Original Article

Spatial Analyses of the Relation between Rodent's Active Burrows and Incidence of Zoonotic Cutaneous Leishmaniasis in Golestan Province, Northeastern of Iran

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Abstract

Background: Zoonotic cutaneous leishmaniasis (ZCL) is one of the most important vector-borne diseases in Iran. Wild Rodents play as a reservoir. The main aim of this study was to determine spatial analyses of the relationship between rodent's active burrows and Incidence of ZCL in Golestan Province, north east of Iran**.**

Methods: The cross-sectional study was conducted in 59 rural districts in Golestan Province. Spatial distribution of rodent's active burrows, human cases of ZCL and Incidence of disease were collected, using Geographical Information Systems (GIS). The relationship of them were analyzed by Sperman test, SPSS software version No.13.

Results: The most number of rodents' active burrows, human positive cases (100 persons) and high Incidence of disease (35/1000) were observed in Korand rural district of Gonbad-e Kavoos County. There was significant correlation between the number of rodents active burrows with Incidence rate of disease (0.470, P< 0.001) as well as the number of cases in each districts (0.465, P< 0.001), There is high correlation between higher Incidence rate and human positive cases in districts with number of rodents' active burrows.

Conclusion: Vicinity of wild rodents' burrows to villages plays an important role in transmission of ZCL to humans.

Keywords: Cutaneous leishmaniasis, Rodent burrows, Spatial analysis, Golestan, Iran

Introduction

The World Health Organization considers leishmaniasis as one of the most neglected tropical diseases which has received little attention and resources despite its serious impacts on both the economic developments and quality of life (WHO 2012). Leishmaniasis is one of the most important vector-borne disease and public health problem in Iran that transmitted by sandflies to human and other animals. Iran is facing both form of leishmaniasis: cutaneous and visceral. The main visceral foci are located in Ardabil (Northwest) and Fars (Southwest). There are also foci with low endemicity in other parts of the country. Cutaneous leishmaniasis is the main vector-borne disease in the country with an average of more than 22,000 cases in the last decade (Karimi et al. 2014), about 80% of them are zoonotic cutaneous leishmaniasis (ZCL), the endemic foci of this type are in rural areas of 17 out of 31 province (Yaghoobi-Ershadi 2012, Karimi et al. 2014). ZCL is a disease that primarily uses animals such as rodents as reservoir hosts (Mirzaei et al. 2011). Humans are an accidental host that can be involved in the transmission cycle of Leishmania parasites (Rouhani et al. 2014). Geographically, ZCL is widely distributed in Af-

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rica, the Middle East, Central Asia, and the Rajasthan area of India (Rouhani et al. 2014). In Iran based on animal reservoir host, there are four foci of disease in our country: The first one has been located in central and northeast of Iran, where *Rhombomys opimus* and *Phlebotomus papatasi* play important roles as reservoir and vector of the disease. The second focus of ZCL is located in the west and southwest of Iran, where *Tatera indica* replaced with *R. opimus* as a reservoir and *P. papatasi* as a vector. Baluchistan Province, in the southeast of Iran is considered as the third focus of ZCL. In this region *Meriones hurrianae* has been approved as a natural reservoir host. From the reported evidences, it is apparent that the most rural areas of provinces in central and southern Iran can be considered as the ZCL focus where *M. libycus* is the

Primary and main reservoir host of the disease, while *R. opimus* and *T. indica* were absent and *P. papatasi* is considered as the proven vector of ZCL (Yaghoobi-Ershadi et al. 2001, Rassi et al. 2006, Rassi et al. 2008, Rassi et al. 2011, Azizi et al. 2011, Kassiri et al. 2013). Golestan Province is one of the well-known foci of ZCL in Iran and two counties of this province are famous: Gonbad-e- Kavoos and Maraveh Tapeh that located in north and northeastern of this province. In one study carried out in Gonbad-e-Kavoos county, 4% of population have acute ulcer and 78% scar and in other study in Maraveh Tapeh county the prevalence of acute ulcer and scare rate were 3.03% and 63.7% respectively (Sofizadeh 2007, Cherabin et al. 2012, Sofizadeh et al. 2013). Many researchers have argued that *R. opimus* and *M. libycus* are reservoir hosts of ZCL and *P. papatasi* is the main vector of this disease in Golestan Province (Rassi et al. 2008, Rouhani et al. 2014). The main aim of this study was to determine relation between rodents' active burrows and Incidence of ZCL in Golestan Province using spatial analysis.

Materials and Methods

Study area

A cross-sectional study was carried out in Golestan Province from February 2013 to March 2014. Golestan Province is located (37-38°N and 54-58° E) in northeastern of Iran and is bounded by Caspian Sea and Mazandaran Province in the west, Semnan Province in the south, North Khorasan Province in the East and a borderline with Turkmenistan in the North (Fig 1). Most parts of Golestan Province are plain and more than 2/3 of the plain area has arid and semiarid climates and 1/3 of others have a mild climate. The area of the province is 20437.74 km² (1.3 areas of Iran) with 1823117 population. There are 14 counties, 27 districts, 60 rural districts, 25 cities and 1732 villages in Golestan Province. The main agricultural products are Alfa Alfa, rice, watermelon and cotton. Maximum and minimum of temperatures were recorded as 40.8 and -02 °C respectively and the mean annual relative humidity was recorded as 74%. The total annual rainfall was 772 mm and the minimum precipitation in August and maximum in February.

Collection of data

Estimation of rodent burrows

Three villages were randomly selected in all rural districts (60) of Golestan Province and the number of active rodents' burrows were counted in area of one hectare. The average number of active rodents' burrows in each districts was estimated.

Estimation of human positive cases and incidence rate of the disease

Demographic data of all patients were registered. Furthermore, all villages with positive human cases in 2013 were obtained regardless of the number of cases reported from each village Maps of the spatial distribution of the disease were prepared using GIS software.

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The number of human positive cases in each rural districts of the province, as well as the incidence of disease were calculated. For calculating, the Incidence rate of the disease, we used population at risk in the denominator. All cases with scares were removed from the denominator.

Analyses of data

The relationship between the number of rodents' active burrows with incidence rate and the number of positive cases of disease in rural districts were calculated using SPSS software version 13 and Sperman test.

Results

Among all counties of Golestan Province, the highest incidence rate of the disease were observed in MoravehTappeh (121.5/100000) and Gonbad Kavoos (99.3/100000) respectively (Table 1). These two counties were endemic foci of CL in Golestan Province. In the rest of counties, the incidence of disease were estimated less than 30 /100000.

The highest (53.8%) and lowest (11.5%) of CL cases were observed in the age groups of ≥ 14 and 1≤ years old respectively (Table. 1). It should be noted that, 60.2 % of patients were male.

In the assess the existence of Rodent's active Burrows in a radius of 300 meters from the villages, they were found only in the rural districts of Gonbad Kavoos and MoravehTappeh counties. In the rest of studied districts, there were not Rodent's active Burrows, or were located at a distance of one kilometer of the villages. However, the maximum number of Rodent's active Burrows was observed in rural district of Korand in Gonbad Kavoos County (Fig. 2).

The number of positive cases as well as the incidence of disease were calculated

0-100/100000 and 0-35/100000 in the different rural districts of Golestan Province respectively. It must be mentioned, similar to Rodent's active Burrows, the most positive cases and the highest incidence of disease were found in rural district of Korand in Gonbad Kavoos County (Fig. 2, 3).

Based on the statistical analysis of data, there were significant difference between the number of Rodent's active Burrows with the number of positive cases (0.465, P< 0.001) as well as, the incidence of disease (0.470, P< 0.001) (Tables 1).

The most positive cases were found in the northern villages of plain areas in October and November (Figs. 4, 6). There was no positivecases of disease in southern villages with mountainous condition (Fig. 5).

There was a significant positive correlation between the number of rodent's active burrows and incidence of disease as well as the number of positive cases in studied areas (0.470, P< 0.001). According to Fig. 6. the greatest number of cases were occurred in October and November**.**

Table 1. Demographic characters of ZCL in Golestan Province (2013)

Districts	Number of Cases	Incidence Rate (per 100000)	Travel to endemic area (%)
Aghghala	37	28.72292	36(97.3%)
Aliabad	18	12.83825	18(100%)
Azadshahr	10	10.12925	8(80%)
Bandar-e Gaz	2	3.817814	2(100%)
Bandar-eTurkaman	2	2.51547	2(100%)
Galikesh	12	17.71845	12(100%)
Gumishan	9	14.04078	9(100%)
Gonbad-e Kavoos	334	99.39175	210(62.9%)

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Table 1. Continued…

Gorgan	39	8.66788	35(89.8%)
Kalaleh	10	8.499065	10(100%)
Kordkooy	5	6.893414	5(80%)
MaravehTappeh	69	121.5259	52(75.4%)
Minoodasht	2	2.45053	2(100%)
Ramiyan	24	27.29009	24(100%)
Total (in Golestan Province)	573	31.74271	573

Age group	**Number (%)**
>1	66 (11.5%)
1-6	117(20.4%)
7-14	82(14.3%)
<14	308(53.8%)
Gender	
Male	345(60.2%)
Female	228(39.8%)
Total (in Golestan Province)	573 (100%)

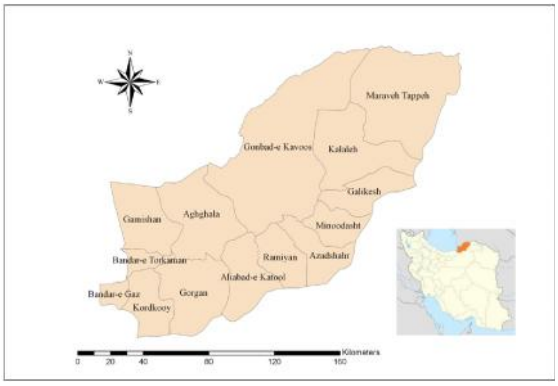

Fig. 1. Location of study area, Golestan Province in Iran

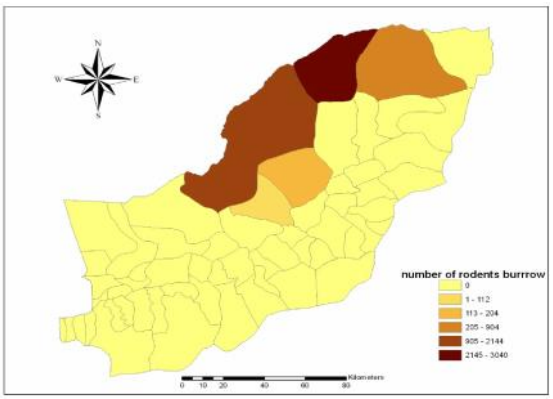

Fig. 2. Distribution of Rodent's active burrows in Golestan Province, 2013

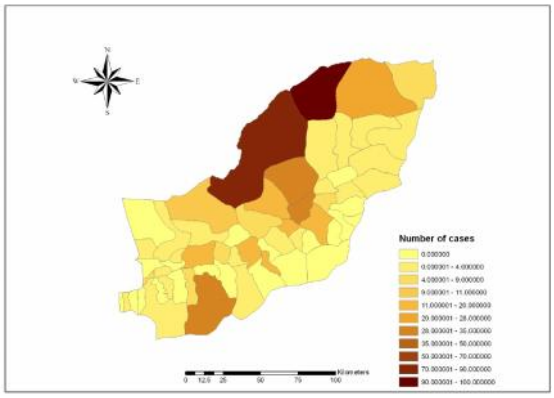

Fig. 3. Number of positive cases of ZCL in Golestan Province, 2013

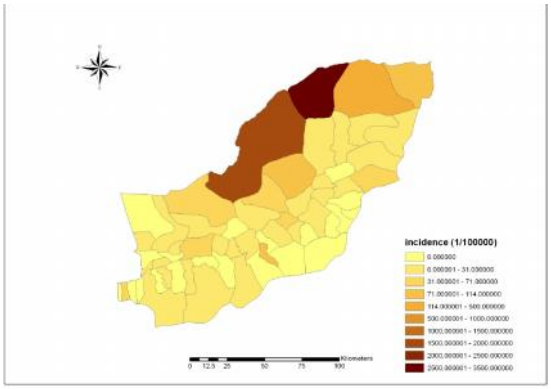

Fig. 4. Incidence of ZCL in Golestan Province, 2013

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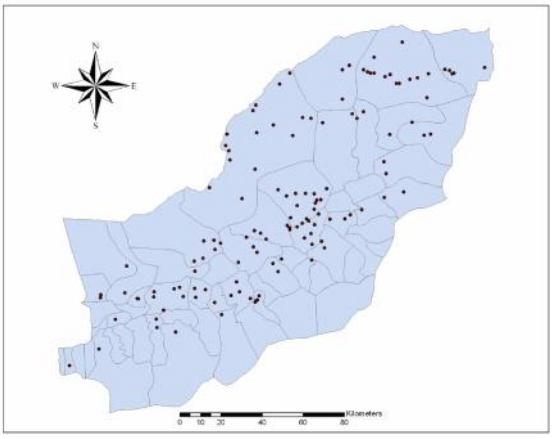

Fig. 5. Spatial distribution of ZCL cases in Golestan Province (2013)

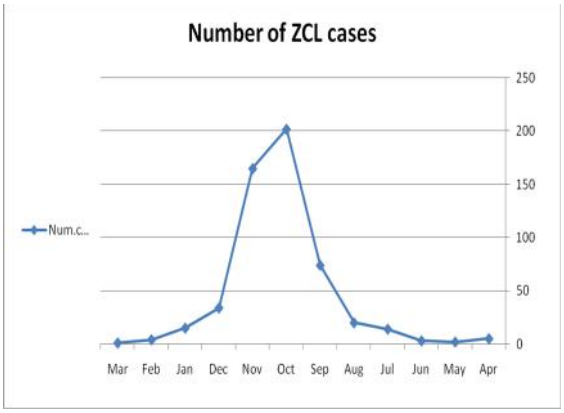

Fig. 6. Trend of ZCL cases in Golestan Province (2013)

Discussion

Based on literature review of cutaneous leishmaniasis in Golestan Province, the causative agent of disease (ZCL) was *L. major* and *P. papatsi* has been reported as the principal vector to human. Two rodents of *R. opimus* and *M. lybicus* were main and secondary reservoir host of disease respectively (Rassi et al. 2008, Parvizi and Hedayati 2010, Roshanghalb and Parvizi 2012, Bordbar and Parvizi 2014).

Since the sand flies are often active in a distance of 200 meters from its habitats (Rassi and Hanafi Bojd 2006), therefore, the presence of rodents' burrows, one kilometer from the village, are considered as one of the risk factors of disease transmission. Based on the results of our study, the active rodents' burrows were only observed in rural districts of Maraveh Tappeh and Gonbad-e Kavoos Counties. The previous studies have demonstrated that two species of *R. opimus* and *M. libycus*, are chosen the plains with soft soil to build their colonies under bushes and along streams (Nadim et al. 2009), So, in the rural district of Palizan to centroid Qazanqaya village (56°15'28.686"E 37°55'31.132"N) due to the rocky nature of area as well as , in the rural districts of Shalami to centroid Arab Qari Haji village (55°45'8.727"E 37°41'23.994"N) and Golidagh to centroid Golidagh village (55°56'41.944"E 37°38'41.094"N) due to the mountainous nature of the region, no rodent burrows were observed. We found several active burrows with high population of rodents in both rural districts of the Korand to centroid Korand village (55°31'5.842"E 37° 57'51.47"N) and Atrak to centroid Dashliburun village (54°48'45.653"E 37°37'57.254"N) located in Gonbad-e Kavoos county. In the rural districts of Agh-Abad to centroid Agh-Abad village (55°14'26.891"E 37°18'14.929"N) and Sultan Ali to centroid Sultan Ali village (55°3'7.15"E 37°14'4.863"N) in some villages, the rodents were active with low abundance .

In the Tamran rural district to centroid Tamer Ghare Ghozi village (55°29'55.568"E 37°29'51.35"N) located at the Kalaleh County, there was no rodent burrows at a distance of one kilometer from the villages. Also, in the rest counties of Golestan Province, no rodent's active burrows were observed nearby villages.

Based on our study, there were high correlation between the number of rodent's active burrows with the number of positive cases (0.465, P< 0.001) as well as, the incidence of disease (0.470, P< 0.001). This was due to the abundance of active wild rodents as the reservoir of disease and vicinity of

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their colonies to human settlements. Therefore, high number of positive cases as well as high incidence of disease were observed in the rural districts of MoravehTappeh (MoravehTappeh county) and Korand and also Atrak in Gonbad Kavoos County. It should be noted that, two rural districts of Agh-Abad and Sultan-Ali in Gonbad Kavoos County were in the second rank of positive human cases. All positive cases in other rural districts of the province were imported cases, due their business trip to endemic areas. Evaluation forms for these patients revealed that in most counties, the patients had a history of traveling to endemic areas of disease including rural districts of Maraveh Tapeh, Atrak or Korand. Some patients had also at least one travel to the provinces of Semnan, Khorasan and Isfahan. For example, the number of 20 cases of cutaneous leishmaniasis had been reported from the district of South Fenderesk to centroid Dar Kalateh village (54°57'38.738"E 36°57'58.499"N) located at the county of Ramian, they were workers of brick kilns, who had traveled to the province of Semnan in the early spring and had returned to their homes in the early autumn of 2013.

The highest incidences of the disease were found in the counties of MaravehTappeh and Gonbad Kavoos Counties respectively, while the high number of positive cases were observed in the second county. Because the most population of the Maraveh Tappeh County (43.1%) were living in endemic areas and were at greater risk of the disease, while in the county of Gonbad-e Kavoos County about 15% of the population were living in endemic areas.

The hightest (53.8%) and lowest (11.5%) of CL cases were observed in the age groups of >14 and <1 respectively (Table 1). Whereas most patients (53.8%) were adults over 14 years old, the diseases have hypo-endemic condition in this area. These results were similar to studies conducted in Maraveh Tapeh and Gonbad-e Kavoos countis in this province (Cherabin et al. 2012, Sofizadeh et al. 2013) and in the rural districts of Damghan, and kasahan in the provinces of Semnan and Isfahan respectively (Doroodgar et al. 2009, Mohammadi Azni et al. 2010).

The lowest morbidity rate of disease (11.5%) was observed in age group of ≤1 years old. This age group had the lowest presence in outdoors and considering to hypoendemic of disease in studied areas (Sofizadeh et al. 2013), they have received less infected bites.

Our study showed, the males are infected more than females (60.2%). Because, the males are busy in agriculture tasks outside of home during the nights of summer and attending to active peak of sand flies (Sofizadeh et al. 2009) they have received more infected bites.

The greatest number of cases were occurred in the months of October and November and coincided with the second peak of sand flies in September (Sofizadeh 2009). Due to direct relation between the number of rodent's burrows and the incidence of disease, we propose to use different methods of reodent control as complementary measure for the control of disease.

Conclusion

Results of current study indicated the direct relationship between the burrows of rodents and ZCL prevalence. Therefore the presences of rodents as the reservoir host of disease play an important role on prevalence as well as incidence rate of disease. Considering this, Control of rodents will have an important role in controlling the disease. The other point that we need to pay attention, do actions that take more than a kilometer distance between human and the rodent's life places.

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References

Azizi K, Davari B, Kalantari M, Fekri S (2011) Gerbillid rodents fauna (Muridae: Gerbillinae) and detection of reservoir hosts (s) of Zoonotic Cutaneous Leishmaniasis using a Nested-PCR technique in Jask City in Hormozgan Province in 2008. J Kurdistan Uni Med Sci. 16(2): 66–76 (Persian).

Bordbar A, Parvizi P (2014) High density of *Leishmania major* and rarity of other mammals' Leishmania in zoonotic cutaneous leishmaniasis foci, Iran. Trop Med Int Health. 19(3): 355–363.

Cherabin M, Sofizadeh A, Palideh AR, Gharavi AH, Gharavi M (2012) Epidemiological characteristics of Cautaneous Leishmaniasis in Maraveh tapeh district, Golestan Province during 2006–2010. J Zabol Uni Med Sci. 4(1): 19–27. (Persian).

Doroodgar A, Mahbobi S, Nemetian M, Sayyah S, Doroodgar M (2009) An epidemiological study of cutaneous leishmaniasis in Kashan (2007–2008). J Semnan Uni Med Sci. 10(3): 177–184. (Persian).

Forozani AR, Khojeeian AM, Darabi H, Foladvand MA, Nabipour E, Bahramian F (2011) Fauna and monthly activity of sandflies in Boshehr district (2008–2009). South Med J. 14(1): 31–40. (Persian).

Karimi A, Hanafi-Bojd AA, Yaghoobi-Ershadi MR, Akhavan AA, Ghezelbash Z (2014) Spatial and temporal distributions of phlebotomine sand flies (Diptera: Psychodidae), vectors of leishmaniasis, in Iran. Acta Tropica. 132: 131–139.

Kassiri H, Naddaf SR, Javadian EA, Mohebali M (2013) First report on isolation and characterization of *Leishmania major* from *Meriones hurrianae* (Rodentia: Gerbillidae) of a rural Cutaneous leishmaniasis focus in South-Eastern Iran. Iranian Red Crescent Medical Journal. 15(9): 789–793.

Meteorological Office of Golestan Province. Available at: https://www.yr.no/place/Iran/Golestan/Gorgan/.

Mirzaei A, Rouhani S, Taherkhani H, Farahmand M, Kazemi B, Hedayati M, Baghaei A, Davari B, Parvizi P (2011) Isolation and detection of Leishmania species among naturally infected *Rhombymuis opimus*, a reservoir host of zoonotic cutaneous leishmaniasis in Turkemen Sahara, North East of Iran. Exp Parasitol. 129(4): 375–380.

Mohammadi Azni S, Nokandeh Z, Khorsandi AA, Sanei Dehkordi AR (2010) Epidemiology of Cutaneous Leishmaniasis in Damghan District. Iran J Military Mede. 12(3): 131–135. (Persian).

Nadim AH, Javadian A, Mohebali M, Zamen Momeni A (2009) Leishmania parasite and leishmaniasis. 3nd. Tehran: Nashredaneshgahi center. (Persian).

Parvizi P, Hedayati M (2010) Leishmania infections in rodents, reservoir hosts of Zoonotic Cutaneous Leishmaniasis in Turkmen Sahra, Gonbad, Golestan Province. J Guilan Uni Med Sci. 18(72): 30–38. (Persian).

Rassi Y, Hanafi Bojd AA (2006) Sandflies, leishmaniasis vectors. Tehran: Noavaraneelm Publication. (Persian).

Rassi Y, Javadian E, Amin M, Rafizadeh S, Vatandoost H, Motazedian H (2006) *Meriones libycus* is the main reservoir of zoonotic cutaneous leishmaniasis in south Islamic Republic of Iran. East Mediterr Health J. 12(3–4): 474–477.

http://jad.tums.ac.ir
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Rassi Y, Sofizadeh A, Abai MR, Oshaghi MA, Rafizadeh S, Mohebail M, F Mohtarami, R Salahi (2008) Molecular detection of *Leishmania major* in the vectors and reservoir hosts of Cutaneous Leishmaniasis in Kalaleh District, Golestan Province, Iran. Iran J Arthropod-Borne Dis. 2(2): 21–27.

Rassi Y, Saghafipour A, Abai MR, Oshaghi MA, Rafizadeh S, Mohebali M, Yaghoobi-Ershadi MR, Mohtarami F, (2011) *Phlebotomus papatasi* and *Meriones libycus* as the vector and reservoir host of cutaneous leishmaniasis in Qomrood District, Qom Province, central Iran. Asian Pacific J Trop Med. 4(2): 97–100.

Roshanghalb M, Parvizi P (2012) Isolation and determination of *Leishmania maj*or and *Leishmania turanika* in *Phlebotomus papatas*i main vector of Zoonotic Cutaneous leishmaniasis in Turkmen Sahra, Golestan Province. J Mazandaran Uni Med Sci. 21(1): 74–83. (Persian).

Rouhani S, Mirzaei A, Spotin A, Parvizi P (2014) Novel identification of *Leishmania major* in *Hemiechinus auritus* and molecular detection of this parasite in *Meriones libycus* from an important foci of zoonotic cutaneous leishmaniasis in Iran. J Infect Public Health. 7(3): 210–217.

Sofizadeh A (2007) Study on vectors and reservoir hosts of Cutaneous Leishmaniasis by using molecular methods in Kalaleh district, Golestan Province. [MSc dissertation]. Medical Entomology and Vector control. School of Public Health. Tehran University of Medical Sciences. Iran.

Sofizadeh A, Faraji Far AA, Cherabin M, Badiei F, Cherabin M, Sarli J, Yapang Gharavi, Mehravaran A (2013) Cutaneous leishmaniasis in Gonbad Kavoos, north of Iran (2009–2011): an epidemiological study. J Gorgan Uni Med Sci. 14(4): 100–106. (Persian).

Sofizadeh A, Rassi Y, Abaei MR, Oshaghi MA, Salahi R, Rafizadeh S, Mohebali M (2009) Ecological characters of leishmaniasis vectors in Kalaleh district, Golestan Province, Iran (2006–2007). J Gorgan Uni Med Sci. 11(3): 81–85. (Persian).

Tari SA, Vakili Z, Moshtaghi S (2004) Prevalence survey of cutaneous leishmaniasis in Kashan district in 1999–2001. Feiz J. 26: 71–76. (Persian).

WHO (2012) A human rights-based approach to neglected tropical diseases. Geneva: World Health Organization, 2008. Available at: http://www.who.int/tdr/ publications/tdrresearch-publications/humanights/en/index.html [Accessed on September 3, 2012].

Yaghoobi-Ershadi MR (2012) Phlebotomine sand flies (Diptera: Psychodidae) in Iran and their role on Leishmania transmission. J Arthropod-Borne Dis. 6: 1–17.

Yaghoobi-Ershadi MR, Hanafi-Bojd AA, Akhavan AR, Zahrai-Ramazani AR, Mohebali M (2001) Epidemiological study in a new focus of cutaneous leishmaniasis due to *Leishmania major* in Ardestan town, central Iran. Acta Trop. 79: 115–121.

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