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UNLOCKING PHARMACOGENOMICS: EVALUATING THE EXPERTISE AND PERSPECTIVES OF HEALTHCARE PROFESSIONALS IN LAHORE

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Abstract:
Pharmacogenomics, the study of how genes affect a person's response to drugs, reveals distinct levels of knowledge, attitudes, and practices among physicians and pharmacists. Improved patient outcomes can be achieved through enhanced knowledge, positive attitudes, and effective practices by healthcare professionals.

This study investigates the knowledge, attitudes, and practices of pharmacogenomics among physicians and pharmacists in Lahore. A cross-sectional survey, conducted in 2024, employed a validated self-administered questionnaire based on published literature. Data analysis involved descriptive statistics and t-tests to compare the responses.

Out of 374 participants, equally divided between physicians and pharmacists, differences in knowledge were observed, yet both groups exhibited positive attitudes and interest in pharmacogenomics practices. The study highlights the need to bolster pharmacogenomics education in Lahore's medical curricula and to provide specialized learning resources for clinicians and pharmacists. Both groups demonstrated a strong interest in increasing their pharmacogenomics knowledge.

Keywords: KAP, pharmacogenomics, physician, pharmacist, cross-sectional, genetics, Lahore

Introduction

Pharmacogenomics (PGX) studies genetic variants influencing drug effects through alterations in pharmacokinetics or pharmacodynamics, aiming to optimize medication choices and dosages for individual patients, falling under precision medicine's scope (1).

Genes, the DNA-encoded instructions for protein synthesis, vary among individuals, affecting physical traits and drug responses (2). Genes are transcribed into mRNA, which ribosomes translate into proteins, including liver enzymes that modify drug compositions. Variations in these enzymes, such as CYP2D6, can significantly alter drug metabolism and effectiveness (3).

Individual responses to medications are influenced by factors such as genetics, environment, nutrition, age, lifestyle, and health status. Understanding genetic makeup is essential for developing personalized, safer, and more effective medications, reducing adverse drug reactions (ADRs) and ensuring quick recovery (4).

ADRs are a significant cause of hospitalization and fatalities in the U.S., with genetic profiling potentially preventing many death. Pharmacogenomics reduces healthcare costs by decreasing ADRs, failed drug trials, approval times, and the physical impact of diseases through early detection (4).

The FDA monitors drug safety and includes PGX information for about 200 medications, guiding doctors on dosing and side effects based on genetic makeup. Pharmacists play a crucial role in PGX testing, ensuring optimal drug selection and dosing, and collaborating with healthcare professionals (5)

The American Society of Health-System Pharmacists (ASHP) outlined pharmacists' responsibilities in PGX, including promoting PGX testing, analyzing test data, adjusting drug regimens, educating stakeholders, and participating in PGX research. Pharmacists' ability to fulfill these roles depends on their education, experience, and practice environment (5).

"Pharmacogenetics" was coined in the 1950s to describe DNA variations causing different drug reactions, merging genetics, toxicology, and pharmacology (6) Friedrich Vogel introduced the term in 1959, with further developments by Elliott Vesell and John G. Page. Advances in the 1980s, including human gene cloning, accelerated pharmacogenetic discoveries (1).

The Human Genome Project and genome-wide variation analysis technologies have significantly advanced pharmacogenetic discoveries, with polymorphic genes like CYP2D6 being central to early findings (1).

Pharmacogenomics addresses the variability in drug responses, reducing adverse effects and ineffective treatments. A meta-analysis of U.S. hospitals found significant ADR rates, highlighting the need for personalized medicine (7)

Environmental factors, such as diet, concurrent medications, diseases, and lifestyle choices, also affect drug response genes, necessitating comprehensive pharmacogenomic approaches (7).

Ethnic differences significantly influence pharmacogenomic traits, with variations in drug-metabolizing enzymes like NAT2, CYP2D6, and CYP2C19 affecting drug responses across populations (McLeod et al., 2001). For instance, TPMT-mediated toxicity differs between Japanese, Chinese, and Caucasian populations due to genetic variation (8).

Data on the cost-effectiveness of pharmacogenomic testing is limited, but the one-time test cost is often lower than the cost of drugs and potential complications from therapy (6).

Identifying genetic variability linked to altered physiology or pathophysiology raises concerns about stigmatization (6).

Extensive education is necessary to integrate pharmacogenomics into practice. Even well-defined medications see slow adoption of PGX testing due to knowledge gaps among healthcare professionals. Proper education will help the community understand the benefits and limitations of genome-based clinical data (6).

Pharmacogenomics faces challenges like proving heritability of drug responses, defining candidate genes and pharmacokinetics, managing data, and ensuring reproducibility and statistical analysis of assay data.

Pharmacogenomic testing includes conventional methods like blood, saliva, or buccal swabs, and advanced methods involving robotics-based techniques for gene expression analysis. Technologies like fluorescence energy transfer detection, kinetic PCR, and mass spectrometry enhance genotyping efficiency (8)

Approximately 7% of FDA-approved medications are influenced by inherited pharmacogenes, affecting drug metabolism and efficacy. (9)

Genetic variations influence drug responses, with specific genes affecting medications like mercaptopurine, codeine, warfarin, and simvastatin (1).
KAP studies assess health-seeking behavior, providing insights into knowledge, attitudes, and practices regarding pharmacogenomics. These studies help evaluate healthcare delivery and are easily interpretable, though they may lack in measuring attitudes accurately (10).

Methodology:

Study Design

This study is a descriptive, cross-sectional study. Cross-sectional survey methods are used to evaluate events within a specific time period in a defined population. Due to its cost-effectiveness and shorter completion time compared to other study methods, a cross-sectional study is ideal for in-depth evaluation and identifying frequency at a certain time point.

Selection of Sample Size

A random sampling technique was employed to determine the sample. The sample size was calculated using the Raosoft sample size calculator, resulting in a target of 377 participants. Out of these, 374 questionnaires were successfully completed.

Data Collection & Study Tool

Data for the study were gathered from a variety of hospitals and pharmacies located in Lahore. The study period spanned from January to April 2024. To collect the necessary data, questionnaires were meticulously designed and distributed randomly among physicians and pharmacists throughout Lahore. These questionnaires were structured into four distinct sections. The first section focused on gathering demographic information, encompassing details such as profession, gender, experience, and age. The subsequent sections delved into the participants' understanding, attitudes, and practices regarding pharmacogenomics. Specifically, the knowledge section comprised 20 questions aimed at assessing the depth of understanding among physicians and pharmacists. Following this, the attitude section included five questions intended to gauge the participants' perspectives towards pharmacogenomics. Lastly, the practice section encompassed five questions aimed at understanding the real-world application of pharmacogenomic principles by physicians and pharmacists.

Inclusion & Exclusion Criteria

The study included individuals aged 20 years or older, comprising general physicians and pharmacists. Exclusion criteria encompassed medical students, pharmacy students, and other healthcare professionals.

Statistical Analysis

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) version 21.0 (SPSS Inc., Chicago, IL, USA). A t-test was used to compare the means of two samples, employing hypothesis testing with the null hypothesis stating no difference between group means and the alternative hypothesis indicating a difference. A p-value of < 0.05 was considered significant.
For demographics, ordinal statistics were applied to age and experience, while nominal statistics were applied to gender and profession. Nominal statistics were also used for knowledge, whereas ordinal statistics were applied to attitude and practice. Frequencies and percentages were calculated for demographic variables. For knowledge, attitude, and practice, means were calculated using descriptive statistics via SPSS-22. The data were then split by profession into physician and pharmacist groups, and a t-test was applied to determine the final results.

Results

Descriptive statistics were employed to analyze the quantitative data utilizing SPSS version 22. Mean and standard deviation calculations were conducted for categorical variables. Inferential statistics were utilized to ascertain variances between the knowledge, attitude, and practice of pharmacists and

physicians. To test the response to the null hypothesis, a t-test was administered. A significance value of $p>0.05$ was deemed statistically significant.

A. Demographics:

Total of 390 questionnaires were distributed to pharmacist and physicians randomly. Total 374 were completely filled questionnaire received yielding a response rate 95.89%. Out of 374, in Health care professional category there were 187(50%) physicians and 187(50%) were physicians. Out of 374, there were 170 males and 204 were females. Out of 374, 128 participants had experience of their respective field from 1-3 years, 114 participants had experience of their respective field from 4-6 years, 89 participants had experience of their respective field from 7-9 years and only 43 participants had experience of field 10-more than 10 years. Out of 374, 102 participants were 20-25 years old, 121 participants were 26-30 years old, 104 participants were 31-35 years old and only 46 participants were 36-40 years old. Table 3.1 describes the demographics characteristics of HCPs.

Table 1: Demographics of HCPs (n=374)

Variables	Frequency (f)	Percentage (%)
Health Care Professional		
Physician	187	50
Pharmacist	187	50
Gender		
Male	170	45.45
Female	204	54.55
Experience of field		
1-3 years	128	34.22
4-6 years	114	30.48
7-9 years	89	23.79
10-more than 10 years	43	11.49
Age		
20-25 years	102	27.27
26-30 years	121	32.35
31-35 years	104	27.80
35-40 years	47	12.56

B. Knowledge of HCPs:

The knowledge of HCPs was analyzed through descriptive analysis. Mean and standard deviation (SD) was calculated. The overall knowledge about pharmacogenomic of physicians was good but pharmacist showed very good knowledge.

Table 2: Mean and standard deviation of knowledge of physician (n=187) and pharmacist (n=187) about pharmacogenomics

Knowledge of HCPs	Physicians		Pharmacist	
	Mean	SD	Mean	SD
1. Have you ever heard about pharmacogenomics?	0.76	0.425	0.93	0.255
2. Is pharmacogenomic study of genome?	0.79	0.411	0.91	0.288
3. Do variations in person genome affect medication response?	0.34	0.476	0.92	0.272
4. Do you think Genetic determinants of drug response change over a person's lifetime?	0.72	0.452	0.75	0.435
5. Do the genetic variation account for 95% of the variability in the drug disposition effect?	0.49	0.501	0.69	0.464
6. Do you think PG testing is currently available for most of the medication in Lahore?	0.70	0.462	0.71	0.457
7. Do you know by which methods PGx testing is done?	0.35	0.479	0.59	0.493
8. Do you know for which drugs PG testing is required?	0.40	0.490	0.66	0.476
9. Is PG testing before prescribing the drugs will be helpful?	0.84	0.368	0.90	0.303
10. Do you think PG is the part of concern for fast and slow acetylators?	0.64	0.481	0.75	0.432
11. Do you think PG testing and study help in reducing ADRs?	0.69	0.464	0.89	0.317
12. Do you think PG provides sense of optimal dosing?	0.74	0.441	0.86	0.347
13. Do you think PG reduces polypharmacy?	0.71	0.457	0.83	0.373
14. Do you think PG is complying with bioethics?	0.30	0.459	0.35	0.479
15. Is PG testing required every time before prescribing drugs?	0.63	0.485	0.59	0.493
16. Is PG testing required for anticoagulants?	0.63	0.484	0.73	0.444
17. Is PG testing required for NSAIDs?	0.44	0.498	0.51	0.501

18. Is PG testing required for antidepressants?	0.67	0.470	0.71	0.454
19. Is PG testing required for anticancer?	0.76	0.425	0.89	0.301
20. Is PG testing required for antidiabetics?	0.29	0.457	0.33	0.470
Overall knowledge score	0.59	0.48	0.7255	0.402

*Very poor = 0.0-0.2, Poor =0.20-0.40, Average = 0.4-0.6, Good =0.6-0.8, Very good= 0.8-1.0

C. Attitude of HCPs:

The attitude of HCPs was analyzed. Mean and Standard deviation were calculated. The attitude toward pharmacogenomic of Physician (3.9±0.825) showed good and Pharmacist (4.27± 0.83) showed very good attitude toward pharmacogenomic that shows both the physician and pharmacist have warm attitude towards the learning and implementation of pharmacogenomics.

Table 3: Mean and standard deviation of attitude of physician (n=187) and pharmacist (n=187) about pharmacogenomics

Attitude of HCPs	**Physicians**		**Pharmacists**	
	Mean	**SD**	**Mean**	**SD**
1. Do you consider PG test for drug prescription prescribing?	3.82	0.803	4.22	0.886
2. Do you think before dispensing medication, overview of PG test report will be helpful for you?	3.96	0.789	4.19	0.793
3. Would you be able to learn PG if taught in different medical institutes?	3.87	0.919	4.24	0.922
4. Do you think PG must be a part of medical health care professional's curriculum?	3.90	0.793	4.37	0.815
5. Do you think will PG's awareness helpful for health care professionals?	3.95	0.818	4.35	0.735
Overall attitude score	3.9	0.825	4.27	0.83

*Very poor = 0.0-1.0, Poor =1.1-2.0, Average = 2.1-3.0, Good =3.1-4.0, Very good= 4.1-5.0

D. Practice of HCPs:

The practice of HCPs was analyzed. Mean and standard deviation were calculated. The practice toward pharmacogenomic of physician (3.8±0.8) showed good and pharmacist (4.12±0.8) showed very good practice towards pharmacogenomics which means both the physician and pharmacist are highly interested towards the beneficiaries of pharmacogenomics for improved outcomes and reduction in the cost of therapy for patients as well as role of pharmacist is more emphasizing in alternating the therapy for patient better health.

Table 3: Mean and standard deviation of practice of physician (n=187) and pharmacist (n=187) about pharmacogenomics

Practice of HCPs	**Physicians**		**Pharmacists**	
	Mean	**SD**	**Mean**	**SD**
1. I would prefer to use PG in practice.	3.86	0.831	4.29	0.791
2. I shall feel easier to intervene the drug therapy depending upon PG.	3.81	0.825	3.89	0.785
3. Pharmacist should need to advise the PG testing in future.	3.83	0.803	4.26	0.748
4. I had seen improvement in outcomes after PG testing.	3.58	0.815	3.98	1.039
5. I noticed PG testing reduce the cost of overall therapy.	3.60	0.864	3.90	1.070
Overall practice score	3.802	0.832	4.12	0.886

*Very poor = 0.0-1.0, Poor =1.1-2.0, Average = 2.1-3.0, Good =3.1-4.0, Very good= 4.1-5.0

E. Comparison of knowledge, attitude and practice among physician and pharmacist

The knowledge attitude and practice of physicians and pharmacist were compared by independent sample T-test. It was assumed that there was significant difference between the means of knowledge, attitude and practice of physicians and pharmacist.

H_0= There is no statistically significant difference between the means of knowledge, attitude and practice of physicians and pharmacists.

H_1= There is statistically significant difference between the means of knowledge, attitude and practice of physicians and pharmacists.

Acceptance Criteria:

Reject the H_0, if the value is less than P value ($P< 0.05$)

Table 4: T-Test

Variables	P value
1. Knowledge of HCPs	0.04
2. Attitude of HCPs	0.451
3. Perception of HCPs	0.832
***p<0.05 (significant difference between knowledge, attitude and practice of HCPs using t-test)**	

There is significant difference between the knowledge of physicians and pharmacists but there is no statically difference between the attitude and practice of physicians and pharmacists.

Discussion

Pharmacogenetics, a critical subset of pharmacogenomics (PGx), is still in the early stages of development in Asia. Our study aimed to assess the knowledge, attitudes, and practices regarding pharmacogenomics among physicians and pharmacists, excluding medical undergraduate students. We distributed a 30-question survey to healthcare professionals, receiving 374 responses in one week. This high participation rate indicates a general interest and understanding of pharmacogenomics among the respondents. The demographic breakdown showed that respondents were predominantly female (54.5%), pharmacists (45.5%), and under 30 years old (59.6%).

These findings highlight a notable curiosity among pharmacists, particularly younger ones, about pharmacogenomics. This contrasts with a previous study in Kuwait where most participants were male physicians, aligning more closely with studies conducted in the United Arab Emirates and Qatar. Our research revealed that the majority of respondents were familiar with the term "pharmacogenomics," though medical and pharmacy students in Lahore were not adequately educated on the subject. Pharmacists were twice as likely as physicians to be familiar with this scientific term, likely due to differences in their educational curricula. This divergence in medical education is a global issue, reflecting a broader need for improved PGx education (11).

In our study, the profession significantly influenced knowledge of PGx, with pharmacists demonstrating better understanding of patient phenotypes, genotypes, and their impact on drug efficacy. However, awareness of PGx testing was more influenced by experience than profession. When asked about mechanisms altering drug reactions influenced by various genotypes, the survey design restricted the ability to select multiple answers, making knowledge gaps more apparent. Pharmacists exhibited more positive attitudes towards the importance of PGx, its integration into practice, PGx testing, and its role in successful treatments compared to physicians (5).

Despite recognizing the importance of PGx, there was no consensus on prioritizing its knowledge. Most participants felt that formal education in college was the best approach to improve PGx understanding. This indicates that although PGx is acknowledged as important, there is a significant gap in knowledge among healthcare professionals, especially physicians with direct patient contact (12).

Globally, pharmacogenetics remains a critical component of healthcare systems, yet many developed nations lack expertise in this area. For instance, a joint study between Japan and the USA found that less than 20% of pediatricians were familiar with PGx. Some Arab countries, particularly in the Gulf, are advancing in this field with initiatives like the Saudi Human Genome Program, supporting specialized PGx research. In Lahore, significant barriers to adopting PGx testing include lack of funding, restrictions on genetic research, economic embargoes, and sanctions. These challenges hinder the integration of pharmacogenomics into clinical practice (13).

Our study found that the majority of pharmacists in Lahore had good knowledge of PGx, contrasting with other studies showing limited PGx knowledge among hospital pharmacists. This suggests that pharmacists in Lahore might be more proactive or have better access to PGx information and training. Both doctors and pharmacists in our study recognized the importance of PGx testing for selecting appropriate medications, highlighting a shared understanding of its potential benefits in personalized medicine.

Overall, our study underscores the need for improved education and training in pharmacogenomics across all healthcare professions. It also highlights the importance of addressing systemic barriers to the adoption of PGx testing, such as funding and regulatory restrictions. By enhancing PGx knowledge and integration into clinical practice, healthcare systems can improve drug efficacy, reduce adverse drug reactions, and ultimately provide more personalized and effective patient care.

Conclusion

This study showed that there is good knowledge among physician and pharmacist about PGx. Additionally, the low level of PGx awareness, particularly among doctors, highlights the urgent need to strengthen medical curricula in Lahore institutions for graduate and undergraduate students and highlights the significance of creating PGx learning resources for clinicians and pharmacists. The attitude and practice study showed that both the physicians and the pharmacists has urge about the knowledge of pharmacogenomic.

In order to adopt particular PGx tests and guidelines fit for our society in the future, we emphasize the importance of education, training, and genotyping studies on the Lahore population.

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