JOURNAL OF PURE AND APPLIED MICROBIOLOGY, December 2012. Vol. **6**(4), p. 1939-1944

Report of Two Foci Epidemics of Malaria in Bushehr Province, Iran

H. Darabi[1], A. Raeisi[2], K. Shemshad[3], F. Pakbaz[1], S. Shamspour[1] and J. Rafinejad[4,5]*

[1]The Persian Gulf Tropical Medicine Research Center, Bushehr University of Medical Science, Iran.
[2]Center of Disease control and Management, Ministry of Health & Medical Education,
[3]Department of Medical Entomology, Faculty of Health,
Mazandaran University of Medical Sciences. Sari, Iran.
[4]Department of Medical Entomology and Vector Control, School of Public Health,
Tehran University of Medical Sciences, P.O.Box 14155-6446, Tehran, Iran.
[5]Center for Solid Waste Research (CSWR), Institute for Environmental Research (IER),
Tehran University of Medical Sciences, Tehran, Iran.

(Received: 04 April 2012; accepted: 12 May 2012)

Establishing and developing of huge energy project of southern Pars Company with regard to migration of non-indigenous human force from different parts of the world as labor and more specifically Afghan peoples provided the possibility of malaria transmission, and caused the occurrence of two malaria epidemics in 2002 and 2005. This study is a retrospective survey that all data were extracted from related epidemiological questionnaire forms, which are included reports of malaria cases and standard entomological surveys in Asaluyeh region. In 2002, regard to the lack of vector control vigorous programs in Asaluyeh region, the first epidemic of malaria has occurred. Just on three months, April , May and June, parasite incidence rate reached to 9.2 per thousand. In that year, predominant parasite was *Plasmodium vivax* (49 %) followed by *P. falciparum* (40%) and mix infection (13%)as well. It found that 64% of all patients was non-indigenous cases, especially Afghan peoples, who worked with oil projects. After three years, although vector control programs, active case finding treatment were carried out seriously, but another epidemic has occurred in 2005 with a parasite incidence rate of 7.5 per thousand, in April, May and June. This year 99% of all infections was caused with *P. vivax* and the remained 1% was due to *P. falciparum*. During that epidemic 81% of malaria patients were non-indigenous people, especially Iranian Baluches. The most effective factors on incidence of malaria epidemic in Asaluyeh region include: ecological changes and demographical shifts, entrance and crowding of worker population by different proceeding of parasitic infections, persistence of powerful vectors, migrant population, insufficient equipment and low member of staff in health - care systems.

Key words: Epidemics, Malaria, Bushehr, Iran.

Malaria is one of the most important hygienic problems in tropical and semi-tropical regions. Annually in the world 300-500 million patients still suffer from the disease, from which 2-3 million cases belong to the children and pregnant women. There were an estimated 216 million episodes of malaria in 2010, of which approximately 81%, or 174 million cases, were in the African Region. There were an estimated 655 000 malaria deaths in 2010, of which 91% were in Africa. Approximately 86% of malaria deaths globally were of children under 5 years of age (WHO,2011). Its parasitic agent is a microorganism of genus *Plasmodium* with four species of *P. vivax*, *P. falciparum*, *P. ovale* and *P. malariae* create

* To whom all correspondence should be addressed.
E-mail: jrafinejad@tums.ac.ir

human malaria (Donald, 2000; Nicholas and Joel, 1998). In the Eastern Mediterranean Region 15 million clinical malaria cases are reported annually. From which 47 thousand cases lead to death. 60 Percent of the region population (287 millions) are exposed to malaria, 15% of all them is living in areas with *P.vivax* transmission, while 45% of them live in areas with both *P. vivax* and *P. falciparum* transmission (WHO, 2009).

In Iran, malaria is one of the important vector-borne diseases, which has created economical and social damages until now. In the last decades, expand and powerful strategy plans, have eradicated malaria in some provinces of Iran, and have reduced its incidence in other endemic provinces. By successful prophylaxes and control programs in the last 50 years, in expand areas of Iran, it has not be seen malaria transmission and just in some areas in south-east of the country the local transmissions of malaria occurs. Although malaria cases have been reduced in last 50 years, from 5 million cases at that time to 16467 cases in 2007. At present although more than 91% of malaria cases in Iran is reported from Sistan and Baluchistan, Kerman and Hormozgan provinces , Sistan and Baluchistan has the first level , but there is still the risk of roll back malaria and it's again incidence in eradicated areas, and so it is still possible to occur expand epidemics in the endemic areas (Raeisi *et al*., 2009). The last studies on Iranian mosquitoes show 31 *Anopheles* species including different sibling species and genotypes, eight of them are reported to play role in malaria transmission (Hanafi-Bojd *et al*, 2011).

Due to its climatic conditions, presence of some important active vectors, its neighborhood to Hormozgan, Khuzestan and Fars provinces, and its relationships with infected areas such as Kerman and Sistan and Baluchistan provinces, Bushehr province have been exposed to expand malaria epidemics. These problems always threat the province. This survey is allocated to report of two epidemic malaria cases in Asaluyeh village in 2002 and 2005.

MATERIALS AND METHODS

Study area

Asaluyeh village is located in 276 km, south of Bushehr city, and 76 km on south-eastern of Kangan district. This area has 15000 native populations. In 1997, by starting and development of a large oil project called Southern Pars, this region accepted about 60000 Iranian and foreign workmen, including 10000 Afghans, 40000 Iranians and 2-3 thousand from South Korea and France as well. Due to the introducing high risk population in this region, malaria cases have increased in spring 2002. This epidemic was suppressed by vector control programs and active care systems and some arranged teams. By creating of malaria control teams in the following years, malaria have been controlled, but due to entering Iranian Baluch workmen who have migrated from endemic areas such as Sistan and Baluchistan province, malaria cases have seen in April, May and June 2005.

Study design

This study is a retrospective–descriptive survey carried out by Asaluyeh public health – care center staff. Malaria cases were diagnosed by microscopy method using peripheral blood slides.

Measures and measurement

Health care in the area is carried out in both active and passive methods. Passive care is perfumed in three passive posts and active care is perfumed by case finding team in order to house to house method. Blood samples are obtained from all patients, then they are transmitted to the laboratory, in less than 24 hours, and are examined under laboratory conditions. After determining malaria cases, case finding teams refer to the patients' house and treat them. They fill some individual questionnaire forms; include patients' characters, illness history, their habits, life conditions, infection focuses and epidemiological systems. Entomological surveys include recognition of larvae habitats is perfumed. All of larvae habitats is diagnosed and different larvae stage randomly are collected from different habitats and are transmitted to the laboratory. Also in order to determine the fauna and frequency of vectors, collection of vectors are performed by total catch method and so frequency and species of vectors are determined exactly. All data about patients were analyzed by SPSS software.

RESULTS

Case report

As it is obvious in table 1, there has been

vigorous increasing in malaria cases from 2002 to 2005.

Epidemic Foci of malaria in 2002

The first focus epidemic of malaria was happened in 2002. In that year 215 positive blood slides were reported by laboratory diagnosis, 102 out of them were due to *P. vivax* (47%), 97 cases were *P. falciparum* (45%) and the remained 16 patients became infected with both parasites (7 %). Some activities such as house to house cares, residual spraying, larviciding and expand education programs make that malaria cases were decreased in future years, so that 53 and 80 malaria cases were reported in 2003 and 2004, respectively .

The rate of parasite incidence, just on April, May and June were 9.2 per thousand peoples of the study area. During that period of time 36% of malaria cases were indigenous and 64% were non-indigenous, especially Afghan employees of the oil project of Asaluyeh.

We found that 75% of malaria patients were men and 25% of them were women. Predominant parasite were *P. vivax* (48%) followed by *P. falciparum* (40%) and mix infection (12%).

Epidemic focus of malaria in 2005

In 2005, 193 malaria cases were diagnosed using microscopy method in the laboratory. Plasmodium vivax was the cause of 98% of cases and just two cases were due to *P. falciparum* (1%). The most numbers of malaria cases (94%) was belonged to the age group >15 years old. Men wee he main group of patients (95%). In this epidemic 136 patients (74%) were Iranian, 44 patients (24%) were Afghan workers of the oil project, and three other cases (2%) were Indian people inhabited in the area. Epidemiological surveys have shown 151 local transmission cases (83%), 13 imported cases (7 %), and 19 relapse cases (10%).

The rate of parasite incidence on three months of April, May and June was 7.5 per 1000 population. In that time 99% of malaria cases became infected with *P. vivax*, and 1% had infection with *P. falciparum*. Indigenous cases were 19%of the total reported patients, while from non-indigenous cases 28% was Iranian Baluches, 29% were non local Iranians and the remained (22%) were Afghan workers of the project.

Due to entomological surveys in external and internal residential places, *Anopheles stephensi*, *An. fluviatilis* and *An. dthali* were caught and diagnosed as possible malaria vectors, based on their role in malaria transmission in malaria of Iran. Activity peak of *An. stephensi* in the area happens in early spring that is synchronous with illness annual peak. In this area, frequency of *Anopheles* would never reach zero. The most numbers of biting were (37%) carried out at 20:00-21:00 o'clock.

Table 1. Malaria cases during 2002 –2005, Asaluye area, southern Iran

Years	2002		2003		2004		2005	
Months	Ira	For	Ira	For	Ira	For	Ira	For
January	1	2	0	0	0	0	1	0
February	0	2	0	0	0	1	1	2
March	0	0	0	1	0	1	2	1
April	2	3	2	18	2	5	1	1
May	22	46	2	5	1	11	14	8
June	39	35	1	4	2	7	60	19
July	1	24	1	2	3	12	44	5
August	1	1	2	1	4	9	10	6
September	1	4	1	4	2	6	1	5
October	1	8	4	1	0	5	3	2
November	4	5	2	0	2	3	1	2
December	1	4	2	0	1	3	5	0
Total	73	134	17	36	17	63	143	51

Ira: Iranian For: Foreigners

Survey on physiological age of caught Anopheline mosquitoes showed the 15%,14%, 24% and 47% of the females gravid, half gravid, fed and unfed, respectively. The most numbers of the collected larvae were *An. fluviatilis* (77%). Catch percentage of *An. stephensi*, *An. dthali* and *An. fluviatilis* in internal residential places was 86%, 10% and 4%, respectively.

DISCUSSION

Malaria varies greatly around the world in the level of intensity, in the mosquito vectors that transmit it and in the species causing the disease. *Plasmodium vivax* appears to be more widespread among 20 countries in Asia while the fatal *P. falciparum* are widely spread in about 50 countries in Africa. Africa including parts of Asia suffers infrastructural decay and poverty occasioned by malaria burden which seems to have defiled many solutions for complete eradication (Osamor, 2010). Nigeria is an example of the malaria endemic areas in Africa. Epidemiological surveys about malaria cases during the study period in Asaluyeh region have shown that from 2002 until 2004 this region was similar to the other high transmission potential regions and epidemic areas, transmission level of disease were increased in indigenous persons by entrance of non-indigenous infected persons. From 2002 up to now, entrance of Afghan workers as parasitic resources have increased the transmission of the disease, so that 65% of malaria cases were belong to the Afghans. In 2005 by incoming of Iranian Baluch workers to this region, transmission of the disease has been increased.

The epidemiologic situation of malaria in six years in Iran from 2002 to 2007 showed this disease was mainly found in three southeastern provinces. In 2002, 68% of positive cases belonged to these provinces whereas in 2007 it increased to 95%. In 2002, 41% of the infected people were in Sistan and Baluchistan province which increased to 60% in 2007. A 6.5% reduction in malaria positive cases from 2002 to 2007 has been recorded and even with the unsuitable geographical conditions of the southeastern provinces neighboring Afghanistan and Pakistan, the percentage of *P. falicparm* has had a considerable downward trend from 15% in 2002 to 8.5% in 2007 (Raeisi *et al*., 2009). According to the surveys that had been carried out from 1986 to 1996 in Isfahan province, 9720 malaria cases were studied, 91.5% of them were Afghan immigrants, 96.2% were men, and 3.7 % of them were women (Ataei *et al*., 2000). In Hamedan province from 1980 to 2000, among 506 reported malaria cases, 62% of them have been internal transmission in Iran, and 13.4% of them have been external transmission from neighborhood countries, and 2.96% of them were local transmission (Falah *et al*., 2003). Another study that carried out in Ardabil province from 1999 until 2000, showed 509 malaria patients had been reported, all of them were results of local transmission (Arshi *et al*, 2000). These studies show the imported cases are the main problem of some areas of the country, especially in non-endemic foci, although the risk of local transmission of malaria exists is some area. Development and expansion of South Pars Gasses Square and other refinery factories, regarding to the entrance of worker population into this region and the lack of equipment and the lack of residential places and other environmental problems for immigrants, ecologic changes and environmental shifts that have been created from environmental damages and different population with different cultures and socials , made violent and sever changes and ecologic and epidemiological instability in this region. Entrance and crowding of large job seeking population in this region with different preceding of parasite infections from different regions of Iran and other countries, persistence of suitable and powerful vectors such as *An. stephensi*, *An. fluviatilis* and *An. dthali*), ecological changes and expansion of larval habituates, immigrant population, especially Afghan and Baluch workmen, were effective and important factors on creating of focus epidemic of malaria in Asaluyeh region.

Nigeria is located primarily within the lowland humid tropics and generally characterized by a high temperature throughout the year. Record shows that malaria accounted for over 45% of all out-patients and about 50% of the Nigerians suffer from at least one episode of malaria each year (Ayeni, 2011).

One hundred and twelve infants and children (27.2%) were positive for asexual malaria parasites in Maiduguri Metropolis, North Eastern

Nigeria . 15.8% were males while 47 (11.4%) were females. Infection rate was not significantly different between the sexes ($p>0.05$). The level of parasitaemia were significantly related to age ($p<0.05$) the majority 87 (77.6%) of infected infants and children were between the ages of 12-36 months (Samdi *et al*., 2005)

According to the surveys that was carried out in Brazil and Amazon region of Latin America about human migration and the spread of malaria, it has been shown that some human migration into Amazon region from the other parts of Brazil, make a steady increasing in malaria cases in Amazon region (Marques, 1987).

Due to the US Institute of Medicine in 2006 observed that over the past two centuries, the average distance and spread of human travel have increased a thousand-fold but incubation times for infectious diseases have remained the same (EASAC, 2007). Some European countries such as Greece and Spain as they are strongly related to increasing migration from Asia, Africa and Latin America., many of the migrants develop the infection diseases in consequence of their socio-economic status in host countries. the European Society for Clinical Microbiology and Infectious Diseases(ESCMID) also noted both the vulnerability of the EU to the re-introduction of malaria during migration because of re-colonization by *Anopheles* mosquitoes of other previous habitats in Balkans and potential health issues related to migration from Latin America , for example Dengue fever in Spain. In some European countries Leishmaniasis and Malaria is increasing in prevalence in the northern regions of Europe, because of human migration from Africa, Asia and Latin America to the Europe (EASAC, 2007).

According to the surveys that were carried out in Romania in 1974-2007, Malaria was eradicated in Romania in 1961 due to a national eradication program that was considered as a Global Model. Around 30-60 imported malaria cases are diagnosed yearly in Romania. Imported malaria were entranced from endemic countries of Africa and Asia. African workmen and Asian students in Uganda, Guinea and so India and Pakistan (Neghinaa *et al*., 2008). Although malaria control is important in all regions, but this problem is very important in Asaluyeh region. Because this region is the largest gasses square in all of the world, and it is one of the most important economic poles in Iran and may play a role as a place for distribution of some diseases like malaria to other parts of the country as well as the world. There are different method including biological-chemical and environmental management for combating malaria vectors (Darabi *et al*., 2011). So attention to all of methods in prevention of malaria in this region is through necessary. It is recommended that in this region that initiates new foci of active transmission in previously controlled areas elsewhere in the country, the surveillance system and vector control program must be enhanced.

REFERENCES

1. Arshi, S., H. Sadaghi and M. Mohebali. Epidemiology of malaria in Ardabil province. *Ardabil. Univ. Med. Sci. J*., 2000; **2**: 28-33 .
2. Ataei, B., R. Labaf Ghasami and G.H. Sadri. A Survey on malaria in Isfahan province during yearse 1986 to 1996. *Kowsar. Med. J*., 2000; **5**: 63-67
3. Ayeni, A.O. Malaria morbidity in akure, Southwest, Nigeria: A temporal observation in a climate change scenario. *Trends. Applied. Sci. Res.,* 2011; **6**: 488-494.
4. Marques, A.C. Human migration and the spread of malaria in Brazil. Parasitol Today., 1987; **3**: 166-170.
5. Darabi, H., H. Vatandoost, M.R. Abaei, O. Gharibi and F. Pakbaz. Effectiveness of methoprene, an insect growth regulator, against malaria vectors in Fars, Iran: A field study. *Pak. J. Biol. Sci*., 2011; **14**: 69-73.
6. Donald, J.K. Malaria in Cecil Text Book of Medicine, Goldman, Bennett. 21st Edn., W.B. Saunders Company, USA., pp: 1947-1950; 2000.
7. EASAC. Impact of migration on infectious diseases in Europe. The Royal Society, European Academies Science Advisory Council, http://www.leopoldina.org/fileadmin/user_upload/Politik/Empfehlungen/EASAC/EASAC_Statement_Migration-infectious-diseases_2007.pdf; , 2007.
8. Falah, M., A. Miraarab, F. Jamalian, A. Ghaderi, A.Z. Alfaghari. Epidemiology of malaria in Hamadan province during a 20-year period (1980-2001). *Behbood*. *Summer*., 2003; **7**: 36-44.
9. Hanafi-Bojd, A.A., S. Azari-Hamidian , H. Vatandoost and Z. Charrahy. Spatio-temporal distribution of malaria vectors (Diptera:

Culicidae) across different climatic zones of Iran. *Asian. Pac. J. Trop. Med.*, 2011; **4**: 498-504.
10. Neghinaa, R., A.M. Neghinab, L.D. Giurgiuc, I. Marincud and I. Iacobiciua. Import of malaria in a Romanian Western county. *Travel. Med. Infectious. Dis*., 2008; **6**: 215-218.
11. Nicholas, J.W., G. Joel. Malaria and Other Diseases Caused by Red Blood Cell Parasites. In: Harrison's Principles of Internal Medicine, *Nicholas, J.W.* and *G.B. Joel (Eds.).* 14th Edn., McGraw Hill, New York, USA., pp: 1180-1188; 1998.
12. Osamor, V.C. The Etiology of Malaria Scourge: A Comparative Study of Endemic Nations of Africa and Asia. *J. Biol. Scien.,* 2010; **10**: 440-447.
13. Raeisi, A., F. Nikpour, M.R. Kahkha and L. Faraji. The trend of malaria in I.R. Iran. *Hakim. Med. J*., 2009; **12**: 35-41.
14. Samdi, L.M., S. Oguche, N.B. Molta, I.M. Watila, P.U. Agomo and A.C. Ene. *Plasmodium* infection in severely ill children aged 0-8 years in maiduguri metropolis, North Eastern Nigeria. *J. Medical. Sci*., 2005; **5**: 294-297.
15. World Malaria Report, 2011.