International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

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STUDY OF THE DISTRIBUTION OF THE MOST COMMON GENETIC DISEASES IN THE LAST FIVE YEARS BY USING GIS (CASE STUDY: KURDISTAN PROVINCE)

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ABSTRACT

Identification of the accumulation of certain diseases in the province and the country will considerably be helpful for the human resources management, allocation of budget, and health services in centers of accumulation of the diseases. Considering that so far no project has been conducted on the issue of spatial analysis of genetic disease in the Kurdistan province, preparing the maps of prevalence of genetic diseases, determining the geographical direction of the spread of these disease in the province of Kurdistan and specifying the areas susceptible to disease and centers of accumulation of genetic disorders in Kurdistan province will significantly be helpful in identifying the way that geographic areas are influential in the creation of these diseases. According to the graphs and tables, it was found that the rate of the prevalence of phenylketonuria, in Kurdistan Province, is higher in males than in females and the highest number of disease were seen in children aged between 1 and 5 years old and the rate of prevalence of this disease in Saqqez is higher than other cities of Kurdistan province. Also, in Kurdistan Province, the rate of prevalence of Thalassemia is higher among males than females and the greatest numbers of patients were aged between 21 to 25 years old and according to

statistics the rate of prevalence of this diseasein Sanandaj, is higher than other cities of Kurdistan province. Also the rate of prevalence of hemophilia, in Kurdistan, is higher in males than the females and most of the patients were aged between 11 to 30 years old, and figures show that the highest rate of prevalence of the disease was seen in Sanandaj. The prevalence rate of physical motor impairment with genetic causes, in Kurdistan, is more in males than females and it has been reported that the statistics of the prevalence of this disease in Bijar, is higher than the other cities of Kurdistan. Also the prevalence of blindness and mental disabilities with genetic causes, in Kurdistan, is more in males than females and the rate of the prevalence of this disease in Sanandaj, is higher than the other cities of Kurdistan and the prevalence of hearing loss and deafness with genetic causes, in Kurdistan, is more in males than females and the rate of the prevalence of this disease in Kamyaran, is higher than the other cities of Kurdistan

Keywords: GIS, genetic disease, Geographical distribution

1- INTRODUCTION

Geographic information system has an efficient and significant role in monitoring and evaluation of diseases and in the field of hygiene & health. By using this knowledge, the areas of accumulation of the diseases can be placed at the disposal of the authorities of healthcare centers in the form of graphs, maps and tables. Spatial analysis of various diseases, with the use of geographic information system, indicates the distribution pattern of diseases in different regions of the earth that this issue leads to the examination of the causes of its distribution in order to find that whether the causes of the distribution are environmental or weather and climatic factors or that other problems have caused the distribution of the disease with their specific pattern. If the disease is concentrated in certain parts of the study area, then the causes of this matter should be searched in these regions and the type of food, water and weather and also eating habits of these regions and every factor that exists in that region and can be helpful in the creation and spread of the disease should be investigated. One of the most important diseases that affect human is genetic diseases that in terms of treatment and recovery it imposes the greatest costs on the patient and after spending high costs, the chance of recovery of the patient is very low. Many of genetic diseases are incurable and high costs will be imposed at the stages of preventing the spread and the development of disease in the patient prone to these disease. In intra-familial marriage, the possibility of incidence

of the disease is much higher, for this reason the genetic counseling and genetic testing for avoiding the birth of children with genetic diseases are among the most important ways to prevent individuals from being affected by these diseases. Identification of the accumulation of certain diseases in the province and the country will considerably be helpful for the human resources management, allocation of budget, and health services in centers of accumulation of the diseases. Considering that so far no project has been conducted on the issue of spatial analysis of genetic disease in the Kurdistan province, preparing the maps of prevalence of genetic diseases, determining the geographical direction of the spread of these disease in the province of Kurdistan and specifying the areas susceptible to disease and centers of accumulation of genetic disorders in Kurdistan province and also determination of the coefficient of influence of climatic and environmental parameters in the development of genetic diseases with respect to the geographical, climatic and situational parameters of the study area will significantly be helpful in identifying the way that geographic areas are influential in the creation of these diseases. Studying the spatial factors that are involved in the development of the disease seems to be

necessary. In the present study, it has been tried to investigate the distribution pattern of genetic disease in Kurdistan province, and to model the causes of this distribution and effective parameters.

2- MATERIALS AND METHODS

2-1 The study area

Kurdistan province with an area of approximately 28,203 square kilometers is one of the western provinces of Iran that has been placed in neighborhood of the provinces of West Azerbaijan, Zanjan, Hamedan and Kermanshah and it is on the border with Iraq and there are more than 200 kilometers of common border with Iraq. The geographical coordinates of the Kurdistan Province are at 34 degrees 44 minutes up to 36 degrees 30 minutes north latitude and 45 degrees 31 minute to 48 degrees and 16 minutes eastern longitude. Sanandaj is the capital of Kurdistan Province and is located at 1373 meters above the sea level. Other cities of the province are: Saqqez, Marivan, Qurveh, Baneh, Bijar, Dehgolan, Divandarreh, Kamyaran and Sarvabad. This province is located on the scattered slopes and plains of central Zagros Mountain and it is bound by Iraq on the west, the province of West Azerbaijan and Zanjan to its north, Zanjan and Hamedan to the east and Kermanshah to the south. Kurdistan Province is entirely a

mountainous region and roughness of the province consists of two western and eastern sections. Wide range of Sanandaj, Marivan and its surrounding lands up to the south of the Kurdistan constitute the western roughness. East of the Sanandaj is covered by the eastern roughness. This area is surrounded with the mountainous fence that is composed of metamorphic and sedimentary rocks. The highest mountains of this region, Shah Neshin, are located in the north of Bijar, Sheida at the center and Panjeh Ali between Qurveh and Saqqez (Figure 1).
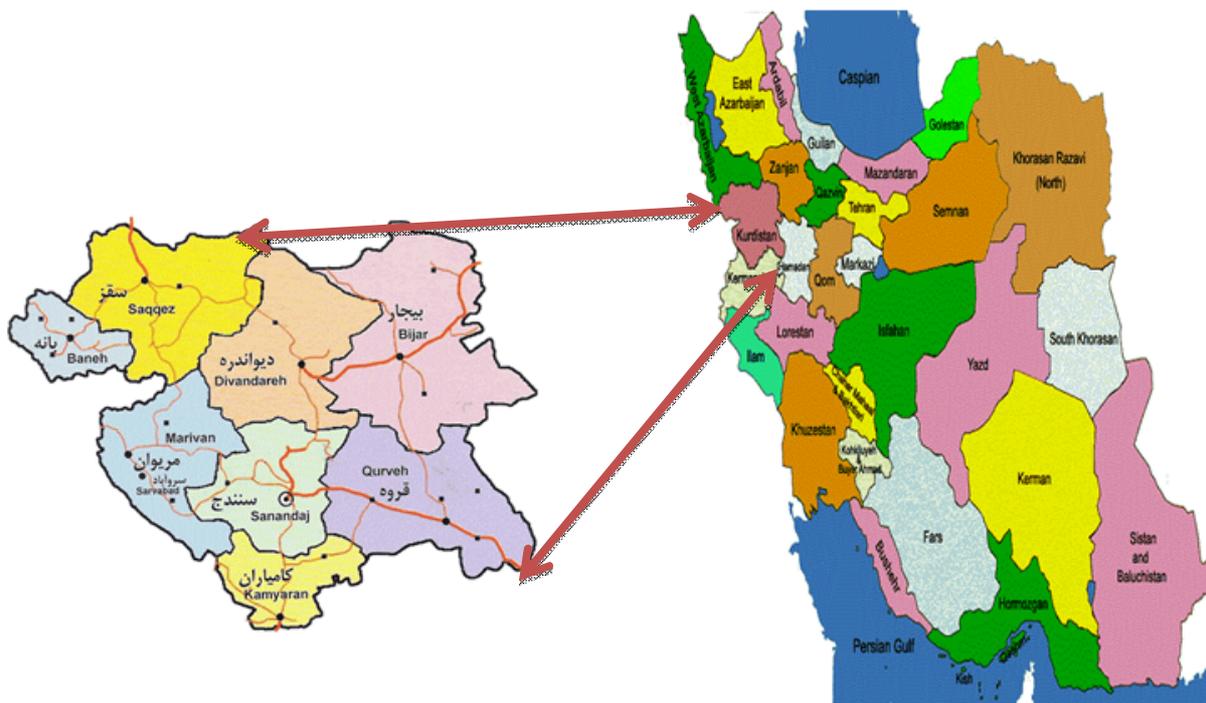
Figure 1- Position of Kurdistan province in Iran

According to the latest political and administrative division of 2006,Kurdistan Province has 9 cities, 26 counties, 84 districts and 1864 villages that 1765 villages are inhabited and 99 villages are haunted. Cities of Kurdistan province are: Saqqez, Qurveh, Bijar, Sanandaj, Marivan, Baneh, Divandarreh, Kamyaran, Sarvabad that Sanandaj is the capital of Kurdistan province.

3- Examined variables

Data of the disease include ID card specifications and medical records of the patients in Kurdistan Province, from 2009until the end of 2014 and they have been prepared and gathered from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province. This information includes personal information such as age, gender and address of patients and specifications related to

medical diagnosis and the type of disease. All of these specifications were collected for the diseases of hemophilia, phenylketonuria, thalassemia, physical motor disability, mental disability, blindness and deafness with the genetic causes.

4- CONCEPTUAL MODEL OF THE RESEARCH

In the first stage, the required spatial data were collected (such as maps of cities and villages, political and administrative boundaries of provinces, cities and counties, etc.) The spatial data were prepared and collected from map preparing agencies such as the National Cartographic Center and Cadaster of the country and other organizations such as the General Governor Office, Housing and Urban Development, Housing Foundation and ....

In the second stage, the demographic data and maps of the province, cities, districts and the province's political divisions were prepared.

In the third stage, the data of the disease were collected that this task was carried out by referring to welfare centers or health care centers of University of Medical Sciences.

In the fourth stage, the relevant software for the data analysis were determined that included ARC GIS and EDRISI software and methods of spatial analysis and modeling techniques were identified.

In the fifth stage, spatial and statistical analyses were applied on disease and the maps of prevalence and spread of disease were prepared and the type of distribution and the direction of the spread of disease in the province were specified. In the last stage the results were displayed in the form of maps, tables and graphs.
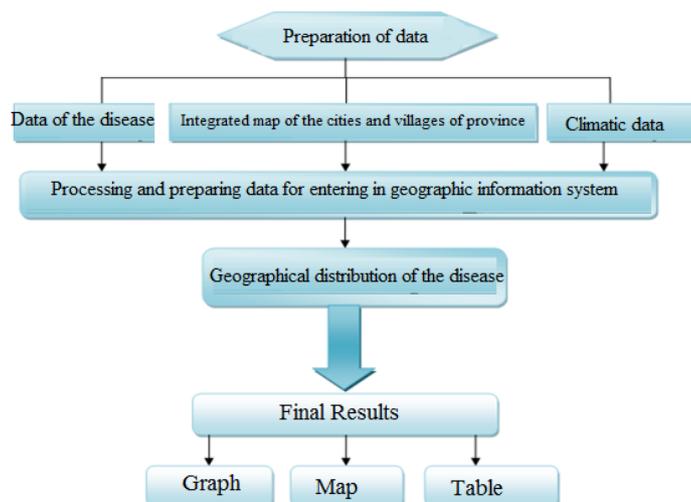

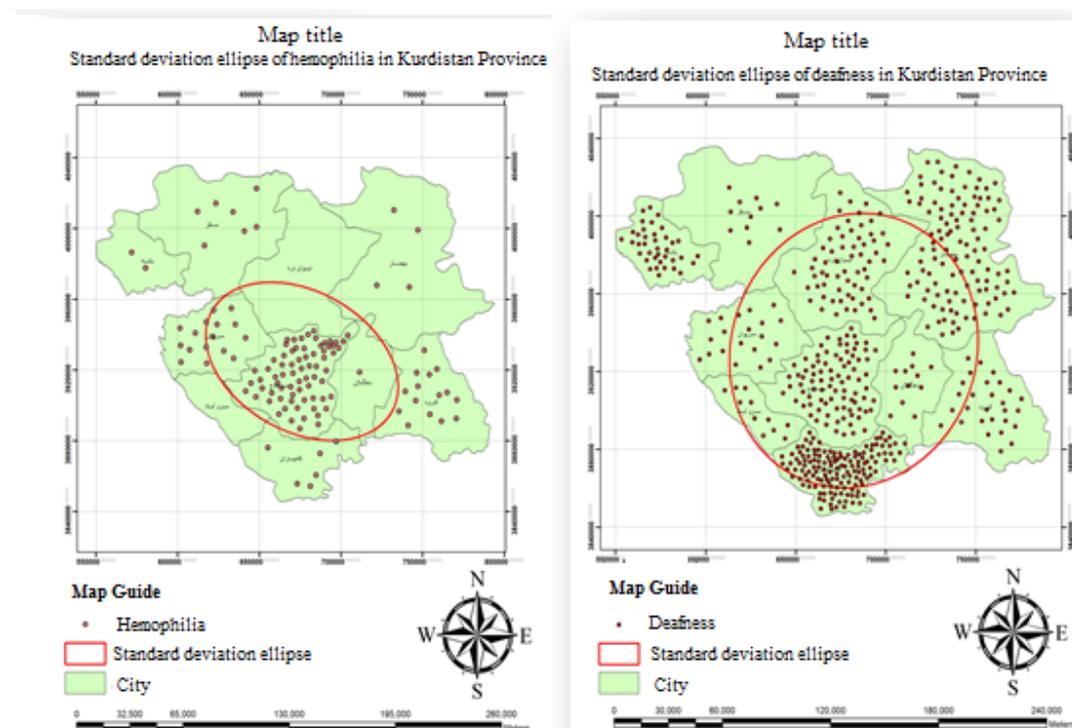**Figure 2- Conceptual model of the research**

In order to prepare a map of the geographical distribution of disease in Kurdistan province, initially, the spatial maps of the province including maps of the province, city, district and village were placed in a GIS environment and then a data layer was prepared in GIS environment with the geometric point in order to enter the data about the patients. According to the data collected from patients in Kurdistan province in the statistical years of 2009 until the end of 2014 and with regard to the exact address of patients, for every patient a point was considered in the position of the patient's address and consequently the stages of preparation of the map was completed and the output was a map which included borders
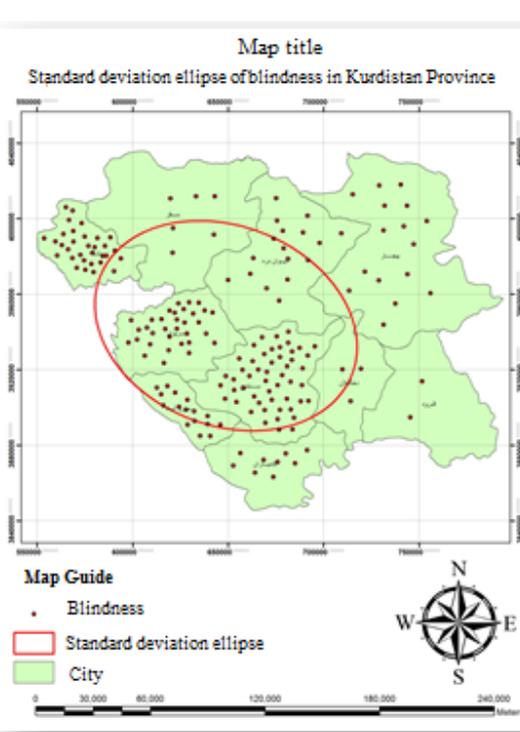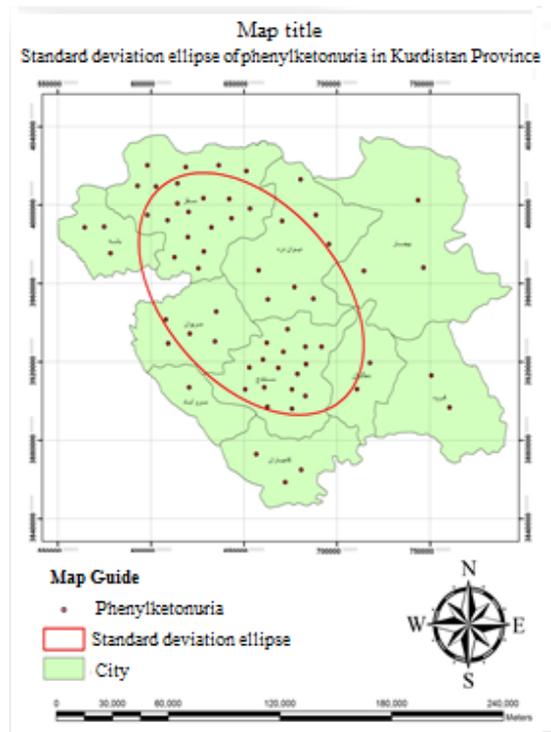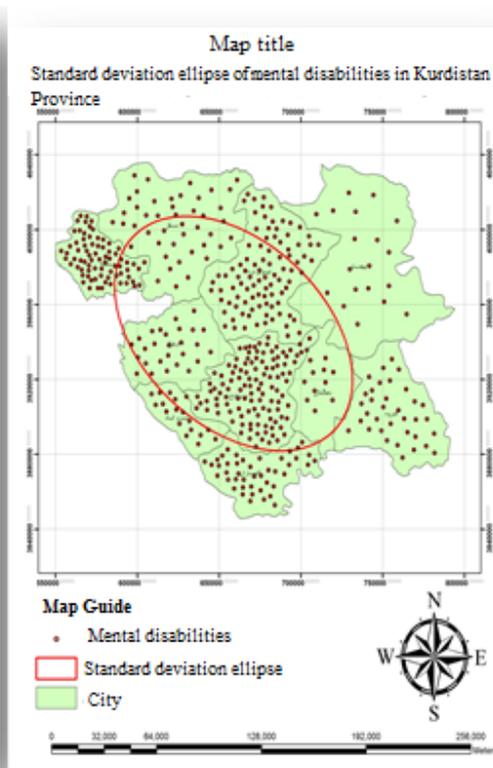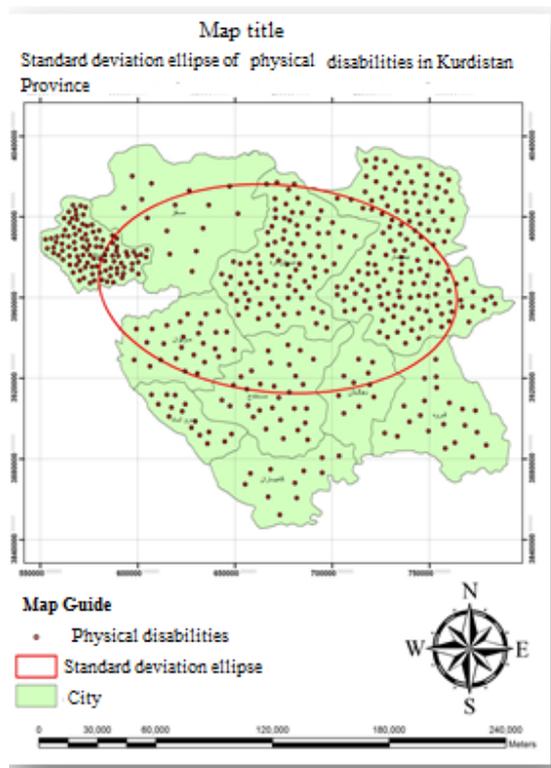
of the province, borders of cities and areas of disease. All the spatial - statistical analysis will be carried out on the basis of this basic map.

In the following part of the research, the map of the geographical distribution of the disease is drawn for the most common genetic disease in the province in the statistical years 2009 to 2014 and according to the number of patients who have referred to genetic counseling centers in Welfare Organization of the province in the border of cities of Kurdistan province.

5. The spatial analysis of disease

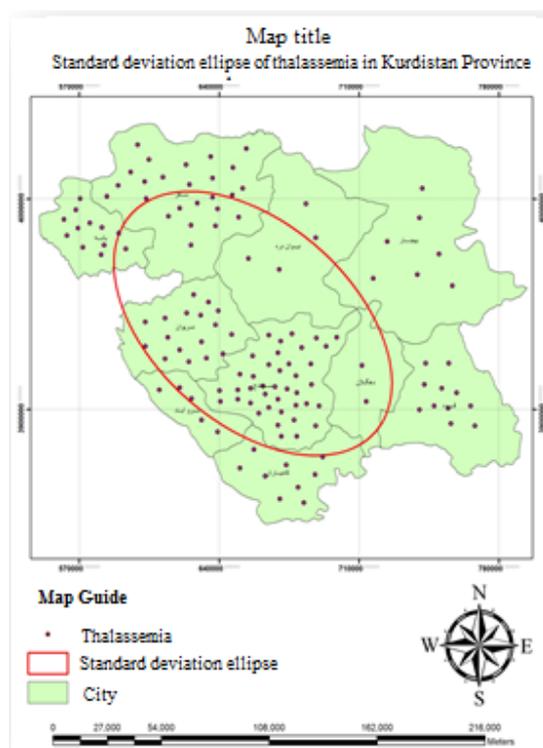In order to determine the direction of spread of disease, a standard deviation ellipse and mean center is drawn.

Map title
Standard deviation ellipse of physical disabilities in Kurdistan Province

Map title
Standard deviation ellipse of mental disabilities in Kurdistan Province

Map title
Standard deviation ellipse of phenylketonuria in Kurdistan Province

Map title
Standard deviation ellipse of blindness in Kurdistan Province

Figure 3- Geographical distribution and standard deviation ellipse of diseases in Kurdistan province

6- FINDINGS

6-1 The situation of phenylketonuria (PKU) in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province,the number of patients with this disease, according to their gender, age and city of residence is as follows.

6-2 The situation of thalassemia in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province, the number of patients with this disease, according to their gender, age and city of residence is as follows.

6-3 The situation of hemophilia in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province, the number of patients with this disease, according to their gender, age and city of residence is as follows.
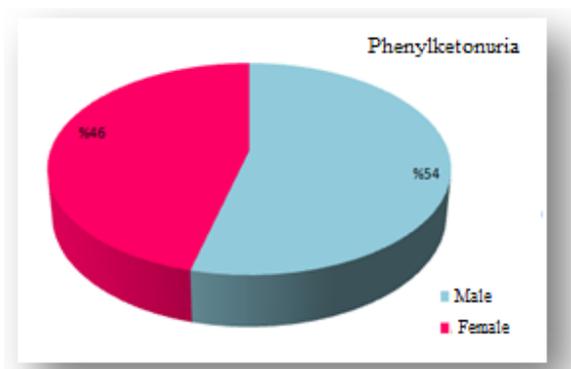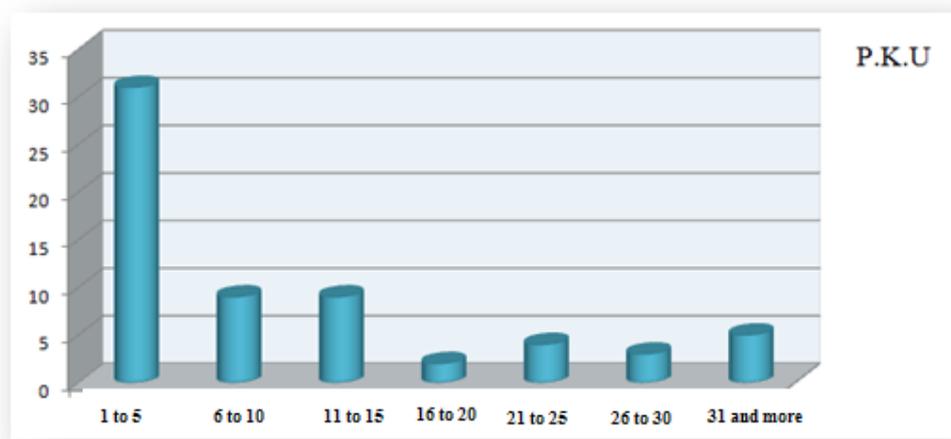
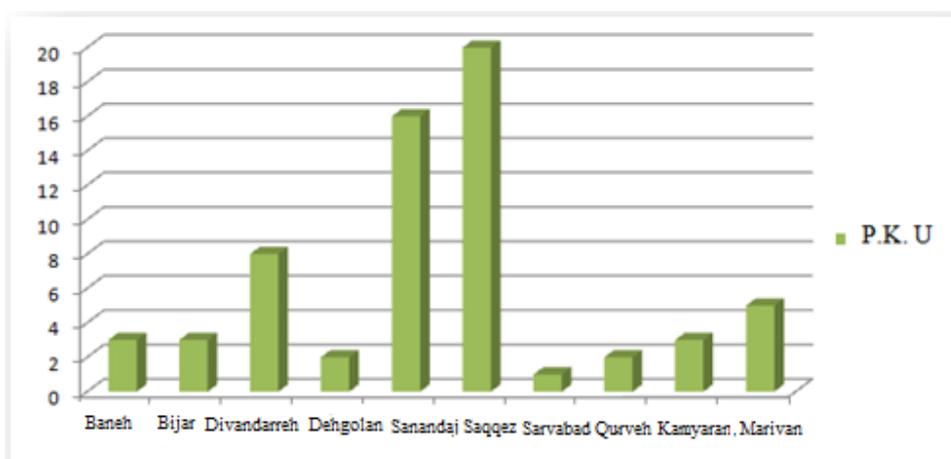| Gender	Frequency
Male	34
Female	29
Total	63

Table and Figure 1- Data of Phenylketonuria disease according to the gender of patients in Kurdistan Province (2014)

Table 2- Data of Phenylketonuria disease according to the age of patients in Kurdistan Province (2014)

Age (Year)	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 and more
Frequency	31	9	9	2	4	3	5

Graph 3-Data of Phenylketonuria disease according to the age of patients in Kurdistan Province (2014)

Graph 4- Distribution of Phenylketonuria in the cities of Kurdistan Province (2014)

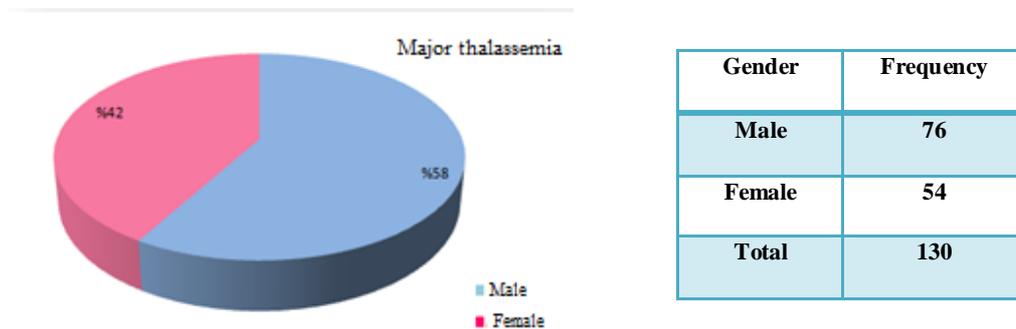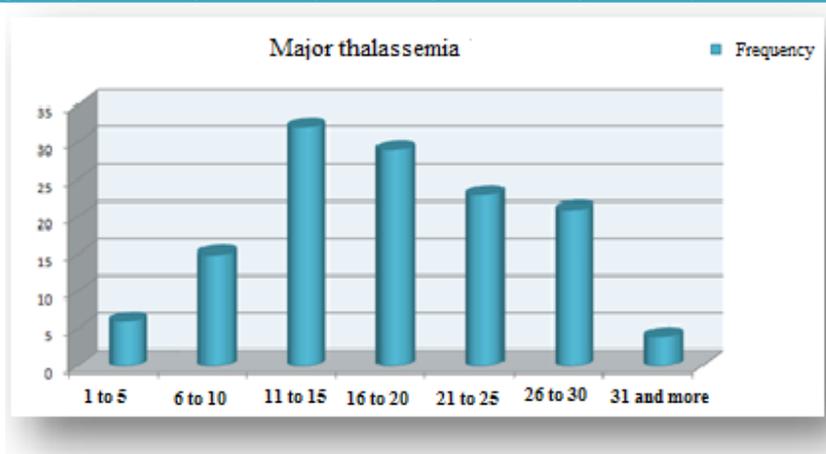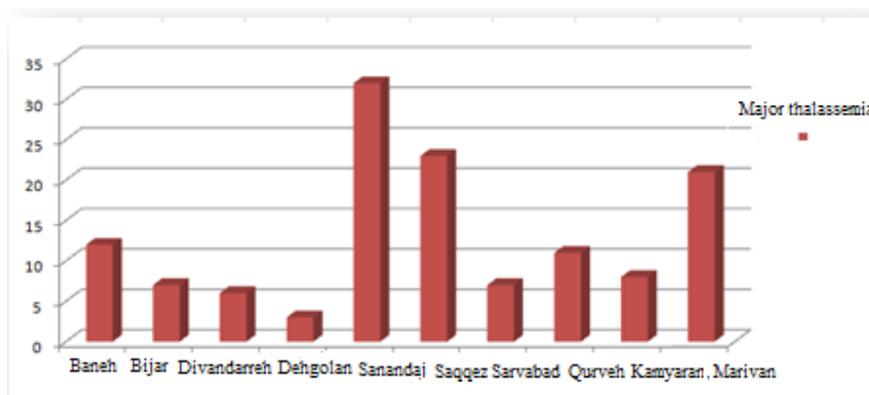| Gender	Frequency
Male	76
Female	54
Total	130

Table and Figure 5- Data of thalassemia according to the gender of patients in Kurdistan Province (2014)

Table 6-Data of thalassemia disease according to the age of patients in Kurdistan Province (2014)

Age (Year)	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 and more
Frequency	6	15	32	29	23	21	4

Graph 7-Data of thalassemia disease according to the age of patients in Kurdistan Province (2014)

Graph 8- Distribution of thalassemia in the cities of Kurdistan Province (2014)

Hemophilia

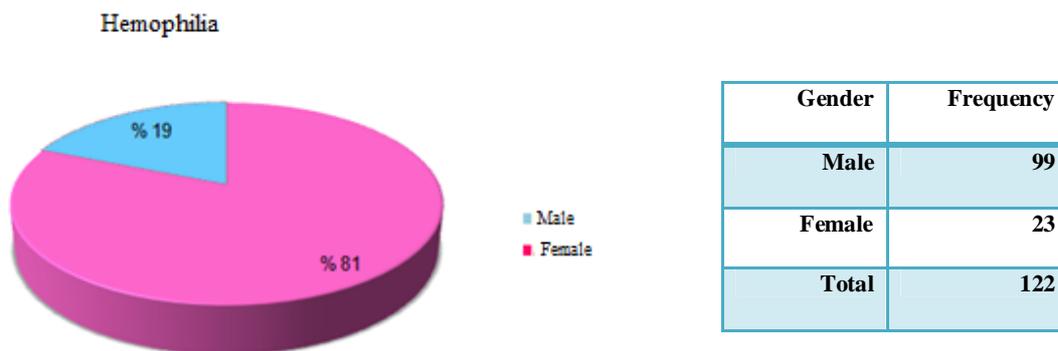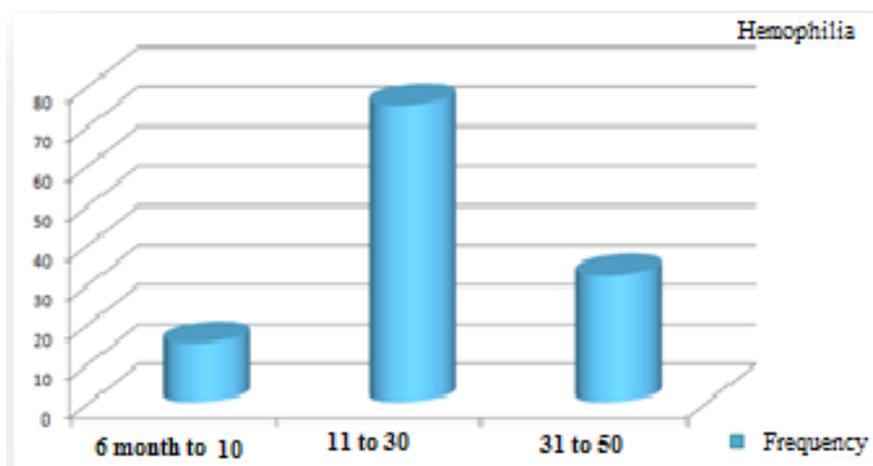| Gender	Frequency
Male	99
Female	23
Total	122

Table and Figure 9- Data of hemophilia according to the gender of patients in Kurdistan Province (2014)

Table 10- Data of hemophilia disease according to the age of patients in Kurdistan Province (2014)

Age (Year)	6 month to 10	11 to 30	31 to 50
Frequency	15	75	32

Graph 11- Data of hemophilia disease according to the age of patients in Kurdistan Province (2014)
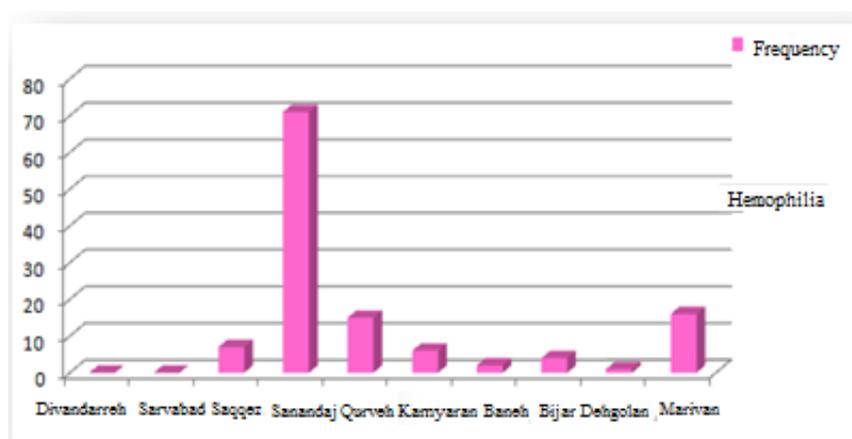
Graph 12- Distribution of hemophilia in the cities of Kurdistan Province (2014)

6-4 The situation of mental disabilities in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province, the number of patients with this disease, according to their gender, age and city of residence is as follows.

6-5 The situation of hearing loss and deafness in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province, the number of patients with this disease, according to their gender, age and city of residence is as follows.

6-6 The situation of blindness in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province, the number of patients with this disease, according to their gender, age and city of residence is as follows.
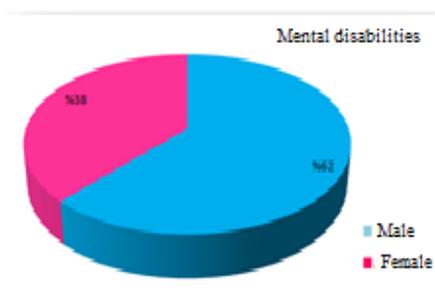

Gender	Frequency
Male	314
Female	192
Total	506

Table and Figure 13- Data of mental disabilities according to the gender of patients in Kurdistan Province (2014)

Graph 14- Distribution of mental disabilities in the cities of Kurdistan Province (2014)

Gender	Frequency
Male	**298**
Female	**237**
Total	**535**

Table and Figure 15- Data of hearing loss and deafness according to the gender of patients in Kurdistan Province (2014)

Graph 12- Distribution of hearing loss and deafness in the cities of Kurdistan Province (2014)

Table and Figure 17- Data of blindness according to the gender of patients in Kurdistan Province (2014)

Gender	Frequency
Male	114
Female	89
Total	203

Graph 18- Distribution of blindness in the cities of Kurdistan Province (2014)

6-7- The situation of physical disabilities in Kurdistan Province

Considering the information obtained from the Welfare Organization and health care center of University of Medical Sciences of Kurdistan province, the number of patients with this disease, according to their gender, age and city of residence is as follows:
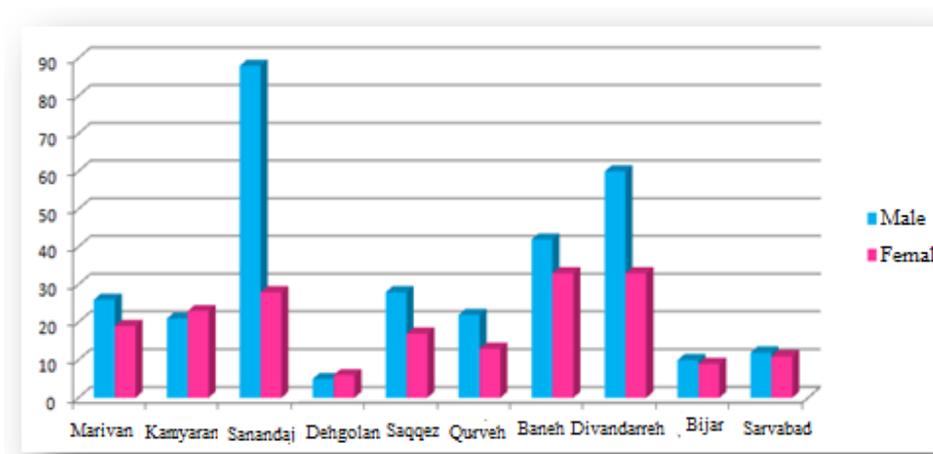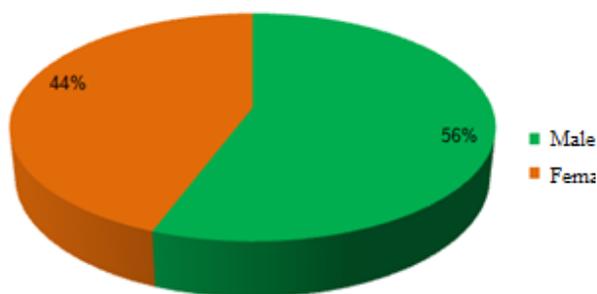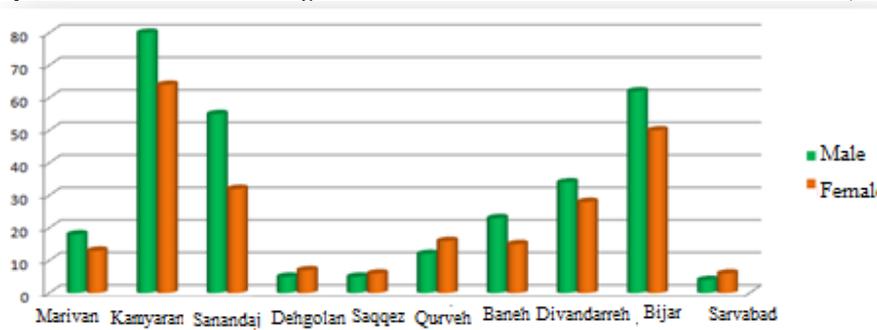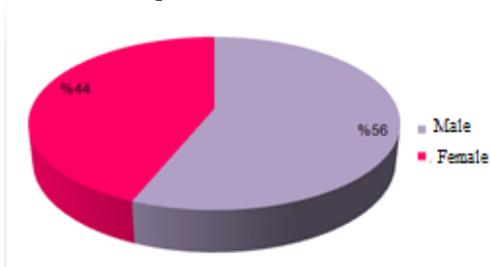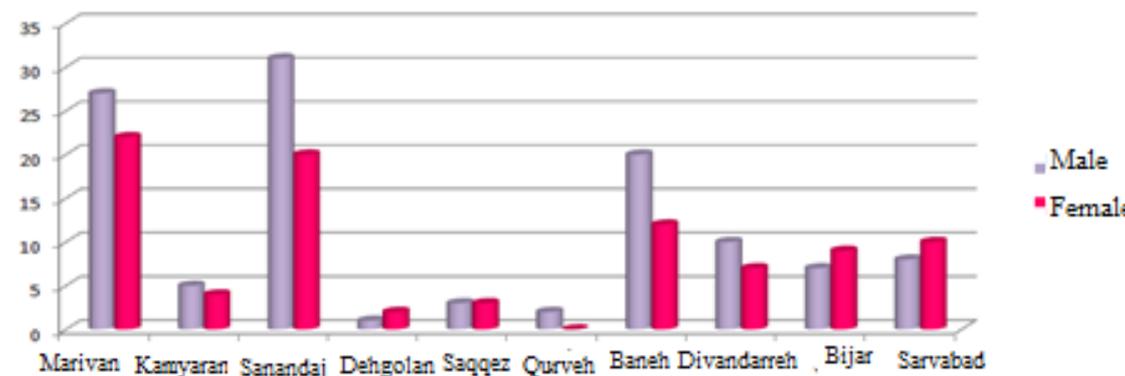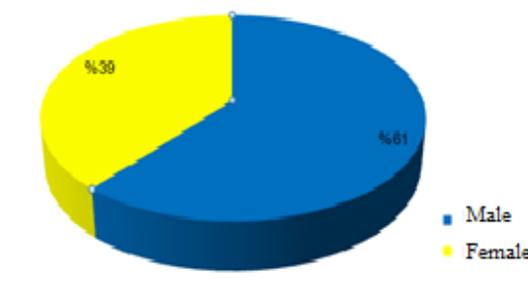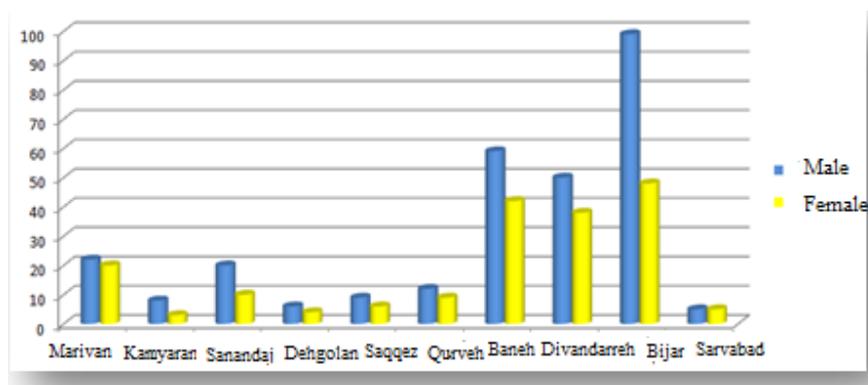

Gender	Frequency
Male	**290**
Female	**180**
Total	**475**

Table and Figure 19- Data of physical disabilities according to the gender of patients in Kurdistan Province (2014)

Graph 20- Distribution of physical motor disabilities in the cities of Kurdistan Province (2014)

7- Comparison of the prevalence of the studied diseases in the province and their prevalence in the country:

According to the graphs and tables, it was found that the rate of the prevalence of phenylketonuria, in Kurdistan Province, is higher in males than in females and the highest number of disease were seen in children aged between 1 and 5 years old and the rate of prevalence of this disease in Saqqez is higher than other cities of Kurdistan province. Also, in Kurdistan Province, the rate of prevalence of Thalassemia is higher among males than females and the greatest numbers of patients were aged between 21 to 25 years old and according to statistics the rate of prevalence of this disease in Sanandaj, is higher than other cities of Kurdistan province. Also the rate of prevalence of hemophilia, in Kurdistan, is higher in males than the females and most of the patients were aged

between 11 to 30 years old, and figures show that the highest rate of prevalence of the disease was seen in Sanandaj. The prevalence rate of physical motor impairment with genetic causes, in Kurdistan, is more in males than females and it has been reported that the statistics of the prevalence of this disease in Bijar, is higher than the other cities of Kurdistan. Also the prevalence of blindness and mental disabilities with genetic causes, in Kurdistan, is more in males than females and the rate of the prevalence of this disease in Sanandaj, is higher than the other cities of Kurdistan and the prevalence of hearing loss and deafness with genetic causes, in Kurdistan, is more in males than females and the rate of the prevalence of this disease in Kamyaran, is higher than the other cities of Kurdistan. According to the monitoring and evaluation of some genetic diseases, including thalassemia, hemophilia and phenylketonuria (PKU), which have been conducted in the country and considering the reports obtained from the center of the health care of Medical Sciences Universities of the country and also Kurdistan province and also the studies that have been performed in the present research, it was found that the prevalence of the mentioned genetic disorders in Kurdistan province is less than other provinces of the

country and in the state divisions, in terms of the prevalence of genetic disorders, Kurdistan province is placed in the position of mild to moderate andnorthern provinces, in terms of the prevalence of genetic disorders ,are ranked first in the country and according to the state divisions they are placed in the category of severe to moderate. However, in the case of disease of deafness, according to conducted surveys and statistics and data available in the Welfare Organization, the latest reports indicate that the country's average of deafness disease is 2.6 that this figure is 2.2 in Kurdistan province and this represents that the index of deafness of Kurdistan Province is close to the national average and hence, the prevalence of deafness in Kurdistan province is located in the middle class and this matter can be a wake-up call for the authorities of Kurdistan Province to investigate the cause of this issue. Many of the diseases impose high financial costs on patients and their families. Investigating the causes of the disease and the prevalence of a number of diseases in the province and examining the status of the disease in the country requires laboratory studies and also the identification of the level of impact of all factors related to disease that as a result of it the factor or factors of the prevalence of intended diseases will be

detected in the province or country and the necessary measures would be carried out to reduce or eliminate these factors. Identification of the accumulation of certain diseases in the province and the country will considerably be helpful for the human resources management, allocation of budget, and health services in centers of accumulation of the diseases.

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