ORIGINAL ARTICLE

CONTENTS

Healthcare providers' proficiency, challenges, and attitudes toward genetic testing integration in psychiatric practices: The influence of an educational initiative

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ABSTRACT

Aim: This study examines the impact of an educational initiative on healthcare providers' proficiency and attitudes toward genetic testing.

Materials and Methods: A quasi-experimental design with a single group pre/posttest was employed. Convenience sampling was used to recruit 227 participants. Four valid and reliable tools were used to assess demographic characteristics, knowledge, attitudes, and challenges related to pharmacogenetic testing.

Results: Among the 227 participants, 36% were nurses, 17.7% were physicians, 17.7% were psychologists, 14.8% were pharmacists, and 5.4% were social workers. Most participants had 1--5 years of experience and lacked prior education or workshop attendance related to genetic testing. Most agreed that genetic testing is unused in psychiatric diagnosis but acknowledged its crucial role in guiding medication selection, dosage, and personalized treatment. After the educational program, significant improvements in participants' knowledge and attitudes toward genetic testing were observed.

Conclusions: The educational program effectively enhanced healthcare providers' knowledge and attitudes regarding integrating genetic testing into psychiatric practice. Substantial improvements between pre- and posttest scores indicate increased proficiency in addressing challenges related to genetic testing. The findings reveal a significant knowledge gap, as many participants lacked prior education on genetic testing during their undergraduate studies. This underscores the need for ongoing training and support. Encouraging collaboration between genetic specialists and psychiatric practitioners and ensuring adequate resources are essential for successfully implementing genetic testing in routine psychiatric care.

KEY WORDS: genetic testing, psychiatric care, personalized treatment, healthcare providers, pharmacogenetics, educational initiative, knowledge enhancement, attitudes, quasi experimental design, clinical practice integration

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LIST OF ABBREVIATIONS

KAIMRC: King Abdullah International Medical Research Centre
IRB: International Review Board
NHG: National Guard Health Affairs
KKH: King Khalid Hospital
WHO: World Health Organization
MOH: Ministry of Health
ASD: autism spectrum disorder
HCPs: health care providers

INTRODUCTION

Traditional psychiatric treatment usually focuses on symptom control with psychotropic drugs, which may overlook root causes and produce inconsistent results. These restrictions emphasize the necessity for more personalized therapy approaches. Genetic components are crucial in numerous psychiatric conditions, making genetic testing a valuable resource for tailoring treatment, reducing negative medication effects, and enhancing clinical results. Nonetheless, the incorporation of genetic testing into psychiatric practice is still restricted because of issues like a lack of pharmacogenomic understanding, ethical dilemmas, and doubts about its clinical usefulness.

Progress in genomics has hastened the implementation of precision medicine in various medical fields, such as psychiatry. Genetic testing has proven useful in detecting variants associated with disorders like schizophrenia, bipolar disorder, and depression, facilitating more precise diagnoses and customized treatments. For example, pharmacogenomic information can inform medication choices and dosage, improving treatment

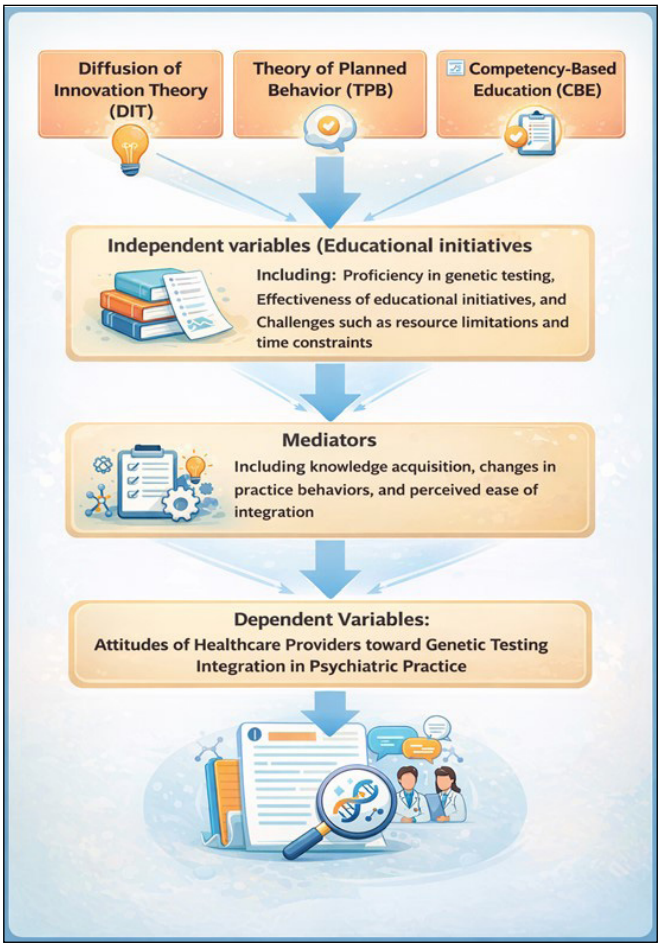

Fig. 1. The theoretical framework interconnections for genetic testing integration Diffusion of Innovation Theory (DIT): Examine the perception and acceptance of genetic testing among healthcare professionals. Theory of Planned Behavior (TPB): Examine how attitudes, social norms, and perceived control affect the adoption of genetic testing. Competency-Based Education (CBE): Stress the importance of specific skills and knowledge acquisition
Source: compiled by the authors of this study

outcomes for individuals with major depressive disorder. However, the successful utilization of these tools relies on healthcare providers' capacity to interpret and implement genetic information a proficiency that is still inadequately developed in numerous psychiatric environments [4–7].

Aside from pharmacotherapy, genetic testing can aid in evaluating the risk for neurodevelopmental and hereditary psychiatric disorders like Huntington's disease, fragile X syndrome, and autism spectrum disorder [5, 8, 9]. Although it holds promise, its execution is obstructed by ethical and logistical challenges such as privacy issues, complexities surrounding informed consent, and a lack of trained personnel [10–13]. These challenges are further complicated by ongoing knowledge deficiencies among healthcare providers, especially in psychiatric settings.

In Saudi Arabia, current pharmacogenomic studies have primarily emphasized pharmacists, showing reduced clinical confidence stemming from insufficient training. Nonetheless, there is limited knowledge regarding how psychiatric healthcare professionals view and utilize genetic testing in their practice. Gaining insight into their existing skills, perceived obstacles, and viewpoints is crucial for creating effective implementation strategies [6,16].

This study explores the baseline proficiency, challenges, and attitudes of psychiatric healthcare providers regarding genetic testing integration. It also evaluates the impact of a targeted educational initiative aimed at enhancing their competence in this area. The findings are intended to inform policy and practice by identifying actionable gaps and supporting the development of precision psychiatry in the region.

THEORETICAL FRAMEWORK

The conceptual structure combines the diffusion of innovation theory (DIT), the theory of planned behavior (TPB), and competency-based education (CBE) to investigate the implementation of genetic testing in psychiatric settings. DIT elucidates how medical professionals view and incorporate genetic testing as an innovative practice, considering factors such as competence, obstacles, and perspectives [17]. The TPB investigates how attitudes, social influences, and perceived control over behavior shape practitioners' intentions and actions regarding genetic testing [18]. CBE focuses on acquiring the specific knowledge and abilities essential for implementing this practice and informing the creation of educational programs [19]. These theoretical approaches

collectively guide the development of interventions to address identified obstacles, with educational initiatives serving as the primary means of enhancing healthcare providers' expertise. Intermediary factors, including knowledge gain, alterations in practice behaviors, and perceived ease of incorporation, influence the relationship between educational programs and the outcome variable, which encompasses providers' attitudes and practices. The figure (1) of the framework illustrates how these components interact to promote the adoption of genetic testing, enhance patient outcomes, and facilitate more methodical integration of genetic tools in psychiatric care.

The relationships between these theories collectively guide educational initiatives designed to enhance understanding and implementation. Intermediary factors such as knowledge gain and behavioral shifts facilitate the impact of educational programs on outcomes. The outcome variables (e.g., perspectives and behaviors) are directly affected by intermediary factors and indirectly shaped by theoretical frameworks.

SIGNIFICANCE OF THE STUDY

This study holds significant importance within mental healthcare. It contributes to integrating genetic testing into psychiatric practice by providing insights into healthcare providers' competence and attitudes. The research can inform targeted educational initiatives to enhance diagnostic and treatment strategies. As personalized medicine gains prominence in mental healthcare, this study aligns with utilizing genomics in psychiatry, making it relevant to evolving psychiatric practice. By examining providers' challenges and attitudes toward genetic testing, this study can impact patient outcomes, enhance recovery, and improve psychiatric care quality. It emphasizes educational interventions to bridge proficiency gaps and foster innovation in psychiatric genomics. Furthermore, this study may be the first in Saudi Arabia to target healthcare providers working in the Erada complex for mental health and addiction; thus, the findings will contribute to psychiatric practice and broader understanding of genetics in healthcare.

ETHICAL APPROVAL

The study received ethical approval from the CON-J research committee, KAIMARC (IRB No. SP23J/167/11), and the Ministry of Health. Approval was also obtained from the Erada Complex for Mental Health and Addiction in Jeddah. Informed consent was secured from all participants, who were given unique passcodes to ensure data privacy. Participants were assured of confidentiality, with data access limited to the PhD researcher and coauthors and were informed of their right to withdraw at any time. All data were securely stored within MNGHA premises in compliance with privacy policies.

AIM

This study aimed to investigate the impact of an educational initiative on enhancing health care providers' proficiency and attitudes in relation to incorporating genetic testing in dealing with psychiatric patients.

RESEARCH QUESTIONS

RQ 1≠ What are the relationships among healthcare providers' knowledge, attitudes, and the barriers they face in integrating genetic testing in psychiatric care?
RQ2≠ Is there a relationship between healthcare providers' demographic characteristics (professional role, years of experience, or specific training in genetics) and their attitudes, knowledge, and clinical practices regarding the integration of genetic testing in psychiatric patient care?

MATERIALS AND METHODS

RESEARCH DESIGN

This study used a quasi-experimental research design with a single group (pre/post) to meet its objectives. We gathered data in pretest and posttest phases and compared results (as discussed in "Tutorial on Integration of Genetic Testing in Psychiatric Practice" [20]). To mitigate possible confounding variables, we gathered demographic and professional information (such as years of experience and knowledge of genetic testing) to evaluate their impact. When necessary, these variables were statistically adjusted to isolate the effects of the educational program. The assumptions underlying statistical analyses were examined. The Shapiro-Wilk test assessed data normality, and Levene's test checked for homogeneity of variance. For assumption violations, we used nonparametric tests or bootstrapping methods to ensure reliable results.

RESEARCH SETTING

This study was conducted at the Erada Complex for Addiction and Mental Health in Jeddah, Saudi Arabia. The complex consists of six facilities including male patients, psychiatric wards for female patients, outpatient departments, and emergency departments. Located in

the Al-Mahjar neighborhood in southern Jeddah, it is the only psychiatric hospital in the city, providing comprehensive services for psychiatric patients and families, including emergency, outpatient, and inpatient care.

RESEARCH SUBJECTS

Healthcare professionals working in Erada for Mental Health and Addiction were approached for data collection. This included physicians, social workers, and psychiatric nurses at the Psychiatric Disorders Hospital in Jeddah. The hospital has 264 healthcare providers: 247 nurses, 60 doctors, and 20 social workers. Convenience sampling selected participants who met the criteria: individuals aged 20 years and older, with at least two years of patient experience, who were willing to participate.

SAMPLE SIZE

The Rao software program (www.reosoft.com) was used to calculate the sample, with a minimum sample size of 178 out of 330 healthcare providers working in the selected setting at 5%. The margin of error is the amount of error that can be tolerated, and the 95% confidence interval is the amount of uncertainty that can be tolerated. A higher confidence level would require a larger sample size. In terms of the numbers selected above, the sample size n and margin of error E are given by:

$x = Z(c/100)2r(100-r)$

$n = N\,x/((N-1)\,E2 + x)$

$E = Sqrt\,[(N - n)\,x/n(N-1)]$

SAMPLING TECHNIQUE

Convenience sampling was used to gain insight into the level of efficacy of genetic testing in psychiatric practice among health providers in psychiatric hospitals. This method facilitates the inclusion of health providers who are easily accessible considering their difficult work schedules and limited availability. This approach was adopted to ensure that the data collection was practical and effective. A total of 227 healthcare providers were recruited from the Erada Complex for Addiction and Mental Illnesses: 36% nurses, 17.7% physicians, 17.7% psychologists, 14.8% pharmacists, and 5.4% social workers.

STUDY TOOLS (DATA-COLLECTION INSTRUMENTS)

Four valid tools were used to achieve the study objectives:

1. **The first section** concerned demographic characteristics, consisting of participants' age, sex, profession, years of experience, level of education, and questions regarding any training in genetic testing usage in psychiatric practice.
2. **Knowledge scale:** Participants used a scale developed by Khalil A., the principal investigator of the current study, on the basis of an extensive literature review. A knowledge scale was developed to assess the knowledge of healthcare professionals (HCPs) regarding genetic testing.

The initial tool, consisting of 40 statements, was distributed to a panel of nursing experts for feedback. The experts evaluated each statement for relevance, clarity, and comprehensiveness. On the basis of their feedback, the tool was refined to 30 statements. This process enhanced the content validity of the tool. Construct validity was addressed through expert review and refinement. Although detailed statistical analysis for construct validity was not performed at this stage, the rigorous expert review process provided a strong basis for the tool's construct validity.

Reliability of the scale: Translation and back-translation were performed to ensure accuracy because the participants' primary language was Arabic. The Arabic version was then reviewed by a panel of nursing experts, who provided feedback for refinement. To assess the reliability of the tool, a pilot study was conducted with a sample of healthcare providers. The tool demonstrated good internal consistency, with a Cronbach's alpha coefficient of .87.3."

The final version of the reviewed valid and reliable scale consists of 30 statements covering various aspects of genetic testing, including its overview, advantages, disadvantages, types, patient benefits, challenges, ethical considerations, and communication of results to patients and families. Responses were rated on a 3-point Likert scale: "agree" (2), "do not know" (0), and "disagree" (1). Eight statements (1, 18, 21, 22, 23, 24, 25, and 26) were reverse scored. The total score ranges from 30--90 and is categorized into low knowledge (30-50), moderate knowledge (51-70), and good knowledge (71-90).

3. **Attitudes scale:** The scale consists of 15 statements aimed at assessing participants' attitudes toward pharmacogenomics and its implications. The first seven questions were adapted from Elewa et al. [21], and the subsequent eight questions were adapted from Jessel et al. (2022). The participants responded on a 3-point Likert scale: "agree" (2), "neutral" (0), and "disagree" (1).

• Scoring: The scale assesses both positive and negative attitudes toward pharmacogenomics. Higher scores indicate more positive attitudes, whereas lower scores indicate more negative attitudes.

• Positive Attitudes: Statements indicating positive views on pharmacogenomics were scored as "agree" (2), "neutral" (0), or "disagree" (1).

Table 1. Educational workshop sessions on genetic testing integration

Day	Session	Topic	Key Content
Day 1	1	Introduction to Genetic Testing in Psychiatry	Relevance, history, and current integration in psychiatric care
	2	Fundamentals of Genetic Testing	Basic genetics, types of tests, and interpretation of results
	3	Ethical and Legal Considerations	Ethical principles, informed consent, data privacy, and legal frameworks
	4	Challenges and Barriers	Common barriers, provider challenges, and case-based discussions
Day 2	5	Clinical Decision-Making	Using genetic data in treatment planning and clinical decision-making tools
	6	Interactive Workshops	Group case analysis, role-play on patient-provider interactions
	7	Patient Communication and Counseling	Strategies for discussing genetic testing and addressing patient concerns
	8	Integrating Genetic Testing into Practice	Best practices, implementation strategies, and support resources
	9	Feedback and Discussion	Participant reflections, posttest evaluation, and program wrap-up

Source: compiled by the authors of this study

• Negative Attitudes: Statements indicating negative views were reversed as "agree" (1), "neutral" (0), or "disagree" (2).

Validity and Reliability: The reliability of the translated attitude scale was tested in a pilot study, resulting in a Cronbach's alpha of .926, reflecting high internal consistency and reliability.

4. **Challenges faced by health care providers (HCPs):** Developed by Jessel et al. [22], this scale includes eight statements addressing challenges associated with implementing genetic testing in psychiatry, such as lack of clinical evidence, reimbursement issues, inadequate training, and potential benefits. The respondents rated their responses on a 3-point Likert scale: "agree" (2), "neutral" (0), and "disagree" (1).

o Score interpretation: A higher average score indicates stronger agreement with the statement, and a lower average score indicates stronger disagreement.

o Validity and reliability: The reliability of the translated challenge scale was tested in a pilot study, resulting in a Cronbach's alpha of .781, reflecting good internal consistency and reliability.

o Overall reliability of all scales: The reliability of the total scale, including all the translated scales, was examined in the pilot study, resulting in a Cronbach's alpha of .934.

DATA COLLECTION PROCESS

The data collection process received approval after submission to KAIMRC, IRB. The study was conducted at Erada for the Addiction and Mental Health Complex in Jeddah, Saudi Arabia, with MOH permission. Hospital managers of nurses, pharmacists, social workers, psychologists, and psychiatrists were contacted to inform participants about the study's purpose and methodology. Participants were assigned unique code numbers for pretest and posttest. The participants were divided into five groups, and each group was contacted separately. Six sessions of the program were completed with specific groups. The training was conducted by researchers and the principal investigator (PI) with co-author support, in both in-person and virtual settings. Nurses participated in two in-person sessions, while social workers, psychologists, pharmacists, and psychiatrists engaged in four online meetings via Microsoft Teams. Each session included three hours for surveys and program content presentation. The program aims to promote the integration of genetic testing into psychiatric care. Through developing competencies, addressing challenges, and shaping attitudes among healthcare providers, this initiative aims to increase precision in mental health care. The educational initiative is interactive and practical to maximize impact on participants' proficiency toward integrating genetic testing into psychiatric practice, while promoting a collaborative learning environment tailored to the audience's expertise level.

Educational program components and guidelines

Table 1 presents a two-day workshop which was developed for psychiatrists, psychologists, nurses, social workers, and pharmacists at the Eradah Complex for Psychiatry and Addiction. The aim was to enhance participants' knowledge, attitudes, and confidence in integrating genetic testing into psychiatric care. The program combined lectures, case discussions, and interactive activities covering theoretical and practical aspects of genetic testing.

The sessions emphasized ethical conduct, practical utility, and interdisciplinary collaboration. Participants were encouraged to apply the knowledge gained in their clinical practice and were provided with resources for continued learning.

Table 2. Distribution of the studied participants according to their demographic characteristics (N=227)

Variables	n=227	%
Gender		
• Female	122	53.7
• Male	105	46.3
Age (years) Mean ±SD	31.7±7.90	
Marital status		
• Single	107	47.1
• Married	108	47.6
• Divorced	12	5.3
Profession		
• Nurse	81	35.7
• Physician	53	23.3
• Pharmacist	31	13.7
• Psychologist	39	17.2
• Social worker	11	4.8
• Others	12	5.3
Experience		
• No experience	32	14.1
• Less than 1 year	3	1.3
• 1 year to 5 years	96	42.3
• 6 years to 10 years	35	15.4
• 11 years to 15 years	35	15.4
• More than 15 years	26	11.5
Education level		
• Undergraduate	54	23.8
• Graduate	136	59.9
• Master	21	9.3
• PhD	16	7.0
Did you study anything related to genome testing in your undergraduate years		
• No	185	81.5
• Yes	42	18.5
If yes, which level (n=43)		
• High school	1	2.3
• University	40	93.0
• Others	2	4.7
Did you attend any workshop regarding genetics		
• No	213	93.8
• Yes	14	6.2
If yes, where(n=13)		
• University	6	46.2
• Workplace	2	15.4
• Others	5	38.5
What is the source of information you learned about genetic testing		
• Internet	121	53.3
• TV	12	5.3
• Conference	18	7.9
• Others	76	33.5
Do you have any extra credentials postgraduate study apart from your bachelor's degree		
• No	213	93.8
• Yes	14	6.2
If yes, please specify(n=14)		
• Graduate	4	28.6
• Master	5	35.7
• Board	5	35.7

Source: compiled by the authors of this study

Table 3. Distribution of the participants according to their pre-post knowledge of the application of pharmacogenetics testing in the psychiatric field (N=227)

Knowledge statements		PRE		POST	
		n=227	%	n=277	%
KQ11. Genetic testing is not commonly used as a direct diagnostic tool for psychiatric disorders.	Disagree	67	29.5	50	22.0
	I do not know	49	21.6	7	3.1
	Agree	111	48.9	170	74.9
KQ2. Genetic testing is commonly used in autism spectrum disorder and schizophrenia diagnostics	Disagree	47	20.7	39	17.2
	I do not know	57	25.1	15	6.6
	Agree	123	54.2	173	76.2
KQ3 Genetic testing plays a crucial role in guiding medication selection, dosage decisions, and addressing factors related to potential treatment resistance	Disagree	41	18.1	19	8.4
	I do not know	50	22.0	8	3.5
	Agree	136	59.9	200	88.1
KQ4 Genetic testing assists in personalized treatment plan development, predicting medication response and side effects	Disagree	32	14.1	23	10.1
	I do not know	49	21.6	11	4.8
	Agree	146	64.3	193	85.0
KQ5 Minor genetic variations can significantly impact an individual's response to antidepressant medications.	Disagree	41	18.1	22	9.7
	I do not know	57	25.1	14	6.2
	Agree	129	56.8	191	84.1
KQ6 Genetic testing can both pinpoint specific genetic causes of psychiatric disorders and assess the risk of developing certain psychiatric conditions.	Disagree	28	12.3	24	10.6
	I do not know	50	22.0	7	3.1
	Agree	149	65.6	196	86.3
KQ7 In the context of genetic testing in psychiatric practice, it is essential to adhere to ethical guidelines, encompassing informed consent, privacy, and results communication.	Disagree	29	12.8	12	5.3
	I do not know	37	16.3	7	3.1
	Agree	161	70.9	208	91.6
KQ8 Genetic testing in psychiatric practice should ensure patient autonomy and prevent discrimination.	Disagree	31	13.7	22	9.7
	I do not know	51	22.5	10	4.4
	Agree	145	63.9	195	85.9
KQ9 Common genetic tests in psychiatric practice include DNA sequencing and SNP analysis	Disagree	30	13.2	17	7.5
	I do not know	82	36.1	19	8.4
	Agree	115	50.7	191	84.1
KQ10 Interpretation of genetic test results in psychiatry considers the family history of psychiatric disorders	Disagree	26	11.5	17	7.5
	I do not know	44	19.4	14	6.2
	Agree	157	69.2	196	86.3
KQ11 Challenges in psychiatric genetic testing involve high costs and limited access to genetic counselors	Disagree	28	12.3	21	9.3
	I do not know	64	28.2	11	4.8
	Agree	135	59.5	195	85.9
KQ12 Confidence in interpreting genetic test results can vary	Disagree	48	21.1	39	17.2
	I do not know	84	37.0	23	10.1
	Agree	95	41.9	165	72.7
KQ13 Whole Exome Sequencing (WES) is frequently used for diagnosing and assessing the risk of mental disorders	Disagree	33	14.5	27	11.9
	I do not know	106	46.7	29	12.8
	Agree	88	38.8	171	75.3
KQ14 Genome-Wide Association Study (GWAS) is a common tool for assessing genetic predisposition to bipolar disorder and schizophrenia.	Disagree	24	10.6	16	7.0
	I do not know	100	44.1	32	14.1
	Agree	103	45.4	179	78.9
KQ15 Next-Generation Sequencing (NGS) is commonly used to analyze genetic variations associated with psychiatric disorders	Disagree	26	11.5	29	12.8
	I do not know	101	44.5	28	12.3
	Agree	100	44.1	170	74.9

Table 3. cont.

KQ16 A limitation of genetic testing in psychiatric practice is the potential to raise false hopes and anxiety in patients	Disagree	38	16.7	40	17.6
	I do not know	69	30.4	26	11.5
	Agree	120	52.9	161	70.9
KQ17 Respecting patient autonomy and securing informed consent is crucial when conveying genetic test results to psychiatric patients	Disagree	25	11.0	25	11.0
	I do not know	43	18.9	9	4.0
	Agree	159	70.0	193	85.0
KQ18 Genetic test results should not be disclosed to family members of psychiatric patients	Disagree	68	30.0	84	37.0
	I do not know	45	19.8	19	8.4
	Agree	114	50.2	124	54.6
KQ19 Healthcare providers should ideally communicate genetic test results to psychiatric patients with clear, understandable explanations, counseling, and support	Disagree	31	13.7	23	10.1
	I do not know	42	18.5	7	3.1
	Agree	154	67.8	197	86.8
KQ20 An ethical approach involves clear communication of negative genetic test results indicating an elevated risk for severe mental disorders, along with available support options	Disagree	35	15.4	25	11.0
	I do not know	51	22.5	10	4.4
	Agree	141	62.1	192	84.6
KQ21 Genetic factors do not always contribute to treatment resistance in individuals with psychiatric disorders	Disagree	70	30.8	108	47.6
	I do not know	58	25.6	17	7.5
	Agree	99	43.6	102	44.9
KQ22 Identifying genetic factors does not always lead to alternative treatment options for individuals with psychiatric disorders	Disagree	65	28.6	105	46.3
	I do not know	67	29.5	19	8.4
	Agree	95	41.9	103	45.4
KQ23 Genetic testing cannot predict with absolute certainty the development of psychiatric disorders in asymptomatic individuals	Disagree	52	22.9	98	43.2
	I do not know	62	27.3	13	5.7
	Agree	113	49.8	116	51.1
KQ24 Early intervention or preventative measures are not always recommended solely based on genetic testing	Disagree	73	32.2	106	46.7
	I do not know	56	24.7	16	7.0
	Agree	98	43.2	105	46.3
KQ25 Genetic information alone cannot provide a complete and definitive subtype of psychiatric disorders	Disagree	43	18.9	91	40.1
	I do not know	58	25.6	15	6.6
	Agree	126	55.5	121	53.3
KQ26 The development of targeted therapies based on genetic information is not guaranteed and may not always result in effective treatments	Disagree	55	24.2	91	40.1
	I do not know	60	26.4	21	9.3
	Agree	112	49.3	115	50.7
KQ27 Genetic research can lead to the identification of drug targets or pathways involved in psychiatric disorders	Disagree	25	11.0	26	11.5
	I do not know	64	28.2	14	6.2
	Agree	138	60.8	187	82.4
KQ28 Clinical trials can be influenced by genetic information, but treatments are not always tested on a uniform population	Disagree	33	14.5	23	10.1
	I do not know	68	30.0	21	9.3
	Agree	126	55.5	183	80.6
KQ29 Tailoring antidepressant treatments based on genetic profiles can lead to improved outcomes by reducing trial-and-error prescribing	Disagree	26	11.5	33	14.5
	I do not know	64	28.2	15	6.6
	Agree	137	60.4	179	78.9
KQ30 Genetic testing in children and adolescents should be considered, especially when dealing with treatment-resistant conditions and when dosing guidelines are available for specific medications	Disagree	30	13.2	29	12.8
	I do not know	59	26.0	15	6.6
	Agree	138	60.8	183	80.6

Source: compiled by the authors of this study

Table 4. Distribution of the participants according to their attitudes toward the application of pharmacogenetic testing in the psychiatric field (N=227)

Statements		PRE		POST	
		n=227	[%]	n=277	[%]
AQ1 It would be important for me as a health care professional to identify medications that require pharmacogenetic testing	Disagree	13	5.7	9	4.0
	I do not know	87	38.3	69	30.4
	Agree	127	55.9	149	65.6
AQ2 I believe that a patient's genetic variation may influence his/her response to drug therapy in terms of efficacy and safety	Disagree	13	5.7	4	1.8
	I do not know	84	37.0	59	26.0
	Agree	130	57.3	164	72.2
AQ3 It is my responsibility to apply pharmacogenetic testing to drug therapy selection, dosing, and monitoring	Disagree	25	11.0	11	4.8
	I do not know	96	42.3	56	24.7
	Agree	106	46.7	160	70.5
AQ4 It is my responsibility to counsel the patients on the results of their pharmacogenetic testing	Disagree	20	8.8	7	3.1
	I do not know	80	35.2	53	23.3
	Agree	127	55.9	167	73.6
AQ5 Pharmacogenetic testing will improve our ability to effectively control drug therapy expenditures	Disagree	16	7.0	2	.9
	I do not know	72	31.7	50	22.0
	Agree	139	61.2	175	77.1
AQ6 It is my responsibility to make the patients aware of relevant pharmacogenetic tests for their prescribed medication.	Disagree	18	7.9	5	2.2
	I do not know	71	31.3	50	22.0
	Agree	138	60.8	172	75.8
AQ7 I am interested as a health care professional to become involved in pharmacogenetic testing training sessions/workshops	Disagree	17	7.5	9	4.0
	I do not know	65	28.6	50	22.0
	Agree	145	63.9	168	74.0
AQ8 In children and adolescents, pharmacogenetics testing improves the efficacy of psychotropic medications	Disagree	15	6.6	2	.9
	I do not know	76	33.5	51	22.5
	Agree	136	59.9	174	76.7
AQ9 In children and adolescents, pharmacogenetic testing reduces the risk for adverse drug reactions related to psychotropic medications	Disagree	17	7.5	8	3.5
	I do not know	82	36.1	53	23.3
	Agree	128	56.4	166	73.1
AQ10 In children and adolescents, pharmacogenetics testing is clinically useful	Disagree	10	4.4	5	2.2
	I do not know	89	39.2	56	24.7
	Agree	128	56.4	166	73.1
AQ11 In children and adolescents, pharmacogenetics testing should be used to inform psychotropic medication selection	Disagree	18	7.9	4	1.8
	I do not know	84	37.0	47	20.7
	Agree	125	55.1	176	77.5
AQ12 In children and adolescents, pharmacogenetics testing should be used to inform psychotropic medication dosing	Disagree	17	7.5	4	1.8
	I do not know	95	41.9	41	18.1
	Agree	115	50.7	182	80.2
AQ13 In children and adolescents, pharmacogenetics testing should be used to inform psychotropic medication switching	Disagree	16	7.0	3	1.3
	I do not know	93	41.0	48	21.1
	Agree	118	52.0	176	77.5
AQ14 In children and adolescents, pharmacogenetics testing should be used to inform psychotropic medication augmentation	Disagree	16	7.0	3	1.3
	I do not know	93	41.0	47	20.7
	Agree	118	52.0	177	78.0
AQ15 In children and adolescents, pharmacogenetics testing should be used to inform psychotropic medication deprescribing	Disagree	16	7.0	5	2.2
	I do not know	94	41.4	54	23.8
	Agree	117	51.5	168	74.0

Source: compiled by the authors of this study

Table 5. Distribution of the participants in overcoming challenges related to the application of pharmacogenetic testing in the psychiatric field (N=227)

Statements		PRE		POST	
		n=227	[%]	n=277	[%]
CQ1 There is not enough clinical evidence for me to use pharmacogenetics testing in my practice	Disagree	25	11.0	35	15.4
	I do not know	106	46.7	79	34.8
	Agree	96	42.3	113	49.8
CQ2 Lack of reimbursement for pharmacogenetics testing is a barrier for use in my practice	Disagree	14	6.2	3	1.3
	I do not know	96	42.3	59	26.0
	Agree	117	51.5	165	72.7
CQ3 If I wanted to order a pharmacogenetics test, I could identify an appropriate laboratory to perform the testing	Disagree	52	22.9	58	25.6
	I do not know	80	35.2	64	28.2
	Agree	95	41.9	105	46.3
CQ4 I have the necessary training to interpret pharmacogenetics testing results	Disagree	74	32.6	69	30.4
	I do not know	79	34.8	60	26.4
	Agree	74	32.6	98	43.2
CQ5 I have access to experts that can assist me in interpreting or implementing pharmacogenetics-testing results	Disagree	56	24.7	52	22.9
	I do not know	89	39.2	67	29.5
	Agree	82	36.1	108	47.6
CQ6 It takes too long to get pharmacogenetics testing results for it to be clinically useful in my practice	Disagree	19	8.4	34	15.0
	I do not know	104	45.8	58	25.6
	Agree	104	45.8	135	59.5
CQ7 Pharmacogenetics testing results would assist me in discussing psychotropic medication options with my patients	Disagree	16	7.0	8	3.5
	I do not know	91	40.1	46	20.3
	Agree	120	52.9	173	76.2
CQ8 Clinical practice guidelines for the use of pharmacogenetics testing in children and adolescents would be helpful to me	Disagree	16	7.0	4	1.8
	I do not know	83	36.6	48	21.1
	Agree	128	56.4	175	77.1

Source: compiled by the authors of this study

DATA MANAGEMENT AND STATISTICAL ANALYSIS

The collected data were coded and analyzed via the latest version of the statistical software SPSS. Descriptive statistics such as frequencies, percentages, means, and standard deviations were calculated to summarize the data. Independent sample t tests were performed to compare the item means of knowledge evaluation between the pre- and post-program among the study participants. Additionally, paired t tests were conducted to analyze the changes in total knowledge, attitudes, and challenge scores within the participants' responses from the pretest to the posttest. Statistical tests appropriate for assessing the associations between the participants' sociodemographic variables and the study variables were employed, with a significance level set at $p < 0.05$.

RESULTS

A total of 227 healthcare providers participated in the survey. Table 2 provides demographic variables of participants. Most participants were female (74.9%) or nurses (35.7%). The mean age was 31.7 years (SD=7.90). Most participants were graduates (59.9%) with a master's degree (9.3%) or PhD (7.0%). The majority had 1--5 years of experience (42.3%), followed by 6--10 years (15.4%) and 11--15 years (15.4%). Few had no experience (14.1%) or less than 1 year (1.3%). When asked about genome testing studies during undergraduate years, 81.5% answered "No," while 18.5% responded "Yes," mostly studying it at the university level (93.0%). Regarding genetics workshops, 93.8% responded "No," with 6.2% answering "Yes," mainly attending at university (46.2%). Information about genetic testing came primarily from the internet (53.3%), conferences (7.9%), and other sources (33.5%). Most participants (93.8%) had no additional postgraduate credentials beyond their bachelor's degree, while 6.2% had additional degrees, mainly graduate (28.6%) or master's (35.7%).

Table 3 highlights significant improvements in healthcare providers' knowledge about genetic testing in psychiatric practice following an educational interven-

tion. The most notable gain was in understanding the role of genetic testing in guiding medication selection, dosage, and addressing treatment resistance (KQ3), with agreement rising from 59.9% to 88.1%. Another substantial improvement was observed in awareness that genetic testing is not commonly used as a direct diagnostic tool for psychiatric disorders (KQ11), where agreement increased from 48.9% to 74.9%.

However, some knowledge areas showed only slight changes. The belief that genetic test results should not be disclosed to family members rose modestly from 50.2% to 54.6%. Awareness that identifying genetic factors does not always lead to alternative treatment options increased slightly from 41.9% to 45.4%. The belief in the ability to predict psychiatric disorders in asymptomatic individuals using genetic testing changed minimally from 49.8% to 51.1%. Understanding that early intervention or prevention should not be solely based on genetic testing increased marginally from 43.2% to 46.3%. Notably, recognition that genetic information alone cannot provide a complete subtype of psychiatric disorders slightly declined from 55.5% to 53.3%, and awareness that targeted therapies based on genetic information are not guaranteed to be effective rose only slightly from 49.3% to 50.7%.

Before the intervention, Table 4 highlights negative attitudes toward pharmacogenetic testing, with 42.3% unsure about its application and 35.2% unsure about counseling patients. Post-intervention, attitudes shifted dramatically, with agreement increasing to 70.5% for testing and 73.6% for counseling. Additionally, belief in pharmacogenetic testing's role in controlling drug therapy costs rose from 61.2% to 77.1%, and its perceived efficacy and safety in psychotropic medications for children and adolescents increased from 59.9% to 76.7%.

In Table 5, the findings highlight the main challenges healthcare providers face when implementing pharmacogenetic testing in psychiatric settings. The primary obstacle identified was the perceived lack of reimbursement for testing, noted by 51.5% of participants (CQ2). Additionally, 46.7% expressed uncertainty about the clinical evidence for pharmacogenetics (CQ1), and 39.2% lacked access to experts for result interpretation (CQ5). After the intervention, improvements were seen in perceptions of clinical evidence (agreeing increased from 42.3% to 49.8%) and access to experts (from 36.1% to 47.6%). However, challenges like finding appropriate laboratories (CQ3) and delays in receiving results (CQ6) persist, indicating that issues related to reimbursement and timeliness continue to hinder the integration of pharmacogenetics in psychiatric practice, highlighting the need for targeted interventions.

Table 6 presents the Wilcoxon test results, indicating significant improvements in all evaluated parameters (knowledge, attitudes, and challenges) between pre- and postintervention assessments, with p values less than 0.001. Knowledge increased, with median values changing from 72.0 to 76.0 and a mean rank shift from 116.45 to 97.48, reflecting a medium effect size ($r = -0.401$). Attitude also improved, with median values rising from 38.0 to 42.0 and mean ranks declining from 117.49 to 76.32 (medium effect size, $r = -0.458$). Additionally, the challenge variable showed progress, with median values increasing from 18.0 to 20.0 and mean ranks shifting from 109.70 to 92.54 (small effect size, $r = -0.253$).

Figure 2 compares mean values of knowledge, attitude, and challenge before and after an intervention. Knowledge increased from 71.3 (preintervention) to 76.6 (postintervention), attitudes rose from 37.3 to 40.8, and the Challenge Overcoming domain improved from 18.4 to 19.6. These increases are statistically significant ($p<0.001$), indicating the intervention effectively enhanced knowledge, attitudes, and obstacle management.

Table 7 indicates that the Mann–Whitney test revealed significant differences in knowledge, attitudes, and perceived challenges based on gender, undergraduate genome study experience, and workshop participation, while postgraduate qualifications had minimal impact. Men had notably higher knowledge scores both pre- and post-intervention ($p = 0.021$, $p = 0.005$) and perceived greater challenges ($p = 0.016$, $p = 0.046$). Individuals with undergraduate genome study experience showed higher initial knowledge ($p = 0.017$), but this difference disappeared after the intervention ($p = 0.683$). Workshop attendance positively influenced preintervention attitudes ($p = 0.030$), though this effect faded postintervention ($p = 0.214$). Overall, gender, prior genome study experience, and workshop attendance were key factors in knowledge and attitudes, while postgraduate qualifications showed little relevance.

Table 8 summarizes the mean values for knowledge, attitudes, and overcoming challenges before and after the intervention, categorized by education level and experience. While experience and knowledge showed no significant differences pre- ($p = 0.103$) or post-intervention ($p = 0.141$), most groups had modest gains. Attitude changes were significant before the intervention ($p = 0.001$) but not afterward ($p = 0.155$). Challenge overcoming approached significance before the intervention ($p = 0.059$) but showed no significant changes after ($p = 0.781$). Education level saw higher post-intervention means, though knowledge did not significantly change pre- ($p = 0.276$) or post-intervention ($p = 0.175$). Significant attitude differences were noted before the intervention ($p = 0.009$) but not after ($p = 0.643$). Challenge overcoming showed no changes from pre- ($p = 0.266$) to post-intervention ($p = 0.736$).

Table 6. Wilcoxon test (pre-post comparisons) between scores on knowledge, attitudes, and perceived challenges among participants (N=227)

Variable Pair	N	Mean Rank (Pre)	Median (Pre)	Mean Rank (Post)	Median (Post)	p value	r
Knowledge	151	116.45	72.0	97.48	76.0	<0.001	-0.401
Attitude	136	117.49	38.0	76.32	42.0	<0.001	-0.458
Challenge	125	109.70	18.0	92.54	20.0	<0.001	-0.253

r: Effect size (small effect size 0.2, medium effect size 0.5, large effect size 0.8)
Source: compiled by the authors of this study

Table 7. Mann–Whitney test of gender; type of education; workshop attendance; and knowledge, attitudes, and challenges regarding the use of genetics testing in the psychiatric field (N=227)

Variable	Metric	Group 1	N1	Mean Rank1	Median1	Group 2	N2	Mean Rank2	Median2	p value
Gender	Pre Knowledge	Female	122	104.65	70.5	Male	105	124.87	73.0	0.021
	Post Knowledge	Female	122	102.67	76.0	Male	105	127.17	78.0	0.005
	Pre Attitude	Female	122	108.52	38.0	Male	105	120.36	39.0	0.174
	Post Attitude	Female	122	109.07	41.0	Male	105	119.73	42.0	0.213
	Pre Challenge	Female	122	104.30	17.0	Male	105	125.27	19.0	0.016
	Post Challenge	Female	122	105.97	19.5	Male	105	123.33	21.0	0.046
Undergrad Genome Study	Pre Knowledge	No	185	109.03	72.0	Yes	42	135.90	75.0	0.017
	Post Knowledge	No	185	114.85	76.0	Yes	42	110.27	76.0	0.683
	Pre Attitude	No	185	110.64	38.0	Yes	42	128.79	39.0	0.105
	Post Attitude	No	185	117.14	42.0	Yes	42	100.15	41.0	0.122
	Pre Challenge	No	185	117.14	19.0	Yes	42	100.19	17.0	0.128
	Post Challenge	No	185	112.33	20.0	Yes	42	121.37	20.0	0.418
Workshop Attendance	Pre Knowledge	No	213	112.42	72.0	Yes	14	138.04	77.5	0.157
	Post Knowledge	No	213	113.89	76.0	Yes	14	115.68	76.5	0.921
	Pre Attitude	No	213	111.59	38.0	Yes	14	150.71	42.5	0.030
	Post Attitude	No	213	115.36	42.0	Yes	14	93.32	40.5	0.214
	Pre Challenge	No	213	112.14	18.0	Yes	14	142.36	21.0	0.093
	Post Challenge	No	213	111.98	20.0	Yes	14	144.71	22.0	0.069
Postgrad Credentials	Pre Knowledge	No	213	113.45	72.0	Yes	14	122.36	74.5	0.623
	Post Knowledge	No	213	113.53	76.0	Yes	14	121.21	76.0	0.670
	Pre Attitude	No	213	115.36	38.0	Yes	14	93.29	35.0	0.221
	Post Attitude	No	213	114.31	42.0	Yes	14	109.36	40.5	0.780
	Pre Challenge	No	213	114.74	18.0	Yes	14	102.68	17.0	0.502
	Post Challenge	No	213	113.70	20.0	Yes	14	118.50	20.5	0.790

Source: compiled by the authors of this study

ANOVA

Table 9 shows the statistical analysis for varying predictive impacts of participant attributes on pre- and postintervention outcomes. For preintervention measures, older age positively correlated with initial knowledge (B=0.345, p=0.013) and attitudes (B=0.218, p=0.011). In contrast, greater experience negatively influenced pre knowledge (B=-1.662, p=0.020), pre attitude (B=-1.329, p=0.003), and pre challenge (B=-0.536, p=0.023). Gender significantly predicted pre attitude (B=1.886, p=0.048) and pre challenge (B=1.354, p=0.008), while marital status predicted lower pre attitude scores (B=-1.894, p=0.030). Postinter-

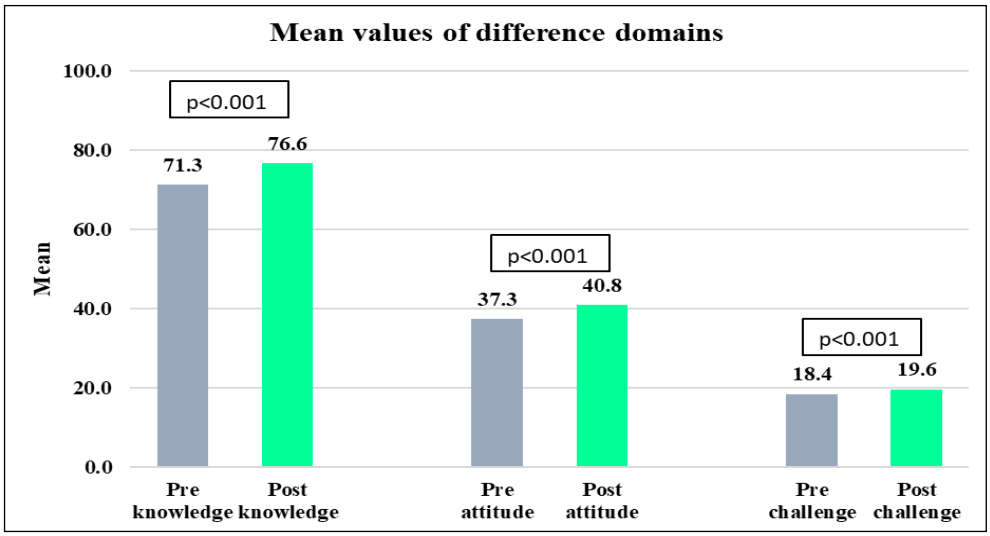

Fig. 2. Comparison between knowledge, attitudes, and challenges in pre- and postintervention assessment programs, N=227
Source: compiled by the authors of this study

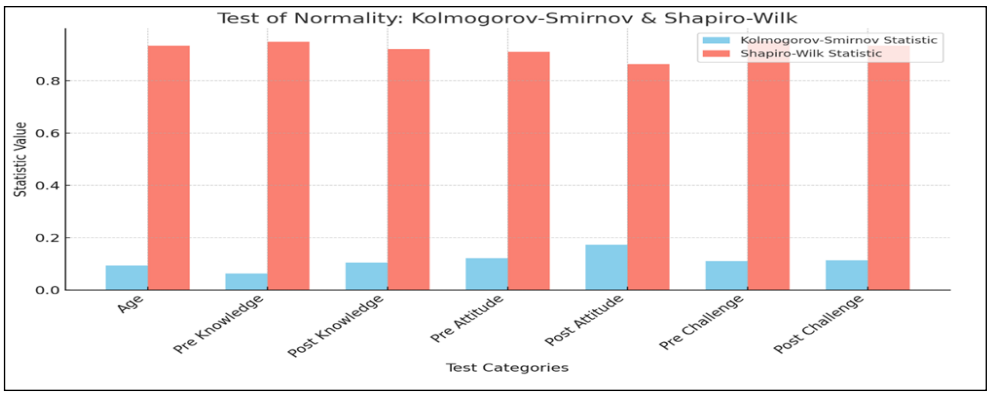

Fig. 3. Test of normality: Kolmogorov–Smirnov & Shapiro–Wilk tests
Source: compiled by the authors of this study

vention models showed no statistical significance ($p > 0.05$) and accounted for minimal variance (R^2: 1.8–3.1%). Age and gender trends were generally positive, with experience reducing preintervention scores. Preintervention models explained 6–9% of the variance, indicating limited predictive value. Notably, gender approached significance for pre knowledge (p=0.063) and post challenge (p=0.076), suggesting potential trends for further exploration. In summary, preexisting characteristics weakly predict baseline measures but do not effectively explain postintervention outcomes.

Figure 3 displays The Kolmogorov-Smirnov (KS) statistic ranges from 0.063 (pre knowledge) to 0.174 (post attitude), indicating the greatest deviation from normality at post attitude. The Shapiro–Wilk (SW) statistics vary from 0.864 (Post Attitude) to 0.952 (Pre challenge), with lower values indicating greater departures from normality. Both Post Attitude (0.864) and Post Knowledge (0.920) show significant nonnormality, while Pre challenge (0.952) is closest to normal distribution. All p values for the KS and SW tests are ≤ 0.05, indicating a non-normal distribution at the 5% significance level. Therefore, nonparametric tests like the Mann–Whitney U test and Wilcoxon signed-rank test may be more appropriate than parametric tests like t tests or ANOVA.

DISCUSSION

This research explored the obstacles to integrating genetic testing into psychiatric practice and assessed the impact of a specific educational intervention on healthcare providers in Saudi Arabia. As one of the first studies in this field, it showed notable enhancements in genomic knowledge and moderate changes in attitudes, consistent with earlier studies by Meiser et al., Bauer et al., and Quinn et al., which indicated that education enhances clinical confidence in utilizing genetic testing [23–25]. Nevertheless, persistent issues - such as genetic determinism, difficulties in data interpretation, and ethical challenges - continue to hinder adoption. These results align with those of Wright et al. and Byres et al., who found that increased knowledge does not always translate into attitudinal change [26–27]. Wondrasek et al. [28] emphasized that existing beliefs and perceived relevance significantly affect receptivity. The intervention led to a slight decrease in perceived barriers (mean difference = 1.17, $p < 0.001$, $r = -0.253$), suggesting that while knowledge improved, participants became more aware of systemic and ethical complexities. This paradox - enhanced literacy paired with increased recognition of limitations—has been observed in similar studies. Ethical concerns included

Table 8. Comparison between healthcare providers in relation to knowledge, attitudes, and challenges pre- and postintervention (N=227).

			N	M±SD	95% CI		p
Profession							
Preknowledge	Nurse	81	68.9±11.36	66.35	71.38	0.060
	Physician	53	72.7±7.45	70.66	74.77	
	Pharmacist	31	74.9±13.81	69.84	79.97	
	Psychologist	39	70.9±10.08	67.60	74.14	
	Social worker	11	75.2±8.32	69.59	80.77	
	Others	12	69.8±8.94	64.15	75.52	
Postknowledge	Nurse	81	76.3±7.22	74.74	77.93	0.381
	Physician	53	75.9±9.77	73.25	78.64	
	Pharmacist	31	78.8±6.86	76.32	81.35	
	Psychologist	39	75.5±5.03	73.91	77.17	
	Social worker	11	79.5±9.59	73.02	85.89	
	Others	12	76.5±8.42	71.15	81.85	
Preattitude	Nurse	81	35.9±7.40	34.23	37.50	0.063
	Physician	53	38.1±4.04	36.94	39.17	
	Pharmacist	31	38.7±7.74	35.90	41.58	
	Psychologist	39	37.3±6.64	35.13	39.43	
	Social worker	11	41.2±5.56	37.44	44.92	
	Others	12	35.8±5.89	32.09	39.58	
Postattitude	Nurse	81	40.1±4.84	39.05	41.19	0.537
	Physician	53	41.0±4.02	39.91	42.13	
	Pharmacist	31	41.8±3.95	40.39	43.29	
	Psychologist	39	41.1±3.80	39.87	42.34	
	Social worker	11	41.2±5.46	37.52	44.85	
	Other	12	41.0±4.29	38.28	43.72	
Prechallenge	Nurse	81	17.7±3.73	16.87	18.52	0.158
	Physician	53	18.8±2.75	18.07	19.59	
	Pharmacist	31	19.4±3.96	17.97	20.87	
	Psychologist	39	18.3±3.45	17.14	19.38	
	Social worker	11	19.5±3.36	17.20	21.71	
	Others	12	18.1±3.29	15.99	20.17	
Postchallenge	Nurse	81	19.0±3.67	18.21	19.84	0.091
	Physician	53	20.0±3.37	19.11	20.97	
	Pharmacist	31	19.4±3.37	18.15	20.62	
	Psychologist	39	19.4±3.18	18.35	20.42	
	Social worker	11	22.2±3.12	20.08	24.28	
	Others	12	19.8±3.19	17.72	21.78	

Source: compiled by the authors of this study

privacy protection, informed consent, and psychological impact, as outlined in international frameworks like GINA [29] Practical challenges - such as cost, workflow integration, and limited access to genetic counseling - remain significant hurdles. Therefore, educational initiatives must be supported by institutional reforms to facilitate sustainable integration. Demographic analysis (Table 1) showed a predominantly young, female, nursing-based group with limited prior exposure to genomics. Most participants had not studied genetics during their undergraduate education (81.5%) or attended relevant workshops (6.2%) [30, 31]. The internet (53.3%) was the main source of information, while conference attendees achieved the highest post-inter-

Table 9. Multiple regression results for the knowledge, attitude, and challenge (pre and post) interventions

Predictor	Pre-Knowledge B (p)	Post-Knowledge B (p)	Pre-Attitude B (p)	Post-Attitude B (p)	Pre-Challenge B (p)	Post-Challenge B (p)
Gender	2.892 (0.063)	1.952 (0.090)	1.886* (0.048)	0.703 (0.282)	1.354** (0.008)	0.915 (0.076)
Age (years)	0.345* (0.013)	0.106 (0.300)	0.218* (0.011)	0.010 (0.867)	0.072 (0.116)	-0.004 (0.932)
Marital Status	-0.479 (0.734)	-0.135 (0.897)	-1.894* (0.030)	-0.113 (0.849)	-0.445 (0.339)	-0.201 (0.668)
Profession	0.535 (0.262)	0.112 (0.751)	0.355 (0.226)	0.263 (0.191)	0.128 (0.417)	0.206 (0.195)
Experience	-1.662* (0.020)	-0.195 (0.711)	-1.329** (0.003)	-0.140 (0.640)	-0.536* (0.023)	0.076 (0.748)
Education Level	-1.299 (0.154)	-0.479 (0.476)	0.457 (0.413)	-0.367 (0.338)	0.194 (0.517)	0.115 (0.703)
Model Significance	F=2.566* (p=0.02), R^2=6.5%	F=1.187 (p=0.314), R^2=3.1%	F=3.518* (p=0.02), R^2=8.8%	F=0.674 (p=0.671), R^2=1.8%	F=2.313* (p=0.029), R^2=6.1%	F=1.066 (p=0.384), R^2=2.8

* - Significant results ($p < 0.05$) are marked with an asterisk

Source: compiled by the authors of this study

vention knowledge scores (mean = 74), highlighting the importance of structured, targeted education. Notably, advanced degrees did not consistently predict better outcomes, underscoring the need for contextual, practice-oriented content [32, 33]. While knowledge gains were evident, attitudinal changes were less consistent. This discrepancy may reflect differences in intervention design or unaddressed psychological factors, as suggested by Byres et al. [34] and Hull et al. [35], who stressed that professional context - not personal demographics - determines intervention effectiveness [27, 30]. Professionally, social workers and pharmacists showed the most significant improvements, likely due to the direct relevance of pharmacogenomics to their roles [36–38]. However, social workers also reported increased perceived challenges post-intervention, possibly due to greater awareness of systemic constraints. Table 8 showed knowledge improvements across experience levels, though these were not statistically significant. This suggests that short-term interventions may be insufficient for lasting attitudinal change. Similarly, postgraduate education and conference attendance improved baseline knowledge but did not significantly influence post-intervention attitudes, reinforcing the need for interventions that address institutional and psychological dimensions [39, 40]. Multivariate regression revealed that demographic traits predicted baseline scores but not post-intervention outcomes. This indicates that successful implementation depends more on external factors such as institutional support, reflective learning environments, and interdisciplinary collaboration. Without reinforcement and follow-up, initial gains may diminish, highlighting the importance of continuous professional development and mentoring [41, 43].

In summary, while the educational initiative effectively enhanced genomic literacy, deeper systemic, ethical, and logistical challenges must be addressed to achieve meaningful integration. Future genomic education in Saudi Arabia should be tailored to diverse professional roles and supported by institutional frameworks to foster sustainable change in psychiatric practice [44, 45].

WHAT WAS ADDED BY THIS STUDY

This study on integrating genetic testing into psychiatric practice through education is both innovative and timely, offering valuable insights into personalized medicine. By evaluating healthcare providers' knowledge, attitudes, and barriers, it highlights key factors influencing adoption. The development of a reliable, expert-validated educational tool (Cronbach's alpha = .87) demonstrates methodological strength and practical relevance. The findings can guide targeted interventions and policy development, promoting wider use of genetic testing to enhance diagnostic accuracy and individualized treatment. Overall, the study provides a strong foundation for future research and advances both scientific and clinical applications in psychiatry.

LIMITATIONS

This study offers valuable insights but has several limitations affecting its generalizability. The use of convenience sampling may have introduced bias, as participants could have had a preexisting interest in genetic testing. The limited sample size and demographic scope further restrict the applicability of the findings. The short-term nature of the intervention prevents assessment of long-term impact, and reliance on self-reported data raises concerns about response bias. Additionally, findings may not be transferable to different cultural or healthcare settings. Future research should use probability sampling, include more diverse participants, and explore broader factors like institutional support and interprofessional collaboration.

CONCLUSIONS

This research demonstrated that a targeted educational program significantly improved healthcare professionals' understanding of genomics and their readiness to integrate genetic testing into psychiatric practice. The notable enhancements in knowledge and attitudes observed before and after the intervention highlight the effectiveness of structured training, particularly in environments with limited prior exposure to genomics. Two primary conclusions emerge:

1. While educational efforts are essential, they are insufficient on their own - despite the increase in knowledge, persistent challenges such as ethical concerns, systemic limitations, and inadequate institutional support remain. Addressing these issues requires coordinated policy and infrastructure reforms
2. Tailored, profession-specific training is crucial - the variations in outcomes across different fields underscore the need for education that aligns with specific clinical roles and responsibilities. These findings advocate for the development of ongoing, interdisciplinary genomic education programs to support the meaningful and ethical integration of genetic testing in psychiatric care.

RECOMMENDATIONS

- Implement regular, mandatory training for healthcare providers on genetic testing in psychiatry
- Integrate genetic testing education into undergraduate and graduate healthcare curricula.
- Encourage collaboration between genetic specialists and psychiatric professionals
- Provide sufficient resources and support systems for routine use of genetic testing
- Advocate for supportive legislation and funding to promote genetic testing in psychiatry
- Urge healthcare administrators to offer infrastructure and education for implementation
- Engage institutional and national stakeholders to support system-wide adoption of genetic testing in mental healthcare.

CLINICAL IMPLICATIONS

- Continuing education enhances nurses' proficiency in genetic testing, improving patient outcomes in psychiatry.
- Increased knowledge and positive attitudes enable better clinical decision-making and patient counseling.
- Integrating genetic testing enriches psychiatric care by incorporating genetic insights.
- Ongoing training supports nurses' professional growth and keeps them current with advancements.
- Addressing systemic barriers like cost and access to genetic counseling—through institutional and policy changes is essential for successful implementation.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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