JCHR

Journal of Community Health Research 2019; 8(3): 156-163.

Epidemiological Study and Spatial Modeling of Cutaneous Leishmaniasis in Bushehr Province Using the Geographic Information System (GIS) from 2011 to 2015

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ARTICLE INFO

Original Article

Received: 1 July 2018
Accepted: 5Dec 2018

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ABSTRACT

Introduction: It is generally accepted that cutaneous leishmaniasis is considered as an important health problem all over the world which is caused by leishmaniasis protozoan. This disease is also known as a health problem in some regions of Iran including Bushehr province. The present study investigated the geographical dispersion and the epidemiological characteristics of subjects with the cutaneous leishmaniasis in this province from 2011 to 2015.
Method: In this cross-sectional and analytical study, the epidemiologic data including the age, gender, residential area, and counties with this disease was analyzed and collected from 663 patients who were followed up and treated from 2011 to 2015.
Results: 422 (63.7%) of studied people were residents of urban areas and 241 (36.3%) lived in rural areas. 59.4% (394 people) were male and 40.6% (269) were female. The mean (SD)age of the subjects was 21.91(17.01) (ranging from 1 to 80). Kangan County with an average 5-year incidence of 17.72 per a hundred thousand people had the highest incidence, but Tangestan County with the incidence of 8.47 per a hundred thousand people had the lowest average incidence. Based on GIS results, Jam County, which was not recognized as the focus of this disease in the past, has been considered as a new focus of disease in recent years.
Conclusion: The geographic information system (GIS) is regarded as an effective tool for the organization of diseases and health data. The crisis can be identified and controlled by taking proper measures with the discovery of spatial accumulation of diseases.

Keywords: Cutaneous Leishmaniasis, Geographic Information System (GIS, Epidemiology

How to cite this paper:
Dehghani A, Lotfi MH, Falahzadeh H, Vahdat K, Shabani Z. Epidemiological Study and Spatial Modeling of Cutaneous Leishmaniasis in Bushehr Province Using the Geographic Information System (GIS) from 2011 to 2015. J Community Health Research. 2019; 8(3): 156-163.

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[DOR: 20.1001.1.23225688.2019.8.3.1.0]

[DOI: 10.18502/jchr.v8i3.1566]

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[DOR: 20.1001.1.23225688.2019.8.3.1.0]

[DOI: 10.18502/jchr.v8i3.1566]

Introduction

Cutaneous leishmaniasis is known as an important health problem all over the world. Leishmaniasis is considered as a Zoonosis that is transmitted through the bite of sand flies. This disease has three forms of the Cutaneous, visceral (kala-azar) and cutaneous-mucosal Leishmaniasis. The Cutaneous leishmaniasis is caused by a Protozoan of flagellates from the trypanosome family and Leishmania genus, and it will be transmitted to a healthy human through the bite of a mosquito transmitting the animal sources (mainly carnivores, rodents and domestic and wild carnivores) (1). According to the World Health Organization, Cutaneous Leishmaniasis is endemic in 88 countries around the world such as African, Asian, European, North and South American countries (2). Sand flies are active in temperate areas during the summer, and have the highest activities from June to September. The average temperature and type of soil are among the main ecological factors that determine the sand flies' activities and ultimately the outbreak of cutaneous leishmaniasis (3).

According to the World Health Organization (WHO), 24630 cases of cutaneous leishmaniasis were recorded in Iran from 2000 to 2008; and the incidence of 69000 to 11300000 cases per year was estimated for Iran in 2012 (4). According to statistics of this organization, 18607 cases of cutaneous leishmaniasis would be seen in Iran in 2015 (5).

After malaria, the cutaneous leishmaniasis is the second endemic disease that is transmitted from Arthropods and causes many problems in Iran (6). Annually speaking, 2 million new cases of leishmaniasis occur, and about 511000 of cases have Kala-azar and one and a half million people have cutaneous leishmaniasis (7-9). About 21000 cases of leishmaniasis are annually reported in Iran, but the actual statistics of this disease is 4-5 times higher. This disease is endemic in 17 out of 31 provinces of Iran (10).

Increasing the foci and incidence of cutaneous leishmaniasis in Iran can be attributed to factors such as the development of agricultural projects, the migration of non-immune people to local populations of the disease, the rapid and unplanned expansion of cities, the construction of residential houses near rodents' nests, environmental changes such as the construction of dams and the reduction or elimination of toxic spraying against malaria vectors (2, 11, 12). Since there is not any available effective and reliable vaccine for this disease, the prevention of the disease has always been taken into consideration in Iran's national plans. The national cutaneous leishmaniasis control programs have emphasized the necessity to determine its epidemiological characteristics in foci of disease (13).

Ecological and epidemiological studies, which evaluate important risk factors for the spread of cutaneous leishmaniasis and are effective in controlling disease and preventive measures in different regions of Iran, are significantly vital. The present study investigated the geographical dispersion and epidemiologic characteristics of the cases with cutaneous leishmaniasis in Bushehr Province from 2011 to 2015 due to the fact that it was a health problem in most provinces of Iran including Bushehr which was an endemic area because of its suitable environment for transmission of disease and might increase the incidence of this disease due to the free trade zones and the increased travels of susceptible people to this region. The obtained results from the geographical dispersion of diseases played important roles in the prevention of epidemics, disease control and estimation of facilities. And finally, there was not any a comprehensive study on this issue in Bushehr province and most studies were descriptive.

Methods

The present study was a cross- sectional analytical study. The study population consisted of all the patients with cutaneous leishmaniasis from 2011 to 2015 with recorded data in the Communicable Disease Control and Prevention Department of Bushehr University of Medical Sciences. All patients, who had this disease during

this period, were studied by the census method. After obtaining a license from the research deputy of Shahid Sadoughi University of Medical Sciences in Yazd and then Bushehr University of Medical Sciences, data was extracted from the unit of diseases in the health department of Bushehr province. Patients were clinically or experimentally diagnosed and treated by the help of the national guide to the treatment of leishmaniasis published by the Disease Prevention Department of Iran Ministry of Health and Medical Education. The information of each patient including the year of incidence, residential area, location of ulcer on the body, number of ulcers, type of diagnosis, and etc. were utilized after internal validity check and removal of repeated cases. The present study was a cross-sectional study that it was conducted descriptively and analytically. The Geographic Information System (GIS) was used to map the incidence of cutaneous leishmaniasis in Bushehr. The present study investigated cases with diagnosed cutaneous leishmaniasis from the beginning of 2011 to the end of 2015 for a 5-year period. Bushehr Province is a southern province of Iran and the 17th largest province in the terms of its area located on the coast of the Persian Gulf. Bandar Bushehr is the capital of this province. This province is limited to a part of Khuzestan and Kohgiluyeh and Boyer-Ahmad Provinces from the north, Fars Province from the east, the Persian Gulf from the south and west, and a part of Hormozgan Province from the southeast. This province has an area of 27653 km^2 and a population of 1163400 people. It has more than 707 km of sea border with the Persian Gulf. Bushehr province is located between the latitude of 27° 19' to 30° 16' N and the longitude of 50° 1' to 52° 59' E of the Greenwich meridian. Bushehr province has 10 counties, 24 districts, 46 villages, 37 cities and about 910 small rural areas.

Maps of cities and districts of Bushehr Province in the UTM coordinate system were first inserted in Arc GIS 10.1 software. Given the disease cases in each county in different years, the incidence of disease was determined in each county; and a map of geographical distribution was produced for the province. Coordinate system of all maps was the UTM. The disease incidence map was produced in the GIS after choosing the appropriate color scheme.

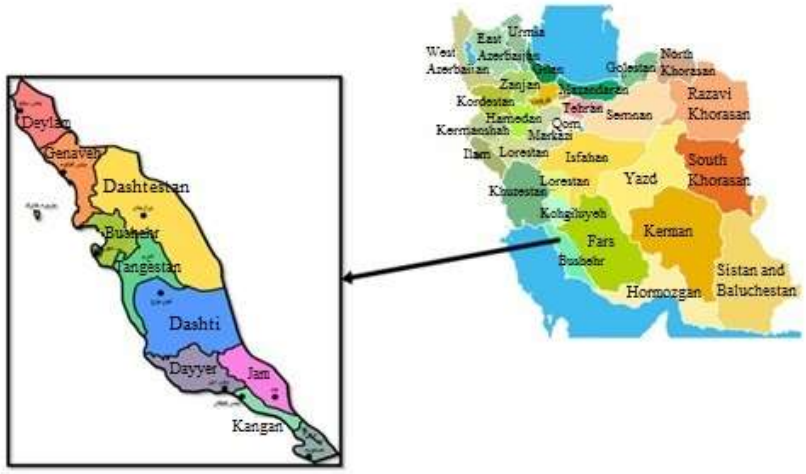


Figure 1. Geographic location of Bushehr province in Iran

The risk map for the incidence of disease in any of the counties was drawn for 10000 people and high risk areas were identified from 2011 to 2015 after adding the disease data to the map by standardizing the frequency of disease based on each county.

Results

663 people were diagnosed with cutaneous leishmaniasis in Bushehr province during 2011 to 2015. 422 (63.7%) were residents of urban areas and 241 (36.3%) lived in rural areas. 59.4% (394 people) were male and 40.6% (269) were female.

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The mean (SD) age of the subjects was 21.91(17.01) (range of 1 to 80 years). Among the studied years, the highest frequency belonged to 2011, and the lowest frequency belonged to 2012 (Table 1). Figure 1 shows the frequency distribution of cutaneous leishmaniasis in Bushehr province from 2011 to 2015. Kangan County with an average 5-year-incidence of 17.72 per a hundred thousand people had the highest incidence, and Tangestan with the incidence of 8.47 per a hundred thousand people had the lowest average incidence. (Table 2)

Diagram 1 shows the incidence of cutaneous leishmaniasis in different counties of Bushehr Province in different years. According to this diagram, Jam County had the highest incidence in 2013.

Table 1. Frequency Distribution of cutaneous leishmaniasis in Bushehr province from 2011 to 2015

Year	Frequency	Percentage
2011	150	22.6
2012	116	17.5
2013	118	17.8
2014	143	21.6
2015	136	20.5
Total	663	100

Table 2. Average of 5 year incidence of cutaneous leishmaniasis per 100000 people in counties of Bushehr Province

County	Average 5-year incidence	Maximum incidence	Minimum incidence
Bushehr	15.56	18.77	13.90
Tangestan	8.47	16.83	4.28
Jam	13.45	32.94	2.08
Dashtestan	12.32	16.45	8.86
Dashti	10.24	16.03	4.96
Dayyer	12.93	29.28	3.64
Deylam	11.89	18.91	6.14
Kangan	17.72	26.03	7.80
Genaveh	7.96	15.05	2.21

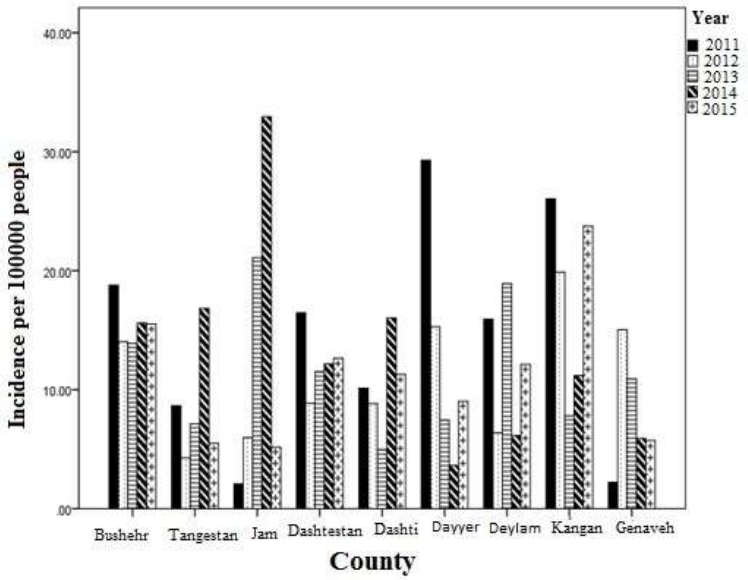


Diagram 1. Incidence of cutaneous leishmaniasis in different counties of Bushehr province in different years

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Figure 1 shows the frequency distribution of cutaneous leishmaniasis in Bushehr province from 2011 to 2015, so that the darker color indicates the maximum frequency of the disease in that area, and the lighter color shows the minimum frequency. According to this figure, the highest frequency belonged to Bushehr County and the lowest frequency belonged to Deylam during these 5 years. (Figure 2)



Figure 2. frequency distribution of cutaneous leishmaniasis in Bushehr province

Figure 3 shows the incidence of cutaneous leishmaniasis in counties in different years. According to Figure 1, the maximum incidence of 2011 belonged to Kangan County (2.63 per 10 thousand people) and the minimum incidence belonged to Jam County (0.21 per 10 thousand people). In 2012, the maximum incidence belonged to Kangan County (1.96 per 10 thousand people) and the minimum incidence belonged to Tangestan County (0.42 per 10 thousand people). In 2013, the maximum incidence belonged to Jam County (2.1 per 10 thousand people) and the minimum incidence belonged to Dashti County (0.49 per 10 thousand people). In 2014, the maximum incidence belonged to Jam County (3.29 per 10 thousand people) and the minimum incidence belonged to Dayyer County (0.36 per 10 thousand people). In 2015, the maximum incidence belonged to Kangan County (2.37 per 10 thousand people) and the minimum incidence belonged to Dashti County (0.12 per 10 thousand people). (Figure 2)

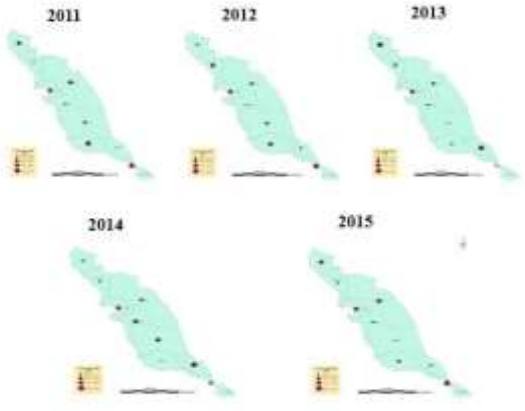


Figure 3. incidence of cutaneous leishmaniasis in counties in different years

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Discussion

The present study indicated that a clearer picture of changes and the spatial spread of disease could be provided in the dimensions of a health system for health policymakers using the Geographic Information Systems (GIS) by drawing thematic maps of cutaneous leishmaniasis in Bushehr Province.

Large data are continuously collected and archived in health systems without being converted into usable information. If any research has ever conducted in the healthcare system, its findings have not been presented in such a way that could be usable for key people and decision-makers to lead to evidence-based decisions (14, 15). Due to the vast area of the covered area and the large variety of climates, health managers of Iran face a large amount of data that is difficult to be interpreted and managed by traditional methods. The GIS and drawing thematic maps will be of great help in optimal and effective use of available data for planning, intervening and evaluating them (16).

Despite the fact that it is usually very costly and time-consuming to locate all the individuals on the map, the present study found that risky areas can be identified and put in the priority for effective interventions by classification of people into neighborhoods of urban regions. The present study is a good example of feasibility of disease management in place and time dimensions by the GIS in a province of a developing country.

Results of this study indicated that 663 people caught cutaneous leishmaniasis during the studied years. The average 5-year incidence was 12.97 per 100,000 people in Bushehr Province. The highest incidence occurred in 2011 and the lowest incidence in 2013. Among the counties, the highest average incidence belonged to Kangan County and the lowest in Tangestan County. As research results indicated, most of patients were living in the urban areas, probably due to the increased urbanization in most counties of province leading to an expansion of marginalization in cities. As Bandar Bushehr is known as a commercial zone of Iran, travelling to this province has been expanded and this is in turn a reason for the increased incidence of cutaneous leishmaniasis in this province. Men were more likely to catch this disease perhaps due to the less clothing than women as well as doing more activities outdoors. Lotfi et al. (17) found that over 80% of patients with cutaneous leishmaniasis have lived in urban areas. Nazari et al. (18) argued that most patients with cutaneous leishmaniasis were villagers. This was not consistent with results of the present study. In terms of gender, research results indicated that most patients were male. Many other studies found that men caught this disease more than women (6, 19-21). Barati et al. found that both genders were at the risk of cutaneous leishmaniasis, but the proportion of males was higher than females (22). Lotfi et al. also found that most patients were male (17).

According to results, the main foci of cutaneous leishmaniasis were Bushehr, Dashtestan, Kangan and Dashti Counties in Bushehr Province during those 5 years. These foci are still active and new foci of this disease are diagnosed in Dayyer, Jam and Deylam during this period. It should be noted that the most important risk foci of Bushehr province were in Dayye County in 2011, Kangan County in 2012, and Jam County in 2013, and Kangan County in 2015. As shown, Jam County was not the focus of this disease in previous years, but it has become a new focus of disease in recent years which is perhaps because of the increased travels as well as job immigrations to this county due to oil and petrochemical industries. In addition, the prevalence of leishmaniasis is related to human activities such as garden development projects, dam construction, road construction, and the construction of new residential complexes which have led to the growth of disease in the provincial foci. According to results of other studies, the cutaneous leishmaniasis vectors start replicating due to the climate warming (23) and the reduction of temperature is an important factor for the spread of disease in other areas (24). Several studies have investigated the trend of increasing this disease and its epidemic due to climatic

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changes as well as changes that cause more growth of the vectors (25, 26). Differences in climate of regions can have a different effect on the incidence of leishmaniasis as well as the growth of sand flies which transmit the disease (27).

In addition to the above-mentioned factors, and since climatic changes affect the incidence and outbreak of cutaneous leishmaniasis, the future studies are suggested considering these factors and evaluating the impact of weather conditions on the incidence and prevalence of disease in this province.

Conclusion

Based on the research findings, the Geographic Information System (GIS) was an effective tool for organizing the health and disease data in order to facilitate the analysis and representation of spatial data accumulation. By diagnosing the spatial accumulation of diseases, the crises can be also identified and controlled through accurate measurements. According to the present study, the main focus of this disease was discovered in the province and it made it possible to identify new foci of disease. This prognosis can inform health planners about developing disease control programs in active and emerging foci.

Acknowledgments

The present study was a research project with the Code IR.SSU.SPH.REC.1396.73 in the research deputy of Shahid Sadoughi University of Medical Sciences in Yazd. The authors would like to appreciate the cooperation of the Communicable Disease Control and Prevention Department of the health deputy of Bushehr University of Medical Sciences.

Conflict of interest

There is no conflict of interest.

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