a family history of serious genetic diseases can find out if they are at risk	173(67.8)	50(19.6)	32(12.5)
I am glad that genetic tests can be ordered on the internet	143(56.1)	67(26.3)	45(17.6)

Table 4 Association Between Students' Knowledge and Demographics

Variables	Number of Respondents	Not Knowledgeable (n=172; 67.5%)	Knowledgeable (n=83 32.5%)	P value
Gender				
Male	Respondents	143	65	0.390
	% within knowledge	83.1%	78.3%	
Female	Respondents	29	18	
	% within knowledge	16.9%	21.7%	
Years of experience				
<1 year	Respondents	48	36	0.061
	% within knowledge	27.9	43.4	
1–5 years	Respondents	61	31	
	% within knowledge	35.5%	33.7%	
6–10	Respondents	22	06	
	% within knowledge	12.8	7.2%	
10–20 years	Respondents	16	47	
	% within knowledge	9.3%	10.8%	
>20 years	Respondents	16%	03	
	% within knowledge	9.3%	3.6%	
Profession				
Pharmacy technician	Respondents	09	01	<0.0001
	% within knowledge	5.2%	1.2%	
Bachelors	Respondents	126	44	
	% within knowledge	73.3%	53.0%	
PharmD	Respondents	32	36	
	% within knowledge	18.6%	43.4%	
Masters	Respondents	05	02	
	% within knowledge	2.9%	2.4%	

Discussion

To better implement pharmacotherapy services, pharmacists must adopt new technologies with continuous education in clinical practice to enhance patients –oriented health outcomes.[13] The pharmacist plays a crucial role in translating PGx into clinical practice and individualized treatment by fusing PGx with pharmacological care. According to this study, CPs in Saudi Arabia have limited-to-fair knowledge and awareness of PGx. This situation is not specific to Saudi pharmacists rather, it is a concern for the majority of healthcare professionals worldwide, as evidenced by numerous studies both nationally and internationally where reported low to moderate knowledge of the PGx.[1,7,9,18–21] For instance, a study was conducted in Saudi Arabia among hospital pharmacists, and knowledge of PGx was moderate.[7] Similar findings were found in a cross-sectional study conducted in Malaysia among physicians and pharmacists, where participants opted to learn through ongoing professional education despite having poor knowledge but a high desire towards PGx.[19] On the other hand, Pharmacists in Zimbabwe have low to moderate knowledge about PGx.[13] However, another study by Alexandrea et al, among Independent CPs reported that more than 50% of the CPs were not knowledgeable.[20] Another study by Petit et al community and hospital pharmacists reported that a total of 50% of the questions on the participants' knowledge are answered correctly, with a stepwise increase of right answers with hours of education in pharmacogenetics.[21] Therefore it is essentially important to educate the CPs using online lectures, workshops, and patient case studies, these methods of education to the CPs were found to have an improvement in their knowledge and competence in pharmacogenomics.[22]

In this study, 56.1% of the CPs were interested in participating in PGx research and 56.9% of the CPs were interested in attending a genetics (PGX) course or seminar. In addition, these findings also reported that CPs alone can explain genome reports. These results were somewhat similar to previous studies by Alexander et al among independent CPs and Petit et al among hospitals and CPs.[20,21] For instance, Alexander et al study found that pharmacists were not comfortable in making drug therapy recommendations to physicians or confident in providing counseling to patients based on results of genetic screenings without further training and education.[20] Similarly in Petit et al study pharmacists believe that pharmacogenetics will gain more room in their future practice, the overall rate of confidence in their ability to use pharmacogenetics information was low and 90.3% desire more training.[21]

Pharmacogenomics has been shown in the literature to provide prescribers with additional information on unobserved patient characteristics that affect drug response. The pharmacist is responsible for DNA sample collection for testing and discusses with the patient how their pharmacogenomics results would impact their current and potential future medications, as well as any non-genetic factors that may influence drug response.[23] Therefore, it is necessary to include more PGx-related courses and training in the pharmacy undergraduate and postgraduate programs in light of this potential role in PGx testing. PGx-related continuing medical education programs must be developed for currently practicing pharmacists. To successfully adopt PGx in the Saudi healthcare system, education and training reform is a critical step.

In this study, 62.4% of the CPs agreed that the FDA advises pharmacogenomics testing for several medications and 76.1% of the CPs also agreed that genetic variations in the patient can have an impact on certain medications. While Papastergiou et al among Canadian community pharmacists reported that PGx is mostly indicated for ineffective therapy, to address an adverse reaction (32.6%). Furthermore, findings reported that an average of 1.3 drug therapy problems directly related to pharmacogenomic testing were identified per patient.[24] These findings from the literature confirmed the readiness of CPs to adopt pharmacogenomic screening into practice and their ability to leverage this novel technology to positively affect medication therapy management. Furthermore, community pharmacy services in providing PGx to their patients were already established in well-developed countries like the USA, Canada, the Netherlands and Cyprus, and Saudi Arabia.[10,25] Furthermore, to work well with these CPs' services, CPs need patient interest, pharmacist engagement, training, and supporting information for pharmacists, and prescriber acceptance of recommendations for any changes to patient prescriptions is needed.[25]

The knowledge score of pharmacogenomics differs significantly depending on the qualification of the CPs. The gender of the CPs, on the other hand, did not affect their knowledge of PGx. There are currently no studies that look at the relationship between PGx knowledge and CP characteristics. There have been some studies on PGx knowledge evaluation among students and pharmacists,[1,2,15] but those earlier studies did not look at the relationship between the

knowledge score and the characteristics of CPs.[1,15] The fact that professionals with a higher level of education consistently demonstrate a higher level of theoretical knowledge than their less educated colleagues. Furthermore, prior exposure to PGx during the graduation process (via a course, congress, seminar, etc.) may have influenced this situation.

However, the current findings were consistent with past studies, in which a survey of pharmacists in Saudi, Qatar, and Jordan, as well as earlier surveys of pharmacists and doctors independently, both, found that there was a limited understanding of PGx and its clinical applications.[7,15,26] This finding suggests incorporating the PGx as a part of the pharmacy curriculum in educational courses relating to pharmacy. Although this study found that most CPs had a moderate perception of the practical aspects of PGx. Such as about one-third of CPs wanted to attend pharmacogenomics courses or seminars, while 56.2% wanted to participate in genetic research. In contrast, other studies showed a more positive attitude, however, this study demonstrated that Saudi CPs are willing to see the implementation of PGx as a component of clinical care. Pharmacy professionals work in a clinical setting with strong communication between doctors, pharmacists, and allied clinical personnel (laboratory). Because of this, evaluating them provides a broad understanding of their perceptions as well as the obstacles to PGx deployment in such a context. About one-third of CPs wanted to attend pharmacogenomics courses or seminars, while 56.2% wanted to participate in genetic research.

The fact that our study is the first of its kind in Saudi Arabia to look into pharmacogenomics and genomics with the perspective of Saudi CPs as their distinctive features. Through a variety of questionnaires, the knowledge of the CPs was accessible, and it was found that the majority of them felt that genetic medicine was applicable and played a positive role in effective clinical practice and patient care. Genome explanation should also be possible for pharmacists. Particularly, the findings show a modest level of comfort with their knowledge of the term "Pharmacogenomics" and its application in personalized medicine. Future studies should evaluate the generalizability of our findings by performing a more detailed assessment of CPs, on the whole. The results of this type of assessment may enable policymakers to conduct a timely assessment of health-related problems and make recommendations accordingly.

This study has some limitations. First, because it was conducted among employed CPs in the Riyadh region of Saudi Arabia, the results of this study may not be generalizable to other regions and thus cannot be generalized. Second, because of the nature of the self-administration, of the survey which may increase bias, particularly in the knowledge assessment. Thirdly this study was limited to the Riyadh region only, therefore the sample of the CPs may not be representatives of the whole pharmacist working in the city, last, the women pharmacist responses also another limitation, since more recently in Saudi Arabia female pharmacists were allocated to work in the community setting. Pharmacogenomics is remarkable and will be a significant topic of research in the future, thus some of the essential measures that must be addressed include integrating full-time pharmacogenomics courses into the pharmacy curriculum and continuing education modules for working pharmacists.

Conclusions

The current findings demonstrated a CPs in Riyadh found a lack of knowledge and understanding regarding pharmacogenomics and its perspectives, Furthermore, the knowledge was significantly associated with the qualification of the CPs. Most of the CPs revealed interest in pharmacogenomics and genetics courses and seminars too, in addition to half of the CPs. There is a need to increase awareness among CPs to reduce the knowledge gap between pharmacogenomics and genetics. Finding the most effective and practical approaches to improve pharmacists' comprehension of this subject may be possible with the help of our research.

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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Disclosure

The authors declare no conflict of interest.

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