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DETERMINATION OF CUTANEOUS LEISHMANIASIS PREVALENCE AND INCIDENCE, BETWEEN 2009-2014 IN ADANA BY USING GEOGRAPHICAL INFORMATION SYSTEMS

Hakan KAVUR, Ozan ARTUN

Cukurova University, Vocational School of Karaisali, Adana, Turkey

Corresponding author email: oartun@cu.edu.tr

Abstract

We aimed to calculate the incidence and prevalence values of cutaneous leishmaniasis (CL) between 2009-2014 for all the districts of Adana and also to produce the maps by using Geographical Information Systems (GIS) via incidence and prevalence to show the distribution of the disease.
After geographic correction, the borders of Adana were drawn using by ARCMAP 10.2. (ARCMAP; Esri, New York, United States of America) In order to make independent interpretations for all districts, boundaries were divided into separate layers. Prevalence and incidence between 2009-2014 were entered into the GIS database and interpreted.
Our maps were created with the geographically corrected cartographic map and a database were evaluated based on the aim of the study. Although Kozan was the district where the most reported case of CL was seen (23.14%), the highest prevalence (0.345%) and incidence (0.1761‰) were detected in the province of Imamoglu in 2011. However, it has been found that the incidence and prevalence of CL tend to increase in regions where Syrian refugees lived.
Creating maps based on the prevalence and incidence of CL commonly seen in the Eastern Mediterranean and especially in Adana, will have an important role in improving the measures to be taken against the disease.

Key words: *cutaneous leishmaniasis, prevalence, incidence, Geographical Information Systems, Adana.*

INTRODUCTION

Leishmaniasis is a zoonotic/anthropogenic protozoon parasitic infectious disease infected with vector sand flies, which spreads all over the continent except Antarctica. The disease that caused by *Leishmania* parasites were first identified and named in 1901 by William B. Leishman. Various *Leishmania* species that are not morphologically different cause different diseases, such as systemic infection, which are relatively non-lethal and spontaneously healing skin infections, involving internal organs and causing thousands of epidemics to die (Marquardt et al., 2000). Until now, the presence of leishmaniasis has been reported in 88 countries, and 350 million people live at risk every year. Cutaneous leishmaniasis (CL) is disabling and presents with a remarkable variability of the clinical manifestations such as multiple lesions, which are frequently self-healing in the old world. These lesions leave a permanent immunity that protects the person from new infections for life after treatment or spontaneous resolution (Ozbel, 2007).

The incidence value, that meanwhile expressing the number of new occurrences of a specific disease or disease within a given period of time for a given population, used to determine the epidemiology, distribution and possible risks of diseases. Prevalence value refers to the proportion of all cases with a specific disease or illness within the scope of the study within a specified period of time. In addition, GIS-based prevalence and incidence maps play an important role in determining disease trends in society (Ozdamarci, 2010; Ostad et al., 2016).

Cutaneous leishmaniasis is seen in a wide area in Turkey. It is estimated that climate change will expand the breeding areas of the vector and thus spread the disease to the more northern regions. Also, the civil war and the resultant migrations from Syria to Turkey, which have taken place in recent years, cause the disease to be seen more frequently in the cities which are bordered on Syria, located in the southern part of Turkey (Saylan et al., 1986; Momeni et al., 2007; Ozkeklikci et al., 2017).

Geographic Information System (GIS) is a system based on databases that are effective in determining spatial information in vector-borne diseases. Environmental factors such as altitude, climate, emission and vegetation are effective in shaping the geographical

distribution of sand flies and infectious diseases. Equipped with new technologies, GIS enables researchers to generate risk maps that include relationships between vector-borne diseases, environmental factors, and vector arthropods (Kahime et al., 2016; Ebrahimi et al., 2016).

The first aim of our study was to obtain the incidence and prevalence values. These values are calculated in relation to the number of CL patients and the total population in 15 provinces of Adana between 2009-2014. Then we produced the 6 years incidence and prevalence maps using Geographic Information System (GIS) instruments.

MATERIALS AND METHODS

Study Area

Adana is located in the eastern part of the Mediterranean Region of Turkey andit is the fifth major city of Turkey. The city has a human population of 1.7 millions. Its basin is 14,032 km^2 in area. Adana has fifteen districts and it is located at 37.002 latitude and 35.329 longitude (UTM Zone 36N– WGS84) (TSI, 2016) (Figure 1).

Figure 1. Map of Turkey, Adana province.

Obtaining Data and Map Producings

The population data and CL patient numbers of 15 districts of Adana between 2009-2014 were obtained from related institution's databases and used to calculate the incidence and prevalence values (Table 1).

All obtained data were processed in ARCMAP 10.2 software and CL maps of the city were produced. In the study, it was aimed to evaluate the incidence and prevalence values in the districts of Adana in GIS environment (Table 1). Adana province and its district borders are digitized in the GIS software as polygons. ARCMAP 10.2 software was used for this purpose.

The topographic maps included in the software in question are used as cartographic bases. Because of the software works based on layer, every attribute obtained is evaluated as a layer. First of all, the boundaries of the study area are digitized by geographical correction.

The entire border is divided on a provincial basis as a separate layer so that the questioning of Adana can be carried out independently of its territories. Similarly, the districts of Adana are divided into district boundaries as a separate layer. All obtained data were evaluated by ARCMAP 10.2 program and CL maps of Adana province were produced.

RESULTS AND DISCUSSIONS

A total of 1646 CL patients was reported in fifteen provinces of Adana between 2009 and 2014. Although the Kozan district has the most

CL cases with 384 patients in the following 6 years, no CL patients were reported between these years in the Tufanbeyli district. When considering the years, the most patients with CL were reported in 2010.

The highest number of CL cases over the years was reported in the Kozan district in 2010 (Table 1).

Table 1. Cutaneous Leishmaniasis Cases in Adana Districts between 2009-2014

Districts/Years	2009	2010	2011	2012	2013	2014	Total	%
Kozan	94	149	67	22	21	28	381	23.14
Sarıcam	37	27	55	31	95	64	309	18.77
Seyhan	58	32	34	14	40	49	227	13.79
İmamoglu	26	51	53	32	29	17	208	12.63
Yüregir	33	28	26	24	17	46	174	10.57
Karaisali	33	31	33	14	2	14	127	7.71
Ceyhan	19	17	21	26	5	6	94	5.71
Cukurova	13	16	11	10	5	8	63	3.82
Yumurtalik	9	16	7	4	3	0	39	2.36
Aladag	2	4	6	2	0	0	14	0.85
Karatas	5	0	2	0	0	0	7	0.42
Feke	1	0	0	0	0	0	1	0.06
Saimbeyli	0	0	0	0	1	0	1	0.06
Pozanti	0	0	0	0	1	0	1	0.06
Tufanbeyli	0	0	0	0	0	0	0	0
TOTAL	330	371	315	179	219	232	**1646**	**100**

According to the case numbers reported in Adana between 2009-2014, when the prevalence values are calculated, it is determined that the highest prevalence value is in the province of Imamoglu and in 2011 (0.345%).

The lowest prevalence value was found to be "0" in the provinces of Aladag, Karatas, Feke, Saimbeyli, Pozanti and Tufanbeyli (Table 2).

Table 2. Prevalence values of cutaneous leishmaniasis between 2009-2014 in Adana Districts

District/Year	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)
Kozan	0.136	0.191	0.169	0.07	0.033	0.038
Saricam	0.032	0.053	0.066	0.065	0.091	0.063
Seyhan	0.011	0.012	0.009	0.006	0.007	0.011
Yüregir	0.023	0.013	0.013	0.012	0.010	0.015
İmamoglu	0.103	0.252	0.345	0.286	0.205	0.158
Karaisali	0.277	0.278	0.282	0.210	0.072	0.074
Ceyhan	0.017	0.023	0.024	0.030	0.019	0.007
Cukurova	0.005	0.008	0.008	0.006	0.004	0.004
Yumurtalik	0.073	0.134	0..126	0.061	0.038	0.016
Aladag	0.011	0.035	0.059	0.047	0.012	0
Karatas	0.023	0.024	0.009	0.010	0	0
Feke	0.010	0	0	0	0	0
Saimbeyli	0	0	0	0	0	0
Pozanti	0	0	0	0	0.005	0.005
Tufanbeyli	0	0	0	0	0	0

According to the six year incidence data based on population and CL case numbers in Adana province, the highest incidence value was determined for the year 2011 in the province of Imamoglu (0.1760‰).

In addition, the lowest prevalence value was determined as "0" in Yumurtalik, Aladag, Karatas, Feke, Saimbeyli, Pozanti and Tufanbeyli districts within 6 years (Table 3).

Table 3. Incidence values of cutaneous leishmaniasis between 2009-2014 in Adana Districts

District/Year	2009 (‰)	2010 (‰)	2011 (‰)	2012 (‰)	2013 (‰)	2014 (‰)
Kozan	0.747	1.172	0.524	0.172	0.164	0.217
Saricam	0.321	0.224	0.443	0.233	0.688	0.446
Seyhan	0.080	0.044	0.045	0.018	0.052	0.063
Yüregir	0.079	0.066	0.061	0.057	0.040	0.110
Imamoglu	0.840	1.669	1.761	1.077	0.975	0.584
Karaisali	1.428	1.349	1.454	0.626	0.090	0.646
Ceyhan	0.120	0.107	0.133	0.164	0.031	0.038
Cukurova	0.039	0.046	0.033	0.029	0.014	0.023
Yumurtalik	0.468	0.857	0.383	0.223	0.162	0
Aladag	0.114	0.233	0.351	0.118	0	0
Karatas	0.231	…..0	0.094	0	0	0
Feke	0.052	…..0	0	0	0	0
Saimbeyli	0	0	0	0	0.060	0
Pozanti	0	0	0	0	0.048	0
Tufanbeyli	0	0	0	0	0	0

After the year 2011, when Syrian refugees started to migrate to Turkey, the incidence and prevalence values of Seyhan Yuregir and Saricam districts where intensive migration occurred were increased. The prevalence and incidence value in the Seyhan district in 2014 were calculated as 0.011% and 0.063‰ respectively. The prevalence value in Yuregir district is 0.015% in 2014 while the incidence value is determined as 0.010‰. The prevalence value of the refugee camp in Saricam province, which was established in 2013, was 0.091% and the incidence value was 0.688‰ in 2013. The incidence and prevalence values calculated for the Yuregir and Seyhan districts in 2014 were higher than in the past years, while the values in the Saricam province were found to be the highest in the year 2013 (Tables 2 and 3).

CL is a vector-borne protozoan disease that transmitted by sand flies (Ozbel, 2007; WHO, 2010). Adana province is known as a viable area for the vector sand flies of the CL in terms of climate, location and other environmental factors. The number of CL cases in the Adana, especially Kozan, which is accepted as endemic in terms of CL disease, is high enough to be underestimated (TMoH, 2016). It is known that *Phlebotomus tobbi*, the vector of *Leishmania infantum*, which was caused by CL, in the previously carried out vector sand fly fauna studies, was identified as the dominant species in Karaisali, Imamoglu and Kozan districts (Alptekin et al., 1999; Ok et al., 2002; Svobodova et al., 2009; Kavur et al., 2015).

Our findings suggest that in Adana, CL case numbers have recently declined. This situation is explained as the result of planned and conscious vector control strategies. Between the years 1990-2010 a total of 46 003 new cases have been reported in Turkey, 96% of these cases are reported from Sanliurfa, Adana, Osmaniye, Hatay, Icel, Mersin and Kahramanmaras. While, in recent years, the number of cases in Sanlıurfa, Osmaniye, Adana, Diyarbakir, Mersin and Kahramanmaras tended to decrease compared to the previous years. In Aydin, Antalya and Hatay provinces, an increase tendency is observed (TMoH, 2016). Prevalence and incidence values show a declining trend in

recent years, they were determined changeable in the following years. The highest prevalence values were observed in 2011 and the lowest values were determined in 2014 (Figures 2c, and 2f).

Feke, Saimbeyli, Pozanti and Tufanbeyli are not considered as habitats preferred by sand flies because they differ than the other district in terms ofaltitude and climate conditions (Svobodova et al., 2009; Belen et al., 2011; Kavur et al., 2016).

No CL cases were detected in the observed years,except 2009 and 2013 in these districts which don't have viable conditions in terms of vector sand flies (TSMS, 2016). The prevalence value was recorded as "0" in the province of Aladag in 2014 and in the province of Karatas between 2013-2014.

The prevalence of CL was found to be highest in İmamoglu in 2011, 2012, 2013 and 2014 (Figure 2c, Figure 2d, Figure 2e and Figure 2f) in Karaisali in 2009 and 2010 (Figure 2a and Figure 2b). Because of the reported new cases in Pozanti and Saimbeyli districts showed an increase in prevalence values in 2013 and 2014 (Figure 2e and Figure 2f).

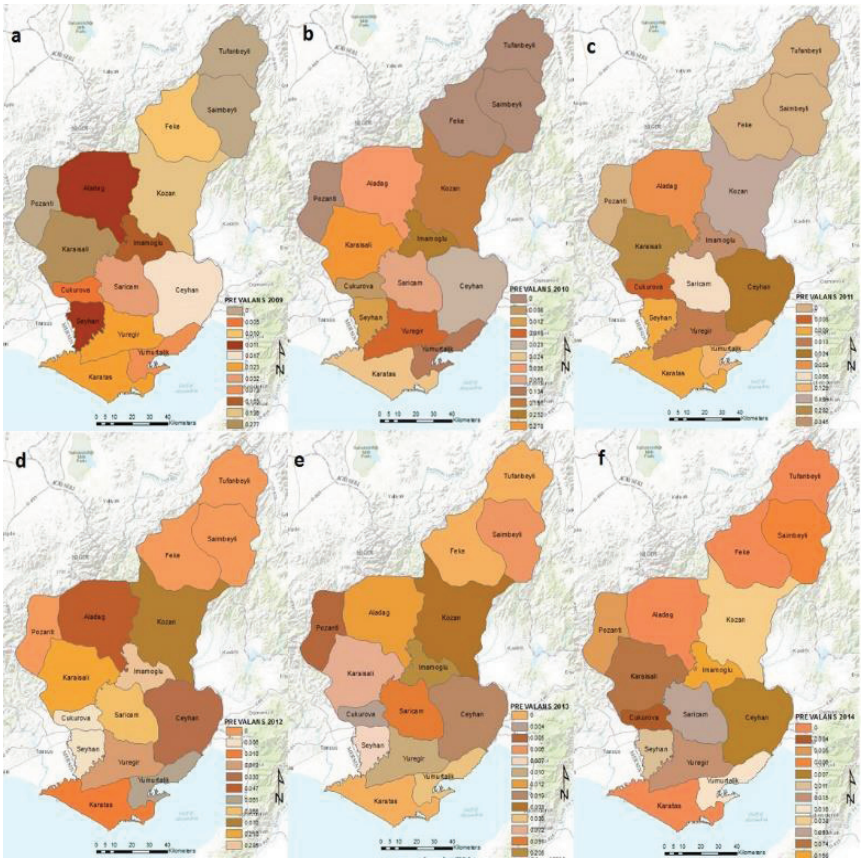

Figure 2. Maps produced for Adana due to cutaneous leishmaniasis prevalence values between 2009-2014: a) 2009 b) 2010 c) 2011 d) 2012 e) 2013) f) 2014

The incidence values in parallel with the prevalence values were the highest in 2011 and the lowest in 2014 (Figure 3c and Figure 3f). The incidence of CL was constantly low over the six year period followed in the provinces of Feke, Pozanti, Saimbeyli and Tufanbeyli except for the increases in 2009 and 2013.

It is observed that the incidence values of the Aladag and Karatas districts have fallen to the lowest level between 2013 and 2014 (Figure 3e and Figure 3f).

Karaisali district was identified as having the highest incidence value in 2009 and 2010 (Figure 3a and Figure 3b), and the highest incidence values were also recorded in the İmamoglu district between 2011-2014 (Figure 3c, Figure 3d, Figure 3e and Figure 3f).

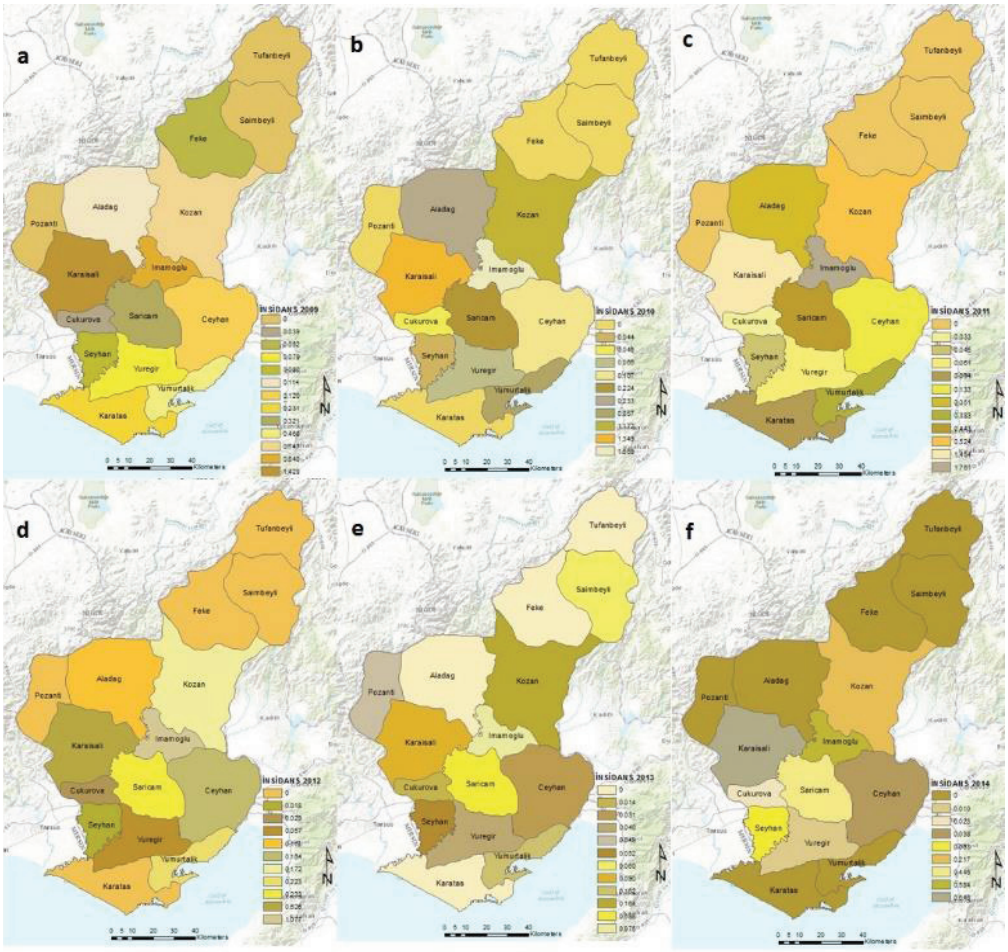

Figure 3. Maps produced for Adana due to cutaneous leishmaniasis incidence values between 2009-2014: a) 2009 b) 2010 c) 2011 d) 2012 e) 2013) f) 2014

In addition, despite the decrease in the prevalence and incidence values calculated according to case numbers, contrary to what is expected after the year 2011 when Syrian refugees throughout Adana started to emigrate, there is a significant increase in the number of migrants in Yüregir and Seyhan, especially in the districts of Yüregir and Seyhan, It is seen that there is an upward trend in the province (Figure 2e, Figure 2f, Figure 3e and Figure 3f). We think that our findings can be accepted as one of the reasons forthe change in the frequency of CL in our country after the civil war in Syria (Saylan et al., 1986; Ozkeklikci et al., 2017).

In conclusion the decrease in the prevalence and incidence values indicates that the probability of development of CL disease in Adana and the incidence of CL has a decreasing tendency. On the other hand, the refugees in the central districts need to take measures to increase the prevalence and incidence values in areas where the Syrians live intensively. In order to control the distribution

of the disease, it is necessary for the health institutions in the provinces to intensify the work of the registered patients, especially the registered patients in the refugee camps, and the identification of possible unregistered patients.

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