ORIGINAL ARTICLE

Analysis of Malaria Epidemic Features in Sistan and Baluchistan Province, Southeast of Iran, 2005-2008

M Salehi[1*], M Mokhtari Amirmajdi[2], I Eftekharzadeh Mashhadi[3], Y Hakemi[4], A Eftekharzadeh Mashhadi[4], A Mirinezhad[4]

[1]Research Center for Infectious Diseases and Tropical Medicine, Zahedan University of Medical Sciences, Zahedan, Iran, [2]Department of Parasitology and Mycology, Mashhad University of Medical Sciences, Mashhad, Iran, [3]School of Health, Zahedan University of Medical Sciences, Zahedan, Iran, [4]School of Health, Mashhad University of Medical Sciences, Mashhad, Iran

Abstract

Background: An essential determinant for designing accurate strategies in malaria control is the precise knowledge of local epidemiology, which is time and location dependent. This study was designed to analyze the data on the verified malaria cases, reported in the southeast Province of Iran, Sistan and Baluchistan, from March 2005 to 2008.

Methods: All the reported cases of malaria in the mentioned period were defined and epidemiologic characteristics of each case were registered and statistically analyzed.

Results: The annual incidence rates were 469, 345, and 359 (per 100000) in the 3 consecutive years, respectively. Malaria patients were mainly 15-44 year old males, mostly living in the rural areas. Imported malaria from Afghanistan and Pakistan was considerable (15-20%). While malaria was more prevalent in the southern part of the province, the percentage of *Plasmodium falciparum* was higher in the western areas. The incidence of malaria reached its annual peak from July to October.

Conclusion: This study clearly reveals that malaria is a significant disease in southeast Iran. The geographic pattern may implicate an important role of cross-border traffic in the importation of malaria in this area.

Keywords: Malaria; Epidemiology; Southeastern Iran

Introduction

Although Malaria Roll Back (MRB) program has been designed to reduce the sufferings of this disease by 2010,[1] it seems that except Europe and North America, the world is still highly engaged in this socioeconomically influenced burden.[2,3] Malaria is a major health problem in Africa and to a lesser extent in South Asia.[4,5] Several epidemiological studies indicated that south-east of Iran is an endemic area in the Middle East.[6-8] Manouchehri *et al.* proposed an annual incidence rate of 145 cases per 100,000 in 1990 and 36 in 1999 in Iran.[9] Sistan and Baluchistan Province is one of the three endemic areas in Iran.[10] The south-eastern part of Iran, consisting of Sistan and Baluchistan Province, Hormozgan Province and the tropical part of Kerman Province with a combined population of approximately three million, is considered to be a 'refractory malaria region'. Annual parasitic index (API) was reported to be 8.74 per 1,000 populations in 1997.[11] Being geographically adjacent to *P. falciparum* endemic regions of Afghanistan and Pakistan,[12,13] and susceptible to malaria epidemics precipitated by several factors such as climate diversity in the region,[14] this area requires repeated reviews of malaria epidemiology. An essential component for designing accurate strategies in malaria control is the precise knowledge of local epidemiology of the disease.[15] Analysis of available

***Correspondence:** Masoud Salehi, MD, Research Center for Infectious Diseases and Tropical Medicine, Zahedan University of Medical Sciences, Sistan and Baluchistan, Iran. Tel: +98-915-1430561, Fax: +98-511-7687052, e-mail: Dr.Salehi.Ma@gmail.com
Received: November 26, 2009 Accepted: January 25, 2010

data of malaria in Sistan and Baluchistan Province is necessary to gain a better insight needed for planning malaria control measures and assessing the impact of previous interventions. However, it seems that there was less meticulous attention to documentation of malaria epidemic features in the province in the past, and published papers do not provide an appropriate basis for future assessments. The present study is an investigation of the recent trends in the number of reported cases of malaria from March 2005 to 2008. Moreover, this study aims at analyzing the threats and opportunities available for controlling the disease. This extends the scope of this study as more than a localized epidemiological one, and it might be useful in other areas with the same problem.

Materials and Methods

To describe the demographic features of malaria in Sistan and Baluchistan Province, the data of malaria cases, collected by the disease management department of the health Vice-Presidency in Zahedan University, Iran from March 2005 to 2008, were analyzed. Malaria cases were diagnosed according to WHO guidelines[16] by thick blood smears, staining with Giemsa dye. A secondary revision by a certified microscopist was performed to confirm the diagnosis and not to miss any positive case. Confirmed positive cases were reported to the district health centers and through them to the Disease Management Department. For each reported case, an epidemiological questionnaire was completed. Questions were about age, sex, nationality, time (year and month) and place (urban or rural) of acquiring the disease, and type of parasite. The data were analyzed by Chi Square and Fisher Exact tests using SPSS software (version 13.5, Chicago, IL, USA). Malaria indices including annual parasitic index (API), annual incidence rate (AIR), and *Plasmodium falciparum* percentage (Pf %) were also determined.

We should remind that Sistan and Baluchistan is the largest Province in Iran, located in the southeast of Iran, with an area of 181,785 Km² and a population of 2,400,000, at the time of study. The districts of the province are Iranshahr, Chabahar, Khash, Zahedan, Saravan, Nikshahr, and Sarbaz (Figure 1). This province is bordered from the south with Oman Sea, Indian Ocean; and has a subtropical climate. Because of appropriate temperature and humidity, transmission cycle of malaria is optimal from April to October in some parts of the province.

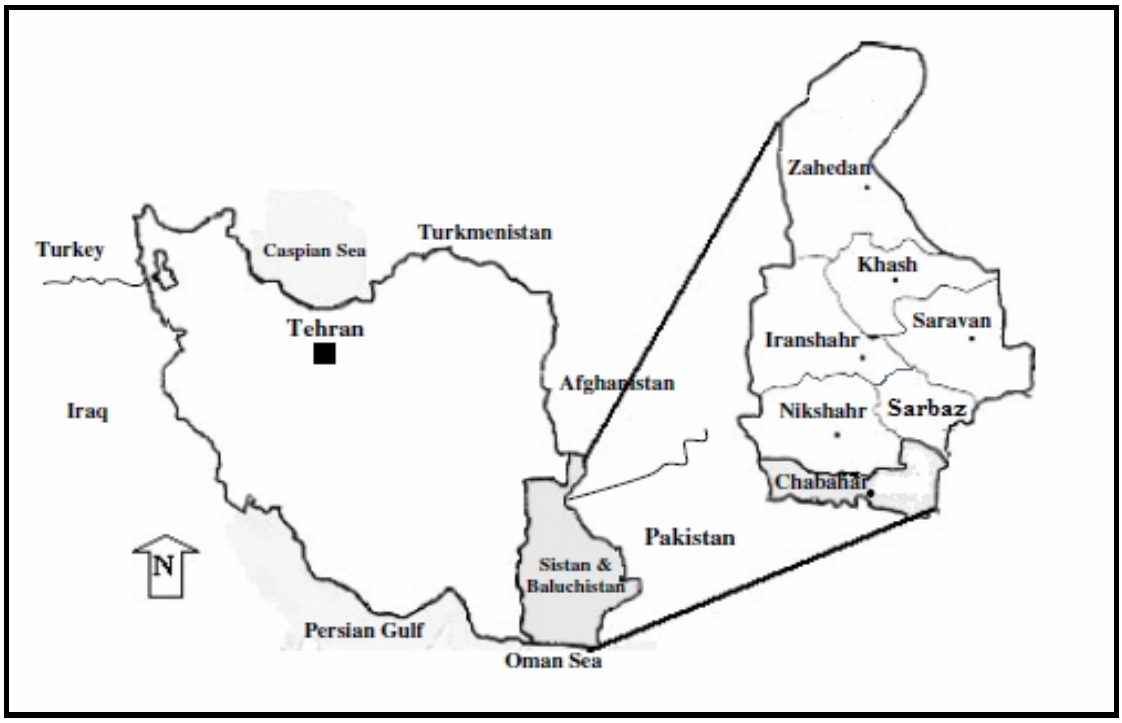

Fig. 1: Map of Sistan and Baluchistan, Iran, Districts and geographical outlines are depicted

Results

The annual cumulative numbers of reported cases of malaria in the province from March 2005 to 2008 were 11305, 8300, and 8657, respectively. Table 1 shows the incidence rates of the disease in different districts of the province. Dividing the province to northern (Zahedan, Khash), southern (Chabahar, Nikshahr), western (Iranshahr) and eastern (Saravan and Sarbaz) quarters (Figure 1), we found more than half of the malaria cases in the last 2 years in the southern districts of the province. While malaria was more prevalent in the southern part of the province ($p<0.001$), the percentage of plasmodium falciparum was higher in the western parts ($p<0.001$). According to Table 2, *P. vivax* was the most prevalent *Plasmodium* found in this province. Reviewing Pf% in the districts shows that whilst Nikshahr had the most reported cases of malaria in the province, it had simultaneously the least Pf%. A glance at the geographical location of districts with the highest Pf% reveals that *P. falciparum* cases were predominantly distributed in the western districts. It should be noted that no case of *P. malaria* or *P. ovale* was seen through these years. Malaria patients were mainly 15-44 year old females, mostly living in rural areas where imported malaria from Afghanistan and Pakistan was considerable (Table 3). Approximately, 15-20% of the malaria patients in this province had Afghani or Pakistani nationality. In Figure 2, the number of reported malaria in various months of the year is depicted. As can be seen, most cases of

Table 1: Number of malaria cases in Sistan and Baluchistan Province by category of districts

District	2005-2006		2006-2007		2007-2008	
	No (%)	AIR*	No (%)	AIR*	No (%)	AIR*
Zahedan	326 (2.9)	30	276 (3.3)	25	436 (5.0)	40
Khash	163 (1.4)	97	94 (1.1)	56	80 (0.9)	47
Saravan	1444 (12.8)	586	819 (9.9)	332	913 (10.6)	370
Iranshahr	811 (7.2)	302	612 (7.3)	228	549 (6.3)	204
Sarbaz	3887 (34.4)	2360	2041 (24.6)	1239	1474 (17.0)	894
Chabahar	2501 (22.1)	869	1521 (18.3)	527	2508 (29.0)	871
Nikshahr	2173 (19.2)	1151	2937 (35.4)	1556	2697 (31.2)	1429
Province	11305 (100)	469	8300 (100)	345	8657 (100)	359

*Annual Incidence Rate (per 100000)

Table 2: *Plasmodium* distribution in the Sistan and Baluchistan Province districts

	2005-2006, No (%)			2006-2007, No (%)			2007-2008, No. (%)		
	P. vivax	*P. falciparum*	Mixed	*P. vivax*	*P. falciparum*	Mixed	*P. vivax*	*P. falciparum*	Mixed
Zahedan	281 (86.2)	40 (12.3)	5 (1.5)	239 (86.6)	32 (11.6)	5 (1.8)	341 (78.2)	88 (20.2)	7 (1.6)
Khash	142 (87.1)	12 (7.4)	9 (5.5)	76 (80.9)	12 (12.7)	6 (6.4)	63 (78.8)	13 (16.2)	4 (5.0)
Saravan	1217 (84.3)	209 (14.5)	18 (1.2)	596 (72.8)	183 (22.3)	40 (4.9)	628 (68.7)	249 (27.3)	36 (4.0)
Iranshahr	749 (92.4)	61 (7.5)	1 (0.1)	591 (96.6)	20 (3.2)	1 (0.2)	504 (91.8)	40 (7.3)	5 (0.9)
Sarbaz	2756 (71.0)	1073 (27.6)	58 (1.4)	1664 (81.6)	367 (18.0)	10 (0.4)	1075 (72.9)	390 (26.5)	9 (0.6)
Chabahar	1984 (79.4)	491 (19.6)	26 (1.0)	1245 (81.8)	255 (16.8)	21 (1.4)	2069 (82.5)	413 (16.5)	26 (1.0)
Nikshahr	2116 (97.4)	40 (1.8)	17 (0.8)	2896 (98.6)	27 (0.9)	14 (0.5)	2678 (99.4)	15 (0.5)	4 (0.1)
Province	9245 (81.8)	1926 (17.0)	134 (1.2)	7307 (88.0)	896 (10.8)	97 (1.2)	7358 (85)	1208 (13.9)	91 (1.1)

Table 3: Gender, location, and nationality distribution of malaria patients

		2005-2006			2006-2007			2007-2008		
		No	%[1]	*P* value	No	%[1]	*P* value	No	%[1]	*P* value
Age	0-4	722	6.4	0.03	619	7.5	0.05	643	7.4	0.04
	5-14	3444	30.5		2577	31.0		2371	27.4	
	15-44	5664	50.1		3723	44.9		4241	49.0	
	≥45	1475	13.0		1381	16.6		1402	16.2	
	Total	11305	100.0		8300	100.0		8657	100.0	
Gender	Male	7395	65.4	<0.001	5299	63.8	0.03	5501	64.2	0.03
	Female [2]	3910	34.6		3001	36.2		3066	35.8	
	Total	11305	100.0		8300	100.0		8657	100.0	
Location	Urban	2200	19.5	0.05	1520	18.3	0.05	1840	21.2	0.05
	Rural	9105	80.5		6780	81.7		6817	78.8	
	Total	11305	100.0		8300	100.0		8657	100.0	
Nationality	Iranian	8946	79.1	<0.001	6903	83.2	<0.001	7233	83.6	<0.001
	Afghan	1796	15.9		1014	12.2		1062	12.3	
	Pakistani	549	4.9		380	4.6		360	4.1	
	Etc.	14	0.1		3	0.0		2	0.0	
	Total	11305	100.0		8300	100.0		8657	100.0	

[1] Percent of each subgroup within the total number of malaria patients in the respective year.
[2] Number and percent of pregnant patients (of the total patients) in these three successive years were 123 (1.0%), 73 (0.9), and 113 (1.3), respectively.

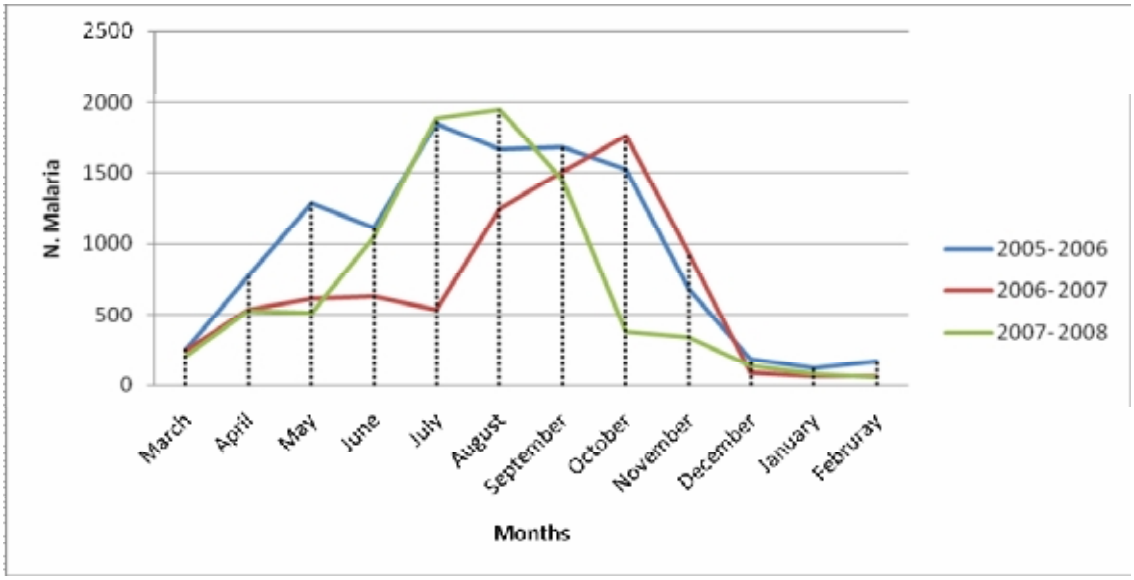

Fig. 2: Malaria reached to peak at July up to October

malaria were diagnosed in spring and summer, and the incidence of malaria reached its annual peak from July to October. Malaria cases were least reported from December to February. This might be due to a relatively undesirable transmission circumstance in these months.

Discussion

According to the roll back program, a reduction in the annual incidence rate of malaria is expected. Some studies have demonstrated this in Iran.[6-7] Masoumi documented a decline in the incidence rates of

malaria in Iran from 145 (per 100,000) in 1990 to 36 in 1999.[6] Sistan and Baluchistan Province is located in southeast of Iran. This area is considered as an endemic region for malaria.[11]The results of this study clearly showed that malaria is prevalent in this province, necessitating more attention for eradication. Annual incidence rates of malaria in the 3 consecutive years were determined. In contrast to roll back program, an interruption in the declining trend happened from 2007 to 2008. Incidence rates from 469 per 100000 in 2006, and 345 in 2007 reached 359 in 2008. Cases of both *P. vivax* and *P. falciparum* had such an increase, and Pf% documented in this study showed that this rising was more prominent in the cases of *P. falciparum*. Several factors might be involved in this interruption of the decreasing trend. Cyclone Gonu occurred in June 2007,[17] making the situation more susceptible to malaria transmission. Formerly, in 1996, climate changes were shown to have a relationship with an increase in the malaria incidence in the northwest frontier province of Pakistan, geographically next to the field of our study.[12] Through numerous mechanisms, this cyclone might lead to increased incidence rates. Attenuation of transmission rate due to the developing of stagnant waters and subsequently higher mosquito density in the air, impairing malaria control measures from diagnosis to treatment in inaccessible areas, and subsequently the vulnerability might be proposed as some contributory mechanisms.

Malaria was most common in 15-44 year old people, rural areas, and males. Incidence of malaria peaks in July to October. All these findings are compatible with malaria transmission features, especially because of higher exposure to vectors. Sarbaz and Nikshahr were the districts with highest API. Chabahar and the southern districts have a tropical climate, with a temperature and humidity reaching to optimal condition for malaria transmission in summer. Similar findings were reported by a spatial study performed in this province formerly. That spatial modeling revealed that humidity, temperature, and altitude were positively correlated with the malaria risk. In the malaria risk map provided, the southern part of the province had a higher risk of malaria.[12] Chabahar and Sarbaz districts together have over one-half of the total annual cases of *P. falciparum* in the province. Pf% was the highest in these districts. In addition to the better ecological situation for transmission of the disease, these districts have a common border with Pakistan, from which importation of malaria and specifically *P. falciparum* might occur. Rafi performed a malaria survey in the border areas of Baluchistan of Pakistan, next to Baluchistan of Iran. He emphasized the importance of cross-border traffic.[18] This importation is so important that it is assumed as one of the main factors for the presence of malaria in this area.[6] No data for comparing malaria indices between the borders of Iran and its neighbors have been established yet. However, studies in Pakistan and Afghanistan show higher Pf% in these countries, in comparison to Sistan and Baluchistan Province. Faulde documented annual incidence rates of 0.0088 per 1000 persons for *P. falciparum* malaria and 3.57 for *P. vivax* in Kundoz Province in 2005.[19] In a 4.5 year study on 521 malaria patients hospitalized in Karachi (Pakistan), *P. vivax* (51.8%), *P. falciparum* (46.5%), *P. vivax* plus *P. falciparum* (1.3%), and *P. malariae* (0.4%) were the detected *Plasmodia*.[20] Meanwhile, studies in Iran showed a Pf% of about 20%, particularly in south-east of Iran.[21]

The results of this study showed that 15-20% of the total malaria patients had Afghani or Pakistani nationality. The same results were formerly reported. Edrissian described imported cases of chloroquine-resistant *P. falciparum* malaria.[22] "People move for a number of reasons, including environmental deterioration, economic necessity, conflicts, and natural disasters. These factors are most likely to affect the poor, many of whom live in or near malarious areas".[23] Burdens of malaria in Afghanistan and Pakistan induced by their specific sociopolitical challenges (e.g. civil war, poverty)[24-26] are hazardous factors that affect eradication of malaria in Iran. The process of eradication is hampered by introducing new sources of parasites in the *P. plasmodium*-cleaned areas, induction of genetic diversity of plasmodium and introduction of drug resistant parasites. Thus, poor control on cross-border traffic makes importation of malaria inevitable, a problem that is truly one of the prime causes of persistence of the disease in the region.

The data of this study clearly reveal that more attention should be directed toward the three main elements of the malaria transmission cycle, including host, vector, and agent. Identification of different species of *Plasmodium*, with determination of those resistant to currently used drugs, is an important point. More surveillance on the process of patient diagnosis, treatment, and education is also necessary. Imported malaria cases, mainly refugees or job

seekers with low cultural and economical status, should be treated with more concern. Their shelters, which might be hidden due to illegality of their presence in some parts of the province, should be recognized as soon as possible, and vector-control measures need to be reinforced in these areas. On the other hand, attention to the quality and quantity of vector-control interventions, through cooperation with other governmental and non-governmental organizations, is an important milestone fulfilling an acceptable mosquito control program is dependent upon. Collaboration with agriculture organization might be extremely invaluable in controlling stagnant waters throughout the province, just as a simple instance. These are simple but practical measures and when materialized, profound impacts might be expected.

As a conclusion, malaria has not been controlled properly in this province yet. Thus, more investigations and interventions are needed for overcoming this disease. Epidemiological features of the disease might be indicative of the influence of the socioeconomic factors such as low level of education, and poor knowledge of people about malaria, especially in rural areas. These might be assumed as the possible inhibiting factors for controlling the disease in this province. Importation of malaria from Afghanistan and Pakistan seems to be another problem in the process of malaria eradication, specifically in the case of *P. falciparum*.

Acknowledgement

This research was supported by the Research Center for Infectious diseases and Tropical Medicine, Zahedan University of Medical Sciences, by co-operation of Mycoparasitology Department of Mashhad Medical University. We should appreciate kind co-operation of the staff of hygiene vice-chancellery, Dr. Vahedi, Dr. Kiani, Mr. Sakeni, and Mr. Hasanzehi, and disease management personnel, since without their great job in data gathering in the fields, such an analysis might be thoroughly impossible.

Conflict of interest: None declared.

References

1 Nabarro D. Roll Back Malaria. *Parassitologia* 1999;**41**:501-4. [10697910]
2 Greenwood B, Mutabingwa T. Malaria in 2002. *Nature* 2002; **415**:670-2. [11832954] [doi:10.1038/415670a]
3 Nafo Traoré F. Rolling back malaria: opportunities and challenges. *Trans R Soc Trop Med Hyg* 2005;**99**:403-6. [15837351] [doi:10.1016/j.trstmh.2005.02.002]
4 Atta H, Zamani G. The progress of Roll Back Malaria in the Eastern Mediterranean Region over the past decade. *East Mediterr Health J* 2008;**14**:S82-9. [19205607]
5 Trigg PI, Kondrachine AV. The epidemiology of malaria and its control. Malaria unit, division of control of tropical disease, World Health Organization, Geneva, Swithersland. Symposium. Parasitol Int; 1998: pp. 25.
6 Masoumi Asl H. Malaria situation in the Islamic Republic of Iran. *Med Parazitol (Mosk)* 2001;**(1)**:47. [11548317]
7 Arshi S, Barough MR, Zareh M. The malaria situation in the Islamic Republic of Iran. *Med Parazitol (Mosk)* 2000;**(2)**:21. [10900913]
8 Edrissian GH. Malaria in Iran: Past and Present Situation. *Iranian Parasitol J* 2006;**1**:1-14.
9 Manouchehri AV, Zaim M, Emadi AM. A review of malaria in Iran, 1975-90. *J Am Mosq Control Assoc* 1992;**8**:381-5. [1474383]
10 Mofidi CM. Epidemiology of malaria and its liquidation in Iran. *Med Parazitol (Mosk)* 1962;**31**:162-4. [14475035]
11 Sadrizadeh B. Malaria in the world, in the eastern Mediterranean region and Iran. WHO/EMRO Report; 2001: p.1-13
12 Bouma MJ, Dye C, van der Kaay HJ. Falciparum malaria and climate change in the northwest frontier province of Pakistan. *Am J Trop Med Hyg* 1996;**55**:131-7. [8780449]
13 Dost AG, Muslim M. Malaria in Afghanistan. *Med Parazitol (Mosk)* 2001;**(1)**:42-3. [11548314]
14 Salehi M, Mohammad K, Farahani MM, Zeraati H, Nourijelyani K, Zayeri F. Spatial modeling of malaria incidence rates in Sistan and Baluchistan province, Islamic Republic of Iran. *Saudi Med J* 2008;**29**:1791-6. [19082235]
15 Nájera JA. Epidemiology in the strategies for malaria control. *Parassitologia* 2000;**42**:9-24. [11234336]
16 World Health Organization: Basic laboratory methods in medical parasitology. In Basic malaria microscopy: Part I. Geneva, Switzerland: WHO; 1991.
17 http://en.wikipedia.org/wiki/Cyclone_Gonu. (20 Oct 2009)
18 Rafi SM, Rashid M, Shorey WU. Malaria survey of border area of Baluchistan adjacent to Iran. *Pak J Health* 1957;**6**:233-42. [13484267]
19 Faulde MK, Hoffmann R, Fazilat KM, Hoerauf A. Malaria Reemergence in Northern Afghanistan. *Emerg Infect Dis* 2007;**13**:1402-4. [18252122]
20 Beg MA, Sani N, Mehraj V, Jafri W, Khan MA, Malik A, Menezes E, Hussain R, Smego R Jr. Comparative features and outcomes of malaria at a tertiary care hospital in Karachi, Pakistan. *Int J Infect Dis* 2008;**12**:37-42. [17576086] [doi:10.1016/j.ijid.2007.04.006]
21 Ebrahimzadeh A, Fouladi B, Fazaeli A. High rate of detection of mixed infections of Plasmodium vivax and Plasmodium falciparum in South-East of Iran, using nested PCR. *Parasitol Int* 2007;**56**:61-4. [17257891] [doi:10.1016/j.parint.2006.12.001]

22 Edrissian GH, Shahabi S, Pishva E, Hajseyed-Javadi J, Khaleghian B, Ghorbani M, Emadi AM, Afshar A, Saghari H. Imported cases of chloroquine-resistant falciparum malaria in Iran. *Bull Soc Pathol Exot Filiales* 1986;**79**:217-21. [3524879]

23 Martens P, Hall L. Malaria on the move: human population movement and malaria transmission. *Emerg Infect Dis* 2000;**6**:103-9. [10756143] [doi:10.3201/eid0602.000202]

24 Kolaczinski J, Graham K, Fahim A, Brooker S, Rowland M. Malaria control in Afghanistan: progress and challenges. *Lancet* 2005;**365**:1506-12. [15850637] [doi:10.1016/S0140-6736(05)66423-9]

25 Aftab O, Syed FK. Malaria: yet another war for Afghanistan. *Lancet* 2005;**365**:2088-9. [15964440] [doi:10.1016/S0140-6736(05)66729-3]

26 Rowland M, Rab MA, Freeman T, Durrani N, Rehman N. Afghan refugees and the temporal and spatial distribution of malaria in Pakistan. *Soc Sci Med* 2002;**55**:2061-72. [12406471] [doi:10.1016/S0277-9536(01)00341-0]