Knowledge and Attitudes of Health Care Providers Regarding Genetic Problems at Primary Health Care Settings

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Abstract

Background: Poor knowledge of genetic problems and its services, causing delayed or inaccurate diagnosis for patients' conditions. Primary health care providers play a vital role in early detection and proper management of it. **Aim of the study:** was to assess the knowledge and attitudes of health care providers regarding genetic problems at primary health care settings. **Design**: A descriptive research design was used in this study. **Settings:** The current study was conducted at all Maternal and Child Health Care Centers which are affiliated to Ministry of Health at Kafr Elsheikh Governorate. **Subjects:** All primary health care providers (81physician and 286 nurse) who are working in previously mentioned settings were included in the current study. **Tool**: A structured questionnaire which composed of four parts, Part1): Social characteristics of primary health care providers. Part 2): Knowledge of health care providers regarding genetic problems. Part 3): Attitudes of health care providers regarding genetic problems. Part 4): Health care providers perceived barriers to genetic services. **Results:** There were 87.7% of physicians and all of nurses had low level of total knowledge regarding genetic problems, 96.3% of physicians and 87.1% of nurses had positive attitude regarding genetic problems. Moreover, 59.4%& 29.4% of the primary health care providers perceived high and moderate level of barriers regarding genetic services respectively. **Conclusion and recommendations:** There was a significant positive correlation between total knowledge score and total attitude score, and significant negative correlation between total knowledge score and total barrier score of the primary health care providers regarding genetic problems. Therefore, health authorities should organize periodic genetic workshops and clinical training programs for primary health care providers about genetic problems.

Keywords: Genetic problems, Services, Primary health care settings.

Introduction

Genetic disorders are group of diseases that caused by mutations in genes or chromosomal alterations. Some genetic disorders caused by chromosomal abnormalities that cell's chromosome numbers deviates from the normal 46 chromosomes or structural change that occur when part of a chromosome is missed, added, switched to another part of chromosome (**Bechar et al., 2023; Cao et al., 2022).** Other genetic disorders arise from a single gene mutation called monogenic disorders. These diseases are inherited according to Mendel's Laws. It can be divided according to the inheritance pattern as follows: Autosomal recessive, Autosomal dominant, X-linked recessive and X-linked dominant **(Ben-Mahmoud, Gupta, Kim, Layman& Kim, 2023; Zhang& Wu, 2024)**.

Other genetic disorders stem from either a combination of gene mutations and environmental factor, called polygenic disorder disease as hypertension, coronary heart disease and diabetes, or mutations in nuclear DNA or mitochondrial DNA, which called mitochondrial genetic disorders **(Abu-El-Haija et al., 2023; Klopstock et al., 2021)**. There are about 1200 different genetic abnormalities identified in Arab countries; over 40% are restricted to a specific demographic or geographic area, and 60% are autosomal recessive disorders. Due to the high number of first-cousin marriages, there is a considerable increase in genetic anomalies recorded in the Arab community. Also other risk factors include family history, advanced parental age especially over the age of 35 years, ethnicity, environmental exposures during pregnancy as infection and lifestyle factors as (bad habits) **(Cao et al., 2023; Parisi et al., 2023; Eaaswarkhanth et al., 2022)**.

The most prevalent conditions among Arabs are molecular defects and hemoglobinopathies such as β-thalassemia, sickle cell disease, α-thalassemia, glucose-6-phosphate dehydrogenase deficiency, and metabolic illnesses such as obesity, type 2 diabetes, and dyslipidemia **(Irom, 2020)**. Worldwide, an estimated 60,000 children are born with β-thalassemia each year. Whereas one case of Down syndrome (DS) is thought to occur for every 1000 live births every year. DS is responsible for between 3000 and 5000 live births **((Angastiniotis & Lobitz, 2019; Rabbani, Mossa, Al Nuaimi & Al Khateri, 2023)**.

Annually, around 32,000 babies are born with various cardiac defects (1 out of every 125 to 150) although, the incidence rate for Egyptian children is 5:6/1000 live births. **(Nasrulloyevna, Olmasovna & Asliyevna, 2022)**. Moreover, 204 cases of muscular atrophy have been identified in Egypt. According to a fairly recent study using data from global cancer statistics (GLOBOCAN 2022), the incidence of cancer worldwide, is estimated to be 19,976,499 in 2022. It is more than 40% of it is genetic, meaning that the number of people who are at risk is rapidly rising **(Ferlay et al.,2024; Hussien, Abd**

El-Megeed, Elahmady & Gamal Eldein, 2023).

The advancement of genetic technologies has an impact on genetically related health services, including performing genetic testing, verifying a diagnosis, offering genetic counseling, assessing risk, and providing treatment alternatives. At every stage of life, genetic testing and counseling can provide vital information to people and families. Premarital screening is a popular use of genetic testing and counseling which is mandated throughout the Middle East **(Gosadi, 2019; Swandayani, Cayami, Winarni & Utari, 2021)**. As the area of medical genetics has reached a turning point, primary care is essential. Due to the scarcity of genetics providers and increase need to satisfy the growing demand for genetic services, it is imperative to involve, utilize, and train the non-genetics primary healthcare workforce in providing genetics-related services as, for many patients, primary care is frequently their only source of access to healthcare **(Chou, Duncan, Hallford, Kelley& Dean, 2021)**.

A genomics nurse's primary focus is on using knowledge of an individuals, families, communities or populations underlying genetics condition to provide nursing care, education, administration, research, advocacy, and/or policymaking. The entire human genome, including interactions between genes and the environment and their effects on health and nursing care, are clearly at the center of genomics nursing practice. Genomic nurses should continually update their practice and knowledge in line with evolving standards of care of precision health and genomics. **(Fu et al., 2020; Walker et al., 2024)**.

Significance of the study

Globally, a large number of individuals and their families must cope with the psychological, social, and medical effects of genetic or hereditary illness. Because most of rare genetic diseases are infrequent and have low prevalence, neither the general public nor medical experts are familiar with them. Failure to recognize unusual disorders can lead to delayed diagnosis, inaccurate diagnosis, and poor quality information, all of which increase the financial burden on the healthcare system. Therefore, the study will be conducted to assess knowledge and attitudes of health care providers regarding genetic problems at primary health care settings.

The aim of this study was to

Assess knowledge and attitudes of health care providers regarding genetic problems at primary health care settings.

Research questions

1. What are the levels of knowledge of primary health care providers regarding genetic problems?
2. What are the primary health care providers' attitudes regarding genetic problems?
3. What are the types of barriers for genetic services that primary health care providers perceived?

Subjects and method

Subjects

Study design

For achieving the aim of the current study, a descriptive research design was used.

Study settings

The current study was conducted at all Maternal and Child Health Care Centers (MCH) which are affiliated to Ministry of Health at Kafr Elsheikh Governorate. The total numbers of MCH centers were nine

Study subjects

All primary health care providers (physicians and nurses) who were working at all Maternal and Child Health Care Centers at Kafr Elsheikh Governorate and available at time of data collection were included in the current study. Their total number was 367 (81physician and 286 nurse).

Tool of data collection

A structured questionnaire was developed by the researcher to collect the necessary data for the study after reviewing the related literatures **Aga, Alghamdi, Alghamdi& Khan, 2021; Alotaibi et al., 2022; Khdair, Al-Qerem& Jarrar, 2021& Lin et al., 2022).** It composed of four parts as follows:

Part I: **Social characteristics of the studied primary health care providers.**

It included 6 items such as type of primary health care providers (physician or nurse), age, sex, level of education, years of experience and number of courses obtained in the field of genetic problems.

Part II: **Knowledge of primary health care providers regarding genetic problems**

It composed of 43 questions to assess the primary health care provider's knowledge about:

a) **Genetic literacy:** it consisted of 18 questions as (definition of gene, chromosome، mutation, genotype, phenotype, polymorphism, allele, numbers of chromosome & gene and characteristics of dominant& recessive traits).

b) **Genetic services:** it consisted of 19 questions which divided as following:

- **Premarital screening:** It consisted of 5 questions as (definition, purpose, target people to be examined and mandatory of pre-marital examinations).
- **Genetic test**: It consisted of 6 questions as (definition, importance, performance during pregnancy, risks on physical health, price of genetic test).
- **Genetic counseling:** It consisted of 8 questions as (definition, Purpose, importance, time and genetic counseling centers in Egypt and role of nurse in genetic counseling).

c) **Genetic disease:** It consisted of 6 questions as (general information about genetic disease, mode for transmission, gene responsible for transmitting hereditary diseases and risks of consanguineous marriage).

Scoring system

The scoring system for the physicians and nurses knowledge was measured as

For the questions with multiple correct answers: the correct and complete answers was given score (2), the correct incomplete answers was

given score (1) and incorrect or don't know answers was scored (zero).

For the questions with one correct answer: the correct answer was given score (1) and incorrect or don't know answers was scored (zero). The total score was ranged from (0-71). The score was summed up and the total score was converted into a percentage and classified as follows:

- **High knowledge level**: if the health care providers score more than 80% (> 57 from the total score 71).
- **Moderate knowledge level**: if the health care providers score is 70 - 80% (50-57 from the total score 71).
- **Low knowledge level:** if the health care providers score less than 70% (<50 from the total score 71).

Part III: **Attitudes of health care providers regarding genetic problems:**

This part was developed by the researcher guided by the tool of other researches) Alotaibi **et al., 2022& Küchenhoff, Doerflinger& Heinzelmann, 2022)** to assess the attitudes of primary health care providers. It included 24 statements classified as follows:

a) **Genetic test**: It consisted of 17 statements as importance of genetic test, its effect on society, genetic test screening during pregnancy, stigmatization for person diagnosed with genetic disease and use of genetic tests to determine the risk of Down syndrome for the fetus with 35 years old pregnant women.

b) **Genetic problems:** it consisted of 7 statements as: each person has the right to know the probability to have the child with genetic problem, family experience of genetic problem will increase their care about genetic counseling, and the presence of genetic disorder in family may led them to stop consanguineous marriage.

Scoring system

Health care providers' responses were measured on a 3-point Likert scale ranging from zero to two distributed as the following; Agree =2, Neutral = 1, Disagree = 0. The total score ranged from (0-48), it was summed and converted into percentage and categorized as follows:

- **Positive attitude**: 50% or more of the total score (≥ 24from the total score 48)
- **Negative attitude**: less than 50% of the total score (< 24 of the total score 48)

Part IV: Health care providers perceived barriers to genetic services :

This part was developed by the researcher guided by the tool of other researches **(Chou, Duncan, Hallford, Kelley& Dean, 2021& Zhong et al., 2021)**. This part included barriers that consisted of 22 statements that were divided into the following items:

- **Knowledge and skills barriers**: It consisted of 9 statements as lack of genetic knowledge, inability to assess genetic risk, and inability to draw Mendelian genetic map (pedigree for the client).
- **Legal, ethical and social barriers:** It consisted of 5 statements as patient anxiety and

insurance limitation, fear of falling in legal accountability, and disclosing patient confidentiality.

- **Policy, evidence and system barriers**: It consisted of 8 statements as lack of basic guidelines that explain the steps for implementing genetic services at the center, lack of sufficient time for health care providers due to increased work pressure and there is no assignment to a specific health team to provide genetic counseling and services at the medical center.

Scoring system

Health care providers responses were measured on a 3-point Likert scale ranging from zero to two distributed as the following: Agree =2, Neutral = 1, Disagree= 0. The total score ranged from (0-44), it was summed and converted into percentage and categorized as follows:

- **Perceived high barriers**: more than 75% of the total score (>33 from the total score 44).
- **Perceived moderate barriers**: 60%-75% of the total score (26 - 33 from the total score 44).
- **Perceived low barriers**: less than 60% of the total score (< 26 from the total score 44).

Methods

1. **Administrative process**: An official permission to carry out the current study was obtained from Dean of the faculty of Nursing, Tanta University, to directors of the MCH in Kafr Elsheikh governorate.
2. **Ethical considerations**

- Approval of the scientific research ethical committee in the Faculty of Nursing Tanta University (code number186/1/2023) was obtained to conduct the study.
- An informed consent of the study subjects who included in the study was obtained after appropriate explanation of the nature and purpose of the study.
- Anonymity and confidentiality of the collected data was assured as a code number was used instead of study subjects' names.
- The right to each participant for withdrawal from the study at any time was assured by the researcher
- Nature of the study had no harm and/or pain to the studied participant.

3. **Developing The study tool**

- Tool was developed by the researcher based on review of the related literature. The developed tool was translated into Arabic.
- The study tool was tested for face and content validity before conducting the study by jury of five professors' expertise in the field of Community Health Nursing specialty, faculty of nursing, Tanta university, and the modifications were done to ensure the validity of tool.

Pilot study

A pilot study was carried out by the researcher on 10% of primary health care providers for testing the tool for its clarity, applicability and to identify obstacles that may be encountered with the researcher during data collection, knowing the need for adding or deleting questions. No necessary modifications were made so, this sample was included in the study.

The study tool was tested for its reliability using Cronbach's Alpha test and it was found to be (0.785) for the study tool as a whole, (0.791) for knowledge about genetic part, (0.815) for attitude part and perceived barrier part.

4. The researcher met the health care providers in the waiting area of the MCH centers. The questionnaire was distributed on the attending health care providers, each of them were asked to fulfill it and return it to the researcher. The researcher collected the questionnaire sheets personally at the end of time. Each participant fulfilled the questionnaire approximately within 30 minutes.
5. The duration of current study started from March to May 2024. The researcher's met the studied sample 2 days a week at the selected MCH centers.

Statistical analysis

The data were organized, tabulated and statistically analyzed using statistical package for social studies (SPSS) version 23. Comparison was done using chi-square test (x^2). Pearson's correlation coefficient (r) was used to identify correlation between variables. A significance was adopted at $P<0.05$ for interpretation of results of tests of significance (*). Also, highly significant was adopted at $P<0.01$ for interpretation of results of tests of significance (**).

Results

Table (1): Distribution of studied primary health care providers according to their social characteristics. The table shows that, more than three quarters (77.9%) of primary health care providers were nursing staff while slightly less than one quarter (22.1%) of them were physicians. As regards to the age, less than half (46.6%) of studied primary health care providers were in the age category of 24 to less than 34years with range 24-59 years and mean of age 37.60±8.752 years. Concerning to the sex, most (85.3%) of health care providers were females. Regarding to the educational level, the finding reveals that more than half (55.6%) of physicians had post graduate study while slightly less than half (47.9%) of nursing staff had nursing secondary education. Also, it was found that, 42.0% of studied primary health care providers had enrolled between 1 to less than 10 years of experience with range 1-42 years and mean 15.93±11.046 years. Finally, in relation to the number of courses obtained in the field of genetic problems and their services, the result shows that, the majority (92.9%) of them didn't have those courses.

Table (2): Distribution of the studied primary health care providers according to their knowledge level about sub-categories of genetic problems. The table shows that, almost all (99.5%) of the primary health care providers had low level of genetic literacy. As regarding to genetic services, it was found that, slightly less than two thirds (62.9%& 65.4%) of primary health care providers had low level of knowledge regarding to premarital examination and genetic counseling respectively. While the large majority (95.1%) of them had low level of knowledge regarding to genetic tests.

Additionally, more than two thirds (68.1%) of primary health care providers had low level of knowledge regarding to genetic diseases.

Figure (1): Distribution of studied physicians and nurses according to their levels of total knowledge score about genetic problems. In accordance to the findings, the figure shows that, most (87.7%) of physicians and all of nurses had low level of total knowledge regarding genetic problems. Also, only 12.3% of physicians had moderate level of total knowledge regarding genetic problems.

Table (3): Distribution of the studied primary health care providers according to their levels of attitude toward genetic problems. In relation to the total attitude score regarding to genetic test, 9.8 % of the primary health care providers had negative attitude, compared to 90.2% who had positive attitude. Also, 10.1% of them had negative attitude regarding to genetic disease, compared to 89.9 % who had positive attitude. Finally the total attitude score for the primary health care providers regarding genetic problems reflected that, most (89.1%) of them had a positive attitude whereas the minority (10.9%) of them had a negative attitude.

Figure (2): Distribution of studied primary health care providers (physicians and nurses) according to their levels of total attitude score regarding genetic problems. The figure shows that, the majority (96.3%) of physicians and most (87.1%) of nurses had positive attitude regarding genetic problems while, only (3.7%& 12.9%) of physicians and nurses had negative attitude respectively.

Table (4): Distribution of the studied primary health care providers according to their levels of perceived barriers sub-categories score regarding genetic services. The table illustrates that, slightly less than three quarters (71.4%) of primary health care providers perceived high level barriers regarding the knowledge and skill of health care providers, and less than two thirds(64.6%) of them perceived high level of policy, system and evidence based barriers regarding to genetic services. While more than one quarter (30.8%) of primary care providers perceived low level of ethical, legal and social barriers regarding to genetic services.

Figure (3): Distribution of studied physicians and nurses according to their levels of total perceived barriers score regarding genetic services. The figure illustrates that, more than half (55.65% &60.5%) of physicians and nurses perceived high level of barriers regarding genetic services. Whereas, nearly one quarter (24.7%) and less than a third (30.8%) of the physicians and nurses perceived moderate barriers regarding genetic services respectively.

Table (5): Correlation between total knowledge score, total attitude score and total perceived barriers score of the studied primary health care providers regarding genetic problems. The table shows that, there was a significant positive correlation between total knowledge score and total attitude score at (r= 0.419) & (p=

0.001). On the other hand, there was a significant negative correlation between total knowledge score and total barrier score at (r= -0.308-) & (p= 0.001).

Table (1): Distribution of health care providers according to their social characteristics.

Variables of health care providers	The studied primary health care provider (n=367)	
	No	%
Physician	81	22.1
Nursing staff	286	77.9
Age		
24-	171	46.6
34-	126	34.3
44 and more	70	19.1
Range	24-59	
Mean ± SD	37.60±8.752	
Sex		
Male	54	14.7
Female	313	85.3
Educational level of physician	(n=81)	
Bachelor's degree	36	44.4
Postgraduate studies	45	55.6
Educational level of Nursing staff	(n=286)	
Nursing secondary school	137	47.9
Nursing Institute	96	33.6
Bachelors of nursing science& Postgraduate	53	18.5
Years of Experience		
1-	154	42.0
10-	96	26.2
20-	68	18.3
30 and more	49	13.4
Range	1-42	
Mean ± SD	15.93±11.046	
Number of courses obtained in the field of genetic problems and their services		
Nothing	341	92.9
Once	15	4.1
Two and more	11	3.0

Table (2): Distribution of studied primary health care providers according to their levels of knowledge about sub-categories of genetic problems

sub-categories of genetic problems	The studied primary health care provider (n=367) Levels of knowledge					
	Low knowledge		Moderate knowledge		High knowledge	
	No	%	No	%	No	%
Genetic literacy	365	99.5	2	0.5	0	0.0
Genetic services Pre-marital screening	231	62.9	120	32.7	16	4.4
Genetic tests	349	95.1	7	1.9	11	3.0
Genetic counseling	240	65.4	127	34.6	0	0.0
Genetic diseases	250	68.1	93	25.3	24	6.6

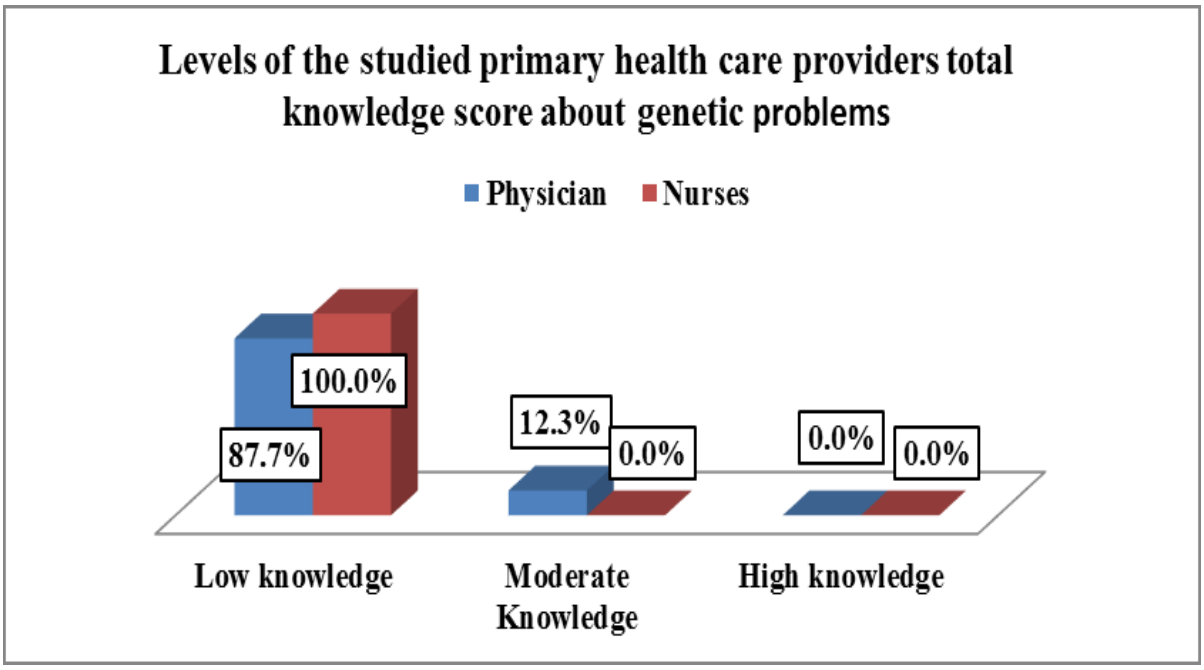

Figure (1): Distribution of studied physicians and nurses according to their levels of total knowledge score about genetic problems

Table (3): Distribution of the studied primary health care providers according to their levels of total attitude score toward genetic problems

Attitude variables	The studied primary health care provider (n=367)			
	Negative attitude		Positive attitude	
	No	%	No	%
Genetic tests	36	9.8	331	90.2
Genetic diseases	37	10.1	330	89.9
Total attitude score	40	10.9	327	89.1

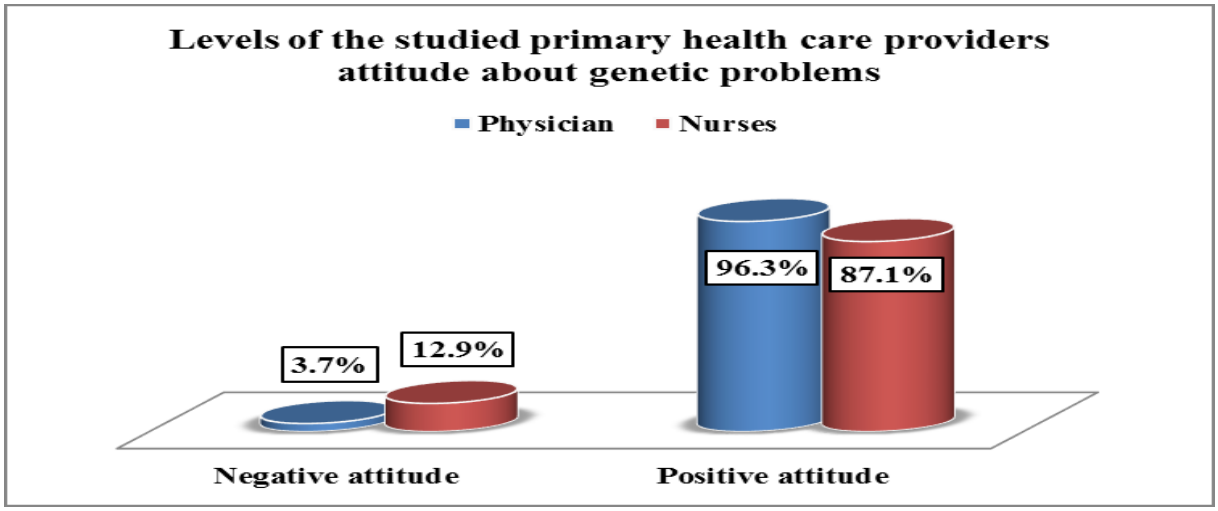

Figure (2): Distribution of the studied primary health care providers (physicians and nurses) according to their levels of total attitude score toward genetic problems

Table (4): Distribution of studied primary health care providers according to their total level of perceived barriers in relation to their sub-categories score regarding genetic services

perceived barriers sub-categories	The studied primary health care provider (n=367) Levels of perceived barriers					
	Perceived low barrier		Perceived moderate barrier		Perceived high barrier	
	No	%	No	%	No	%
Knowledge and skills barriers	49	13.4	56	15.3	262	71.4
Ethical, legal and social barriers	113	30.8	120	32.7	134	36.5
Policy, system and evidence based barriers	52	14.1	78	21.3	237	64.6

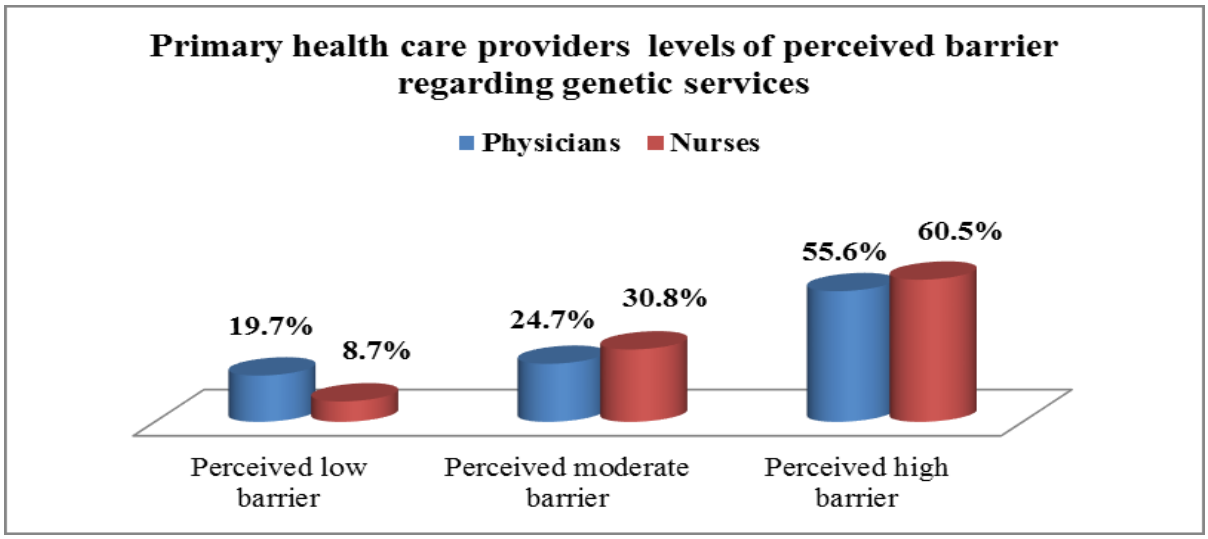

Figure (3): Distribution of studied physicians and nurses according to their levels of total perceived barrier score regarding genetic services

Table (5): Correlation between total knowledge score, total attitude score and total barriers score of the studied primary health care providers regarding genetic problems.

Social characteristics	Total knowledge score	Total attitude score
	r p	r p
Total attitude score	0.419 0.001**	-
Total barriers score	-0.308- 0.001**	0.083

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

Genetic information can help in forming therapeutic decision-making, preventive strategies and management. With new diagnostics and interventions that have been shown to be valuable and clinically significant at every stage of life, genomics is expand the understanding of disease genesis, susceptibility, prognosis, and treatment response **(Claussnitzer et al., 2020; Sharma, Cox, Kruger, Channamsetty& Haga, 2022)**.

Generally, the results of the present study highlighted that, the majority of primary health care providers (either medical or nursing staff) had low level of knowledge regarding genetic problems **(Figure 1)**. As, the study results showed that almost all of primary health care providers had low level of genetic literacy. Additionally, regarding to genetic services, it was

found that, slightly less than two thirds of primary health care providers had low level of knowledge regarding to premarital examination and genetic counseling respectively. While the large majority of them had low level of knowledge regarding to genetic tests. Additionally, more than two thirds of primary health care providers had low level of knowledge regarding to genetic diseases **(Table 2)**. These results were attributed to that, the majority of them reported that, they didn't obtain courses in the field of genetic problems and their services **(Table 1)**. Also, the cause of decreased information regarding genetics among primary health care providers could be due to that they didn't have enough time for searching or participating in clinical training courses regarding to genetics.

This results were consistent with the findings of a study conducted by **Walters et al. (2024)** which assessed the knowledge, attitudes and practices of primary healthcare practitioners in low- and middle-income countries**.** As well as this finding was consistent with the study results that carried out by **Sharma, Cox, Kruger, Channamsetty & Haga, (2022)** which evaluated the primary care providers' readiness for delivering genetic and genomic services to underserved populations that, conducted at (United States of America) . Both studies concluded that, genetic knowledge and skills of primary health care providers were limited. Otherwise, the current study results are disagreed with **Falah, Umer, Warnick, Vallejo& Lefeber, (2022)** who assessed genetics education in primary care residency training program and found that, more than half of them had a satisfied basic genetics concepts and the majority received their genetic experience through a classroom-based education regarding basic genetics. This difference might be due to the studying of genetics as an elective course in their curriculum and having obligatory training rotation in the era of genetic services.

Also, the current study results are disagreed with a study conducted by **Das, Kumar, Chauhan, Kumar & Dwivedi, (2024)** to assess the knowledge, attitude and practices regarding genetic disorders and testing among non-genetic clinicians and concluded that, non-geneticist clinicians have fair theoretical knowledge on genetic disorders and genetic testing.

Attitude can play a significant role in both health and sickness, positive attitude goes a long way towards delivering a higher standard of care **(Ismail, Mohamed, Muda & Ab Rahman, 2020).** Generally, the current study results showed that, the majority of physicians and most of nurses had positive attitude regarding genetic problems (**Figure 2).** As, the majority of primary health care providers had positive attitude regarding to genetic test and most of them had positive attitude regarding genetic disease (**Table 3)**. These results could be due to that, primary health care providers realize the importance of genetic test as, it provide important information about genetic disease and its future consequences. Also, it help in early

detection and early intervention and prevention of the some disease that may develop in the future. Additionally, the commitment of primary health care providers for providing high quality and effective care for patient even when they had a lack of detailed knowledge regarding genetic diseases.

These results were consistent with the findings of a study conducted by **Rosso et al. (2020)** to assess genomics knowledge and attitudes among European public health professionals and revealed that, overall attitudes towards both the use of genetic testing and delivery of genetic services were positive. In the same line, the current study results were agreed with **Kulkarni, Arumugam, Subbiah& Ghoshal, (2023)** to assess the knowledge, attitude, and practice about the process of genetic counseling among clinicians in India who illustrated that, more than half of clinicians were agreed to informing the patient to do appropriate genetic tests for risk determination of disease transmission, and most of them agreed that, parents of children and couples at risk of having a child affected by a genetic disease should undergo genetic counseling.

On the other hand, the current study results were incongruent with the results of the study conducted by **Lin et al. (2022)** who assessed knowledge and attitude towards genetic diseases and genetic testing among undergraduate medical students and showed, that more than two thirds of the students at clinical year had poor attitude towards genetic diseases and genetic testing. This might be due to lake of knowledge and training or fear of ethical or legal issue as a primary health care providers using of some genetic test for predicting future disease that may lead to undesirable choice as abortion based on genetic test. Also, it might be due to their believes that genetic disease is untreatable or some of them may have personal, family experience with genetic disease that lead to unconscious negative feelings.

Due to the developments in genomic technology, the focus of healthcare has shifted from the simple diagnosis and treatment of genetic diseases to genetic risk assessment, counseling, and preventive measures. It was crucial to evaluate the obstacles to providing genetic services in primary health care settings **(Raspa, Moultrie, Toth& Haque, 2021).**

Generally, the present study results highlighted that, more than half of physicians and nurses perceived high barriers regarding genetic services **(Figure 3).** As, the study results showed that, slightly less than three quarters of primary health care providers perceived high level of knowledge and skill barriers, and less than two thirds of them perceived high level of policy, system and evidence based barriers regarding to genetic services. While more than one quarter of primary care providers perceived low level of ethical, legal and social barriers regarding to genetic services (**Table 4)**. These results might be due to that, human genetic is not a unique specialty in medical and nursing field so, the primary health care providers can focus on their specialty rather than medical genetics and its services.

Moreover, primary health care providers were not aware of genetic standard of practice relating to ethical, legal and social issues which is the basics for providing genetic services and they may face ethical dilemma regarding different situations during delivering of genetic services.

The current study results were supported by the study conducted by **Yu et al. (2021)** to evaluate attitudes, clinical practice, and training needs in delivering genetic counseling in primary care and found that, more than three quarters of primary care providers were unaware of the referral pathway for patients with suspected and confirmed genetic disorders and only less than one quarter felt they had enough time to counsel patients on genetic disorders and concluded that, primary care providers had insufficient knowledge, few training opportunities, and self-rated low confidence in their skills as main barriers. Additionally, Primary care providers were least confident with explaining genetic testing results and providing genetic counseling. Moreover, the current study findings were supported by **Truong, Kenneson, Rosen& Singh, (2021)** who evaluated genetic referral patterns and responses to clinical scenarios for primary care providers and clinical geneticists and showed that the financial cost to patients was the most common barrier that primary health care providers reported in regard to the referral of patients to genetic services.

Additionally, the current study results were congruent with the study conducted by **Zhong, Darren, Loiseau, He, Chang, Hill& Dimaras, (2021)** who assessed ethical, social, and cultural issues related to clinical genetic testing and counseling among primary health care providers and found that, the main barrier were legal restrictions surrounding abortion, stigmatization of individuals with genetic disease, and lack of standardization or practice guidelines for genetic testing , local customs may pose barriers to uptake of genetic services and understanding of results, while family structure and unity may become threatened by communication of genetic testing results.

On the other hand, these study results were incompatible with a survey conducted by **Das et al. (2024) and** revealed that, the majority of the non-genetic clinicians were aware of genetic disorders and testing, realize the importance of genetic counseling and referring the patients to the genetic counselor/geneticist for better understanding of the disease. Also, around three quarters of the participants are interacting with the patients having genetic defects on a regular basis.

The current study showed that there were a positive correlation between knowledge and attitude **(Table 5).** As, increasing knowledge leading to increase positive attitude toward genetic problems. This result is supported by the study carried out by **Naidoo& Reddy, (2022)** which assessed knowledge and attitudes toward the use of predictive genetic testing among medical practitioners, medical students and community educator and found that, more than

three quarters of medical practitioners from government and private practice had an excellent knowledge and understanding of genetics, the most of them displayed a positive attitude towards the use of genetic testing.

On the other hand, there were a negative correlation between level of knowledge among primary care providers and their level of perceived barriers regarding delivering of genetic services as shown in the current study results. As, the lower knowledge level they had, the higher barriers they perceived **(Table 5).** This study finding is agreed with **Seibel et al. (2022)** who assessed the primary care providers' use of genetic services in the Southeast United States and concluded that, lack of genetic knowledge was a barrier for providing genetic services.

Conclusion

Based on the findings of the current study; it can be concluded that the majority of the studied primary health care providers had low level of knowledge regarding genetic problems, more than half of them perceived high level of barriers regarding to genetic services and most of them had a positive attitude regarding genetic problems. Also, there was a significant positive correlation between total knowledge score and total attitude score. On the other hand, there was a significant negative correlation between total knowledge score and total barrier score of primary health care providers regarding genetic problems.

Recommendations

Based on the findings of the current study, the following recommendations are derived and suggested

- Installing the genetics basics, disease and services as a subject in curriculum for the medical and nursing students especially in clinical or intern year.
- A multimodal approach combining lectures, laboratory sessions, and problem-solving sessions and case presentation based on real-world scenarios to bridge the gap between theoretical and clinical genetic knowledge.
- Health authorities should organize periodic genetic workshops and clinical training program for primary health care providers to provide them about new issues and technology in this field. Also, determining a specific and highly knowledgeable team from different medical field to deliver genetic services at a specific place.
- Appreciate the role of formal decision makers to increase a number of medical settings which should provide genetic tests and diagnosis with low price.
- In-service training program for primary health care providers to increase their knowledge regarding genetic problems.
- Education on the ethical and moral issues surrounding genetic services should be discussed with religious men to increase confidence during applications.
- Emerging electronic consultations which an important tool for primary care providers to gain direct access to genetic expert specialty care for complicated cases.

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