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Research Article

Spatial Epidemiology Study of Congenital Hypothyroidism in Kerman Province Using Geographic Information System in 2011 - 2013

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Abstract

Background and Objectives: Hypothyroidism is one of the most important and preventable causes of mental retardation in newborns. The incidence of Congenital Hypothyroidism (CH) in Kerman province is considerably higher than the whole country.

Methodology: This study aimed to investigate the incidence and geographical distribution of CH by using Geographic Information System in Kerman province during 2011 - 2013. Three-year incidence rate of neonatal hypo thyroid disease was calculated and plotted on digital maps with the scale of 1/100000 using ArcGIS 0.9.2 software in Kerman province.

Result: In this study, 393 newborns with Congenital hypothyroidism who had been diagnosed through the three years (2011 - 2014) in Kerman province were investigated. Among this population, 225 cases were boys and 168 were girls. The incidence of three-years Congenital hypothyroidism was 1 in 230 live births, at the provincial level. The findings of this study showed that the incidence of Congenital hypothyroidism in Raver, Baft, Orzoeeyeh and Kuhbanan was higher than other cities in Kerman province (5.04 to 13.67 in 1000). There was no statistically significant correlation between sea level and the overall incidence of CH disease and only a weak correlation was seen between the average above sea level and incidence of CH in the female newborns (P = 0.116, r = 0.33).

Conclusion: In this study, it was showed that Raver, Baft, Orzoeeyeh and Kuhbanan cities had high incidence of disease, using the Geographic Information System. According to existing patterns, it seems that we should look for other factors such as socioeconomic status, parental consanguinity, genetic factors and also maternal nutritional deficiencies during pregnancy and more studies are needed in this regard.

Keywords: *Neonatal Congenital Hypothyroidism; Geographic Information System; Kerman*

Introduction

Neonatal Congenital hypothyroidism (CH) is one of the most common endocrine diseases and one of the most important preventable causes and treatments of physical growth disorders and mental disabilities [1,2]. Thyroid hormone plays a very important role in the development of fetal nervous system and neonatal physical growth, and the hypothyroidism of the thyroid gland can lead to growth retardation which, if left untreated, may lead to persistent mental and dynamic retardation [3]. Of every 2,000 to 4,000 live births in countries with adequate iodine intake, one CH case occurs [4,5]. According to the report of progress of the implementation of National Screening Program of Neonatal Thyroid Hypothyroidism in Iran, which was published in 1389 by the Ministry of Health, the incidence of

the disease is 233 in 100,000 newborns or (1 patient In 428 live newborns) in the whole country among Iranian newborns, which is more than the global average [6]. The disease has no specific symptoms during the first few weeks or has very mild symptoms, so the only way to diagnose that, is screening with laboratory methods [7]. Due to the importance of this disease, today in many countries of the world, thyroid screening tests are carried out at the birth and early diagnosis and treatment, cause natural, mental, and physical growth of the infants. Delay in treatment or non-treatment results in severe irreversible mental and growth retardation. Therefore, early diagnosis of the disease and its replacement therapy at the first days of the birth would prevent a serious illness [8]. Precise information on the incidence and prevalence of the disease and its variation trends in society and determining its dispersion pattern is essential for preventive and interventional programs. Geographic Information System is one of the suitable methods for identifying disease distribution, which allows to evaluate geographic distribution and dispersion. In addition to study of CH over time and by drawing thematic maps related to CH, effective steps can be taken and this kind of studies also help to fairly allocation of funds and facilities to the cities. Due to the lack of clarity of CH distribution, this study has been performed using data from the national CH screening program with the aim of determining geographical pattern of CH disease in East of Iran and Kerman province for the first time using the GIS.

Materials and Methods

This study was implemented cross-sectional and by the data of national CH screening program, all Kerman born infants through the years of 1390-1392 which were diagnosed to be patients were entered into the study. The TSH test was used as a primary test in the neonatal hypo thyroid screening program. At 3 to 5 days after birth, the blood samples taken from the heel of the infants were studied, and newborns with TSH values of ≥ 5 mU/L were refereed for confirmation of diagnosis by venous TSH and T4 and clinical examinations. Infants who had T4 and TSH values below 6.6 μg/dl and more than 10 mU/L in the second stage (recall), respectively, were treated as infants with neonatal hypothyroidism with levothyroxine [9].

Also in this study, the definition of CH patient is used in screening program as mentioned above. The exclusion criteria also included: patients with infantile thyroid infected with concomitant illness or complications such as intrauterine growth retardation children (IUGR), or those with genetic problems such as Down syndrome or severe anomalies. The incidence of CH at the county level was calculated by dividing the number of newborn infants with neonatal thyroid deficiency diagnosis during whole of study period by the total number of infants born in the same period. Denominator data were extracted from the statistics of the country's civil registry. To illustrate the dispersion of this disease and identifying high-incidence cities, the latest edited digital map of Kerman province (the year 1391) with the precision of 1/100000 was used with the cities division. After adding the three-year incidence of CH disease based on cities divisions to city maps by using ArcGIS 9.2, it was mapped into five levels with equal spacing and green to red color schemes. It should be noted that, dark and light green color show low incidence, yellow color indicates a moderate incidence, and orange and red color indicate high incidences. Also, the mean altitude of the sea level of the cities of the province was obtained from the information of the Meteorological Organization of the province and the map of the correlation between the incidence of CH and altitude from the sea level was drawn. In this map, the integration of the map of the incidence of CH disease in the province level was showed with a red spectrum and the map of altitude from the sea level was showed with a blue color spectrum.

Results

In this study, all infants with neonatal hypothyroidism with 393 newborns were studied during the years 1390 - 1392 in Kerman province, including 225 female neonates and 168 male newborns. The incidence of hypo thyroid during these three years is 1 in 230 live births, which is higher than the average of the country which is 1 in 428 births [6]. The incidence rate has been higher in the year 1392 compared to the years of 1391 - 1390. It has been 2.56 cases per 100 live births in 1392, 2.26 cases per 1000 live births in 1390, and 2.23 cases per 1000 live births in 1391 which have been calculated as highest to the lowest incidence rates of congenital hypothyroidism through these three years (Table 1).

Total		1392		1391		1390		Sex	Location
Incidence Rate	No	Incidence Rate	No	Incidence Rate	No	Incidence Rate	No		
6.23	6	9.46	3	8.96	3	0.0	0	Male	Orzoeiyeh
5.68	5	3.32	1	3.60	1	9.97	3	Female	
5.97	11	6.47	4	6.53	4	4.90	3	Total	
9.85	17	10.6	6	5.11	3	13.96	8	Male	Baft
4.31	7	3.71	2	5.40	3	3.78	2	Female	
7.16	24	7.24	8	5.25	6	9.07	10	Total	
3.65	6	1.92	1	0.0	0	8.8	5	Male	Bardsir
4.24	7	3.55	2	3.58	2	5.67	3	Female	
3.94	13	2.76	3	1.8	2	7.29	8	Total	
2.08	10	2.65	4	0.71	1	2.64	5	Male	Bam
0.63	3	0.65	1	0.0	0	1.09	2	Female	
1.36	13	1.64	5	0.36	1	1.88	7	Total	
2.91	21	3.45	9	2.11	5	3.11	7	Male	Jiroft
1.03	7	2.08	5	0.45	1	0.46	1	Female	
2.00	28	2.79	14	1.31	6	1.82	8	Total	
0.0	0	0	0	9.01	2	7.41	2	Male	Rabor
7.07	5	0	0	0.0	0	4.00	1	Female	
3.38	5	0	0	4.42	2	5.77	3	Total	
15.34	16	17.00	6	20.35	7	8.67	3	Male	Ravar
11.94	12	15.48	5	12.74	4	8.15	3	Female	
13.67	28	16.27	11	16.72	11	8.40	6	Total	
3.02	24	2.91	8	2.29	6	3.88	10	Male	Rafsanjan
2.10	16	0.38	1	3.55	9	2.45	6	Female	
2.57	40	1.68	9	2.91	15	3.18	16	Total	
1.75	8	2.37	4	1.35	2	1.43	2	Male	Rodbar jonob
1.88	8	1.26	2	2.87	4	1.56	2	Female	
1.81	16	1.84	6	2.08	6	1.49	4	Total	
1.16	3	1.03	1	1.25	1	1.23	1	Male	Rigan
1.69	4	3.44	3	1.34	1	0.0	0	Female	
1.41	7	2.17	4	1.29	2	0.64	1	Total	
2.39	11	1.25	2	3.99	6	2.01	3	Male	Zarand
3.48	15	2.66	4	4.9	7	2.9	4	Female	
2.92	26	1.94	6	4.43	13	2.44	7	Total	
3.36	29	4.65	14	3.11	9	2.20	6	Male	Sirjan
1.37	11	1.76	5	1.52	4	0.79	2	Female	
2.4	40	3.25	19	2.35	13	1.52	8	Total	

1.31	3	2.61	2	1.22	1	0.0	0	Male	Shahrbabak
1.9	4	2.69	2	1.37	1	1.59	1	Female	
1.59	7	2.65	4	1.29	2	0.75	1	Total	
1.15	3	2.15	2	1.11	1	0.0	0	Male	Anbarabad
1.77	5	3.15	3	1.14	1	1.01	1	Female	
1.47	8	2.65	5	1.12	2	0.56	1	Total	
0.39	1	0.0	0	0.98	1	0.0	0	Male	Fahraj
1.27	3	0.99	1	0.0	0	5.26	2	Female	
0.81	4	0.47	1	0.50	1	2.59	2	Total	
1.34	4	1.88	2	1.05	1	1.03	1	Male	Ghaleh ganj
3.11	9	1.94	2	5.26	5	2.20	2	Female	
2.21	13	1.91	4	3.16	6	1.60	3	Total	
2.21	50	1.64	13	2.46	19	2.59	18	Male	Kerman
1.42	31	1.3	10	1.24	9	1.73	12	Female	
1.82	81	1.48	23	1.87	28	2.16	30	Total	
4.86	3	9.3	2	5.49	1	0.0	0	Male	Kohbanan
5.23	3	5.65	1	10.42	2	0.0	0	Female	
5.04	6	7.65	3	8.02	3	0.0	0	Total	
2.26	8	4.87	6	0.84	1	0.90	1	Male	Kahnoj
2.92	10	5.71	7	1.78	2	0.93	1	Female	
2.59	18	5.29	13	1.30	3	0.92	2	Total	
0.97	2	2.65	2	1.40	1	0.0	0	Male	Manojan
1.49	3	0.0	0	1.42	1	3.50	2	Female	
1.23	5	1.34	2	1.41	2	1.73	2	Total	
2.57	225	3.02	87	2.41	71	2.62	72	Male	Total
2.01	168	2.07	57	2.04	57	1.88	50	Female	
2.30	393	2.56	144	2.23	128	2.26	122	Total	

Table 1: *The incidence of neonatal hypothyroidism in 1000 live births divided by county, gender, and year in Kerman province.*

According to the obtained data, the highest incidence rate is in the male infants in 1390 with 2.62 cases per 1000 live births and the highest incidence rate in girls is related to 1392 with 3.02 per 1000 live births (Table 1).

Among the cities of the province in 1390, the highest incidence rate per 1000 live births goes to Baft (9.07), Ravar (8.40), Bardsir (7.29), Rabar (5.77), and Arzuyeh (4.90). In 1391, the highest incidence rate per thousand live births goes to Ravar (16.72), Kuhbnan (8.02), Arzuyeh (6.53), Baft (5.25), and Raber (4.42). In 1392, the highest incidence rate per 1000 live births goes to Ravar (16.27), Kuhbanan (7.65), Baft (7.24), Arzuyeh (6.47), and Kahnouj (5.29) (Table 1).

The cities of the province have been divided into five classes according to the incidence rate of CH, which in that, the Ravar, Kohbanan, Baft, and Arzuyeh had higher incidence rate than other cities (7.16 to 13.67 per 1000) (Figure 1).

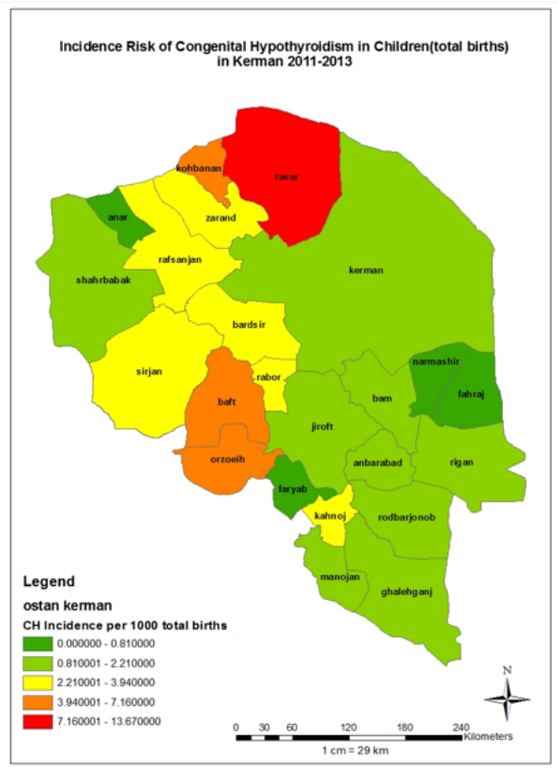

Figure 1: *The incidence rate of neonatal hypothyroidism in Kerman province in 1390-1392.*

Figure 2 shows the incidence rate of hypothyroid in female newborns in the counties level that the counties of Ravar, Kohbanan, Rabar and Arzuyeh had higher incidence than other cities (7.07 to 11.94 per 1000) (Figure 2).

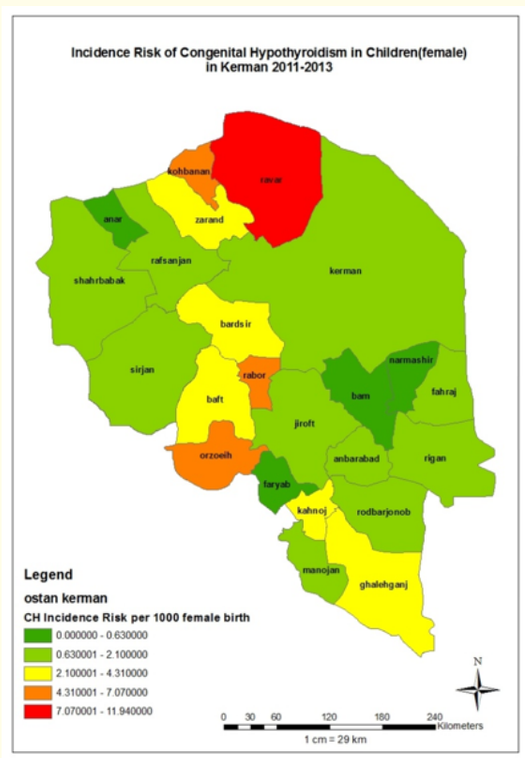

Figure 2: *The incidence rate of hypothyroidism in female newborns of Kerman province in 1390-1392.*

Figure 3 shows the incidence rate of hypothyroid in male newborns in the counties level, which Ravar, Baft, and Arzuyeh cities had higher incidence rates than other cities (9.86 to 15.34 per 1000) (Figure 3).

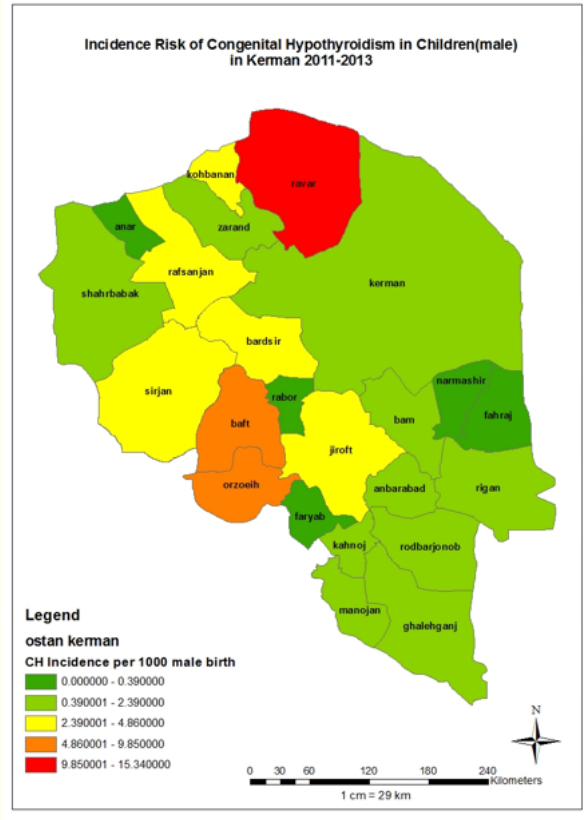

Figure 3: *The incidence rate of hypothyroidism in male newborns of Kerman province in 1390-1392.*

Considering that in this study the relationship between mean altitude above sea level with the incidence of CH was also mentioned, the map of the mean altitude from the sea level of the Kerman province cities was drawn up with a blue color spectrum and the map of the incidence of CH disease with red color spectrum in four floors with the same distance with ArcGIS 0.9 software, and then both maps merged together having the 12-floor color spectrum from dark red to gray scale (Figure 4). Ravar had a high incidence of CH disease and mean altitude above sea level, and in contrast in Shahrbabak city, the incidence of CH disease was low and the mean altitude of the sea level was high. Meanwhile, in order to determine the correlation between the incidence of CH disease and mean altitude above sea level of Kerman province cities, SPSS18 software was used and there was no statistically significant correlation ($r = 0.33$ and $P = 0.116$).

Discussion

The findings of this study showed that by using geographical information systems, by plotting thematic maps about the incidence of new born hypothyroidism, a clearer picture of the process of changes and spatial development of the disease can be provided in the dimensions of a health system that effectively leads to evidence-based decision making. The results showed that in the three years studied, Ravor, Baft, Arzuyeh and Kohbanan had higher incidence rates than other counties (5.04 to 13.67 per 1000). There was no statistically sig-

nificant correlation between altitude above the sea and the incidence of CH. Of the total number of patients, the number of male patients was 225 (57%) with a three-year incidence of 2.57% of live births, and the number of female patients was 168 (43%) with a three-years incidence of 2.01 per 1000 live births which indicates that the CH incidence rates is higher among males than females. In most studies conducted in the field of evaluating the risk factors of neonatal hypothyroidism, the female sex has been introduced as a risk factor [10,11]. In a study conducted in Fars province in 1385, the disease incidence rate in girls was higher than boys [12]. In another study implemented in 2010 in the United States, the increase of incidence of infant hypothyroidism in recent years has been the same in two sexes, and only in a study done in Texas, similar to our study, this rate has shown more increase among boys [13]. So far, few studies in the world and Iran have investigated the geographical distribution of CH and the role of environmental factors on its incidence [14]. In a study conducted in Iran by Dr. Hallakoye., *et al*. High-populated cities such as the provincial centers often had an incidence of nearly 2 per 1000, and in contrast, less populated cities, showed an incidence ranged from 0 to 13 in one thousand cases. Most of these changes are related to the diminution of the denominator [15]. However, in this study, evidence is also in favor of accompanying the low population density of the denominator, including live births, with higher incidence rates.

In a study in Wales, England, which had been done by screened data of 11 years, the incidence of CH in the southern region was lower than northern regions which is attributed to higher population density in the northern regions [16]. In another study in New York, differences in the incidence of CH have been observed in different states due to the Asian race high population density in areas with higher incidence [17]. It is notable that the impossibility of separating the transient and permanent type of disease in neonates at the time of the study, and lack of access to information about social determinants of health and CH risk factors in screened neonates, are considered as the main limitations of this study. It is suggested that the data collection form of country screening plan should be revised and the disparity factors of inequality such as the status of education, and the parents occupational status should also be considered.

Conclusion

GIS is an efficient and inexpensive tool for evaluating the distribution of health-related factors that can be used easily and with high speed at various levels of health systems. In this study, it was showed that Ravar, Baft, Erwiya, and Kohbanan had high incidence of disease, using the Geographic Information System. Regarding the existing pattern, it seems that we should look for other effective factors such as socioeconomic status, parental inflection and genetic causes, as well as maternal nutritional deficiencies during pregnancy, and further studies are needed in this regard.

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Conflict of Interest

None declared.

Bibliography

1. Jameson JL and Weetman AP. "Diseases of the thyroid gland". *Harrisons Principles of Internal Medicine* 16.2 (2005): 2104.

2. Guyton AC and Hall JE. "Textbook of Medical, Physiology". 1st edition. Sounders Elsevier, Philadelphia (2011): 907-916.

3. Lotfi M and Rahimi-Pordanjani S. "Comparison of the growth patterns among children with congenital hypothyroidism and healthy children in Yazd city in 2014: a historical cohort study". *Feyz Journal of Kashan University of Medical Sciences* 19.1 (2015).

4. Hashemipour M., *et al*. "Effect of Diagnostic and Treatment Factors on Growth Development of Children with Congenital Hypothyroidism: A prospective longitudinal study (2015).

5. Maciel LMZ., *et al*. "Congenital hypothyroidism:¬recommendations of the Thyroid Department of the Brazilian Society of Endocrinology and Metabolism". *Arquivos Brasileiros de Endocrinologia and Metabologia* 57.3 (2013): 184-192.

6. Yarahmadi Ajang N and Mahdavi A. "Progress report on the implementation of the national screening program for neonatal hypothyroidism in Iran – 2010" (2012): 30.

7. Delange F. "Neonatal screening for congenital hypothyroidism: results and perspectives". *Hormones* 48.2 (1997): 51-61.

8. Gruters A., *et al*. "Neonatal thyroid disorders". *Hormone Research in Paediatrics* (2004): 24-59.

9. Delavari A., *et al*. "Screening program of neonatal congenital hypothyroidism and transient TSH level increase in Iran". *Ministry of Health and Medical Education of Iran* (2005).

10. Hashemipour M., *et al*. "Prevalence of congenital hypothyroidism in Isfahan, Iran: results of a survey on 20,000 neonates". *Hormone Research in Paediatrics* 62.2 (2004): 79-83.

11. Waller DK., *et al*. "Risk factors for congenital hypothyroidism: an investigation of infant's birth weight, ethnicity, and gender in California, 1990–1998". *Teratology* 62.1 (2000): 36-41.

12. Sepandi M., *et al*. "Risk factors for congenital hypothyroidism in Fars Province, Iran, 2003-2006". *Journal of School of Public Health and Institute of Public Health Research* 7.1 (2009): 35-45.

13. Hinton CF., *et al*. "Trends in incidence rates of congenital hypothyroidism related to select demographic factors: data from the United States, California, Massachusetts, New York, and Texas". *Pediatrics* 125.2 (2010): S37-S47.

14. Lamm SH and Doemland M. "Has perchlorate in drinking water increased the rate of congenital hypothyroidism?" *Journal of Occupational and Environmental Medicine* 41.5 (1999): 409-411.

15. Osooli M., *et al*. "Spatial distribution of congenital hypothyroidism in Iran using geographic information system". *Iranian Journal of Epidemiology* 5.1 (2009): 1-8.

16. Law W., *et al*. "Congenital hypothyroidism in Wales (1982-1993): demographic features, clinical presentation and effects on early neurodevelopment". *Clinical Endocrinology* 48.2 (1998): 201-207.

17. Harris KB and Pass KA. "Increase in congenital hypothyroidism in New York State and in the United States". *Molecular Genetics and Metabolism* 91.3 (2007): 268-277.

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