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ORIGINAL ARTICLE

Impact of Various Geographical Factors on Occurrence of Leukemia in Khuzestan Province of Iran

Seyed Saeid Seyedian[1], Khirollah asadollahi[2], Maria Cheraghi[3,4], Kourosh Sayehmiri[5], Maryam Mombaini[6], Parviz Rostamizarinabadi[7], Changiz Rostami[8]*.

[1]Alimentary Tract Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
[2]Department of Social Medicine, School of Medicine, Ilam University of Medical Sciences, Ilam,Iran
[3]Cancer Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
[4]Department of Public Health, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
[5]Department of Biostatistics and Epidemiology, Ilam University of Medical Sciences, Ilam, Iran
[6]Deputy of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran,
[7]English language, Department of Education, Romeshgan, Iran
[8]Department of Epidemiology, Health School, Ilam University of Medical Sciences, Iran

Study Area: Ahvaz, Iran
Coordinates: 31°19'13"N; 48°40'09"E

Abstract

The present study provided spatial patterns of leukemia incidence in relation to climatic-geographical factors in Khuzestan province; Iran, based on descriptive-analytic research. The research subject was all leukemia patients from cancer Registration population, based in Khuzestan province. The climatic factors were mapped by using Arc GIS software version 10.3 was used. The finding based on 1648 patients with leukemia had shown that the average age of them was 39.6±11.28 years old and percentage of Male and female was like 58.8% and 41.2% respectively. The cumulative incidence rate of leukemia among the population was estimated 36.36/100000. The highest and lowest annual incidence rate was 8.2/100000 in 2012 and 6.05/100000 in 2011. Hot and high-risk spots of leukemia in Khuzestan province were Ahvaz and Behbahan.

Key words: Geographical Information System, Geophysical Characteristics, Blood Cancer

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Introduction:

Cancer is referred to a large group of diseases in which unbridled and uncontrolled cell growth happens, which can lead to disrupting the body's natural balance and severe and deadly disorders (Yavari *et al.*, 2014). In Health System programs, cancer disease is placed in a special position due to their irreparable complications and enormous diagnostic and therapeutic costs (Mehrabi *et al.*, 2004). Key factors such as population growth and aging population, along with other factors like smoking, overweight, physical inactivity, increasing urbanization, and economic situation have increased cancer rates (Torre *et al.*, 2015). In the fifties/sixties, it was believed that cancers would happen in western, industrial, and high-income countries while today, cancer rates are higher in lower or middle-income countries (Thom, 2010). Leukemia contributes eight percent of all types of cancers happen among human populations. It is known as the fifth common cancer in the world. Cancers related to blood-forming tissues including bone marrow and lymphatic system are caused with white blood cells and lymph. White blood cells grow and divide in an organized and controlled way, however, leukemia disrupts this process and makes the blood cells growth uncontrolled (http://apps.nccd.cdc.gov/uscs/, Jemal *et al.*, 2008; Mossoomy & Mesgari, 2008; Melnick, 2002). Contrary to other types of cancer, leukemia is not a solid tumor that can be taken out through an operation. In fact, bone marrow is the main source for this type of cancer; that is why its treatment would be much more complicated (Melnick, 2011). Leukemia is the most common cancer among children. Although acute leukemia incidence rate is less than 3 percent of all types of cancer, it is of particular importance due to its high death rate among children (Pizzo & Poplack, 2006; Deschler & Lübbert, 2006). In a study conducted in Iran, 19.8% of all types of cancer diagnosed in children was leukemia (Bahoush-Mehdiabadi et al., 2014). In some cases, diagnosing risk factors makes it possible to prevent cancer (Wang & Chen, 2001). Report of United States Department of Health and Human Services, two-thirds of all cancers, in America, is related to human exposure to a wide range of natural and man-made materials that have been released in the environment. The environmental factors fall into two groups: i) the lifestyle like smoking, ii) external factors such as chemicals in the

*Corresponding Author: *Rostami_37@yahoo.com*

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air, water, food, workplace, living environment, as well as radiation exposure. In some cases, some special environmental exposure is directly related to some kinds of cancer; for instance, smoking is related to thirty types of cancer. Therefore, cancer mapping can assist us in obtaining specific patterns and relations between cancer cases and environmental factors (Wang & Chen, 2001; Irigaray *et al*., 2007). Studying on geographical changes and their relations to cancer incidence and cancer death rate provide us with some valuable information about both identifying and assessing causes the cancer etiological hypotheses (Glick, 1986; Mayer, 1986). Obtaining the spatial patterns of diseases, including various types of cancers, in a population can give us some valuable information for identifying the causes (Lee & LIrving, 1999). Distribution of diseases such as leukemia and relating them to some specific geographic areas has been already proved and it paves the way for appearing a new science named Medical Geography which studies on effects of locale and climate upon health. Medical science has frequently applied findings of geographical research so that relationships between diseases and various climatic situations can be discovered using disease pattern in geographical space (Hunter, 1974; Jones & Duncan, 1995). Medical-Geographical Information System assesses and classifies the influence of environmental and social-ecology factors upon health (Kennedy, 1988; 2002) so that it seems further studies will not be as careful as possible to predict and assess the process of diseases without using GIS and GPS (Wilkinson et al., 1998). Medical Geography, which is sometimes called Health Geography, is a part of medical research that uses geographical techniques to study the health, distribution, and dispersion of diseases in the world (Akorafas et al., 2002). The present study aimed to investigate the leukemia incidence and its relation to the geographical factors such as climatic zone, vegetation cover, rainfall, and land use by using GIS in Khuzestan province during the year 2009-2013.

Methodology:

This was a descriptive-analytical study that investigated the leukemia incidence and its relation to the geographical, climatic, and environmental conditions of their respective habitats. The research subjects included all the patients with leukemia, those were available in the Cancer Registry population-based in Khuzestan province; Iran 2009-2013. Information of all patients was obtained from Cancer Registry-population based. New cancer cases were marked on the patients' residence. Based on the topography classification, cancer cases registered in 2009-2013 were extracted and included in the study. Moreover, information related to rainfall rate and vegetation cover, climatic zones, and land use were obtained from the meteorological organization and department of Natural Resources and Watershed of Khuzestan province.

To identify the relationship between leukemia and the environmental parameters including climatic condition, average annual rainfall, land use, and vegetation cover, Means Plot, Scatter Plot diagrams, and ETA correlation coefficient were used. Moreover, planning the climatic factors including mapping Khuzestan province, land use, annual rainfall, vegetation cover, and climatic zones were made using Arc GIS software version 10.3.

Data were analyzed by using SPSS software version 16 and to reach the analytical goals, Independent T-test, Kruskai-Wallis test and ANOVA. For the climatic factors mapping, Arc GIS software version 10.3 was used.

Result:

The average age of 1648 patients with leukemia was 39.6±11.28 years old where Male and female was as 58.8% (696 people) and 41.2% (679 people) respectively. The youngest patient whose cancer was diagnosed was five months old and the oldest one was 93 years old. Sex ratio males to females were calculated as 1.42. In general, the cumulative incidence rate of leukemia in Khuzestan province in 2009-2013 was calculated as 36.36/100000. The highest rate of annual incidence was related to the year 2012-2013 with the incidence rate of 8.2/100000 and the lowest rate was related to the year 2011-2012 with the incidence rate of 6.05/100000. Comparing cumulative incidence rate of leukemia in different cities in Khuzestan province during five years, Ahvaz had the highest rate (51.47/100000) and Behbahan and Baghmolk with the rate of 40.62/100000 and 35.37/100000, were placed in the second and third positions respectively. The lowest rate was for Lali town with the incidence rate of 8.03/100000. The leukemia incidence rate was different in various areas in Khuzestan; however, it was not statistically significant ($p>0.35$). As per Fig.-1, Ahvaz and Behbahan were identified as high-risk centers and hot spots (a high-risk canter and a hot spot are referred to a region or a town with the incidence rate higher than the average incidence rate of the disease in the province).

According to the findings, the highest cumulative incidence rate of leukemia was observed in the regions in where the average rainfall was 100-400 millimeters, (with the cumulative incidence rate of 38.40/100000 during five years) and the lowest rate was related to the regions where the rainfall was lower than 100 millimeters (with the cumulative incidence rate of 23.76/100000 during five years). Although, the difference in the incidence rate, in terms of rainfall rate, was not statistically significant ($p>0.38$) (Fig.-2a). The highest five-year cumulative incidence rate of leukemia was related to dry climates with the incidence rate of 40.12/100000 and the lowest rate was for temperate and humid climates with the incidence rate of 26.9/100000 (Fig.-2b). The highest cumulative incidence rate of leukemia (43.6/100000) was observed in arable areas while the lowest rate was related to marine and coastal areas

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(26/100000) (Fig.-2c). However, the relationship between leukemia incidence rate and vegetation covers in different areas in Khuzestan province was not statistically significant (p>0.28). Investigating the relationship between leukemia incidence rate and land use in Khuzestan province showed that the difference between the incidence rate in various areas such as fisheries with the highest rate (49.3/100000) and forest areas with the lowest rate (27.76/100000) was not statistically significant (p>0.44) (Fig.-2d).

Discussion:

Leukemia is the fourth common cancer disease reported from Khuzestan province and the fifth one in the world (Pizzo & Poplack, 2006; Deschler & Lübbert, 2006). As per our findings, the sex ratio of males to females was calculated as 1.42, whereas Zolala et al. (2004) calculated 1.47, Hajazi et al. (2010) conducted in Azerbaijan Province in Iran, it was 1.3 and 1.5 as Zand et al. (2010) . However, Zand et al. (2010) reported that6 the leukemia incidence rate in the age groups of 15-30 and 30-45 were more than those in other groups which is consistent

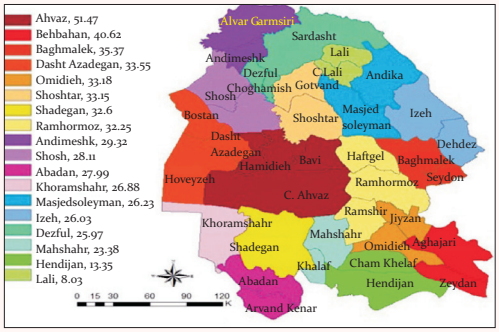

Figure-1: Leukemia incidence rate in various cities of Khuzestan

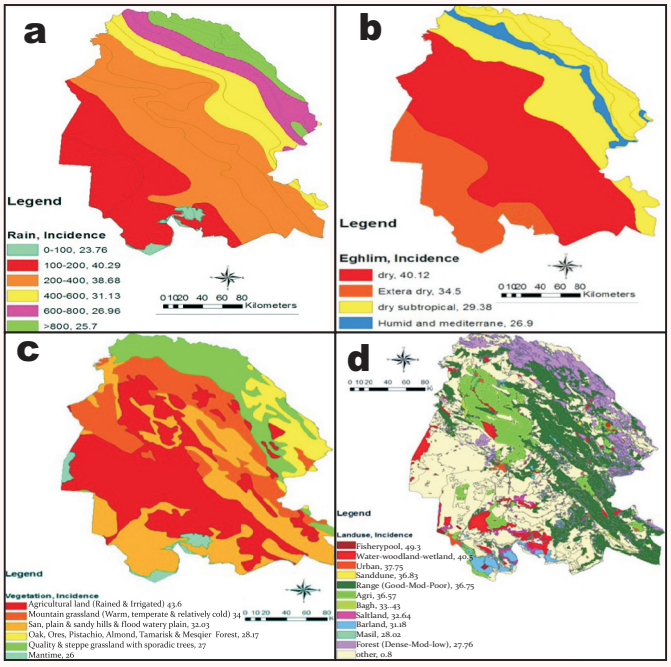

Figure-2: Leukemia incidence rate in Khuzestan province, Iran based on: **a)** annual rain fall **b)** climatic regions **c)** vegetation cover based on GIS **d)** land use based on GIS.

with the findings of our research. Due to the fact that in Iran, the youth (the group age of 20-40) is a large part of the total population of Iran and their exposure to a wide range of environmental factors like chemical and noise pollution etc. is so possible, the highest incidence rate of leukemia is in this age group. However, in the United States of America, the higher incidence rate of leukemia is in the group age of 40-70 (Zand et al., 2010). The data released in 2009 by the Statistics and Leukemia Treatment Organization in USA showed that the leukemia incidence rate was not the same in females and males and this ratio was completely different in different countries and most often, it would be higher in males. The reason can be related to environmental condition, nutrition, etc. (http://www.emedtv.com/advertise.html).

Ahvaz and Behbahan were identified as the high-risk centers and hot spots. In a study conducted in Saudi Arabia, leukemia, after liver cancer and non-hodgkin lymphoma, was the third common cancer among men and the fifth one among women in 1998-2001 and regardless of gender, it was marked as the fourth common cancer (Al-Ahmadi & Al-Zahrani, 2013). In another study, the leukemia incidence rate was estimated as 32.6 among one million under fifteen-year-old children (37.9 among boys and 27.1 among girls) (Zolala *et al.*, 2004). Further, in Azarbaijan province in 2003-2008, the cumulative incidence rate of leukemia was estimated 17.43/100000 among under fifteen-year-old children and it was higher in boys compared to that in girls like the finding of the previous study (Hajazi *et al.*, 2010). Although investigating the relationship between leukemia incidence and geographical-climatic factors (including average annual rainfall, vegetation cover, climate, and land use) showed a positive relationship between the incidence rate of leukemia and the geographical-climatic factors, this relationship was not supported statistically. Moreover, we found, the highest cumulative incidence rate of leukemia during five years was related to dry climates with the incidence rate of 40.12/100000 and the lowest incidence rate was related to temperate and humid climates with the rate of 26.9/100000 but not supported from statistics. In an investigation on geographical cancers dispersion in South Africa, Wesern cope, Gauteng and the western part of Northwest were identified as hot spots and high-risk areas of leukemia incidence. The possible environmental and carcinogenic factors to leukemia were exposure to pesticides and high amount of them in the environment, electromagnetic fields, ionizing radiations, high birth weight, and certain infections, such as varicella, influenza, and Epstein - Barr virus (Rensburg, 2014).

Further, a statistically significant relationship was observed between fetal exposure to pesticides and leukemia risk among under fifteen-year-old children where parents' exposure to pesticides was expected to leukemia incidence (Shu et al., 1988). Nevertheless in a similar study investigating the gastric cancer incidence rate and its relation to climatic-geographical factors based on GIS method, statistically significant relationship was observed between rainfall rate

and gastric cancer incidence rate (Rostami *et al.,* 2017). It is noteworthy to mention that similar articles investigating the relationship between leukemia incidence rate and climatic-geographical factors to be compared have not been conducted.

However, the incidence rate of leukemia was not the same in different cities in Khuzestan and it was higher in some of them. The leukemia is influenced by various geographical factors. Appropriate information on various cancers including leukemia in different geographical-climatic areas can be helpful to cure the disease, screen the high-risk groups, identify the risk factors and early diagnose the disease. Thus, it is suggested that more research be conducted regarding epidemiology and etiology to identify its specialized risk factors in various areas.

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