

Original Article**Malaria Situation Analysis and Stratification in Bandar Abbas County, Southern Iran, 2004–2008***AA Hanafi-Bojd¹, H Vatandoost¹, E Philip², E Stepanova³, AI Abdi⁴, R Safari⁵, GH Mohseni⁵, MI Bruhi⁶, A Peter⁷, SH Abdulrazag⁸, G Mangal⁹¹Department of Medical Entomology & Vector Control, School of Public Health, Tehran University of Medical Sciences, Iran²Torit State hospital, Ministry of Health, Eastern Equatoria State, Government of South Sudan³Martinoskvy Institute, Moscow, Russia⁴Ministry of Health, Somalia⁵Province Public Health Centre, Hormozgan University of Medical Sciences, Bandar Abbas, Iran⁶Senior Evaluator of Malaria Control Program, SINDH province, Pakistan⁷Acting Director General for Malaria Control Program, Upper Nile State- Malakal, State Ministry of Health, Government of South Sudan⁸Ministry of Health, Republic of Sudan⁹Health Center of Khost province, Afghanistan

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Abstract**Background:** The aim of this study was that the past five years data were collected to analyze the situation of malaria and health facilities in this area for better understanding malaria problem and to find solutions.**Methods:** In this retrospective study data of the last 5 years were obtained from health center of Bandar Abbas, published papers and reports, weather forecasting organization of the city and annual reports of Hormozgan official authorities. An excel databank was created and analysis was conducted using this software.**Results:** According to the national health system, Bandar Abbas also has referral net work system from periphery to the district health center. The maximum and minimum Annual Parasitic Index (API) were observed in 2005 (1.31) and 2008 (0.17), respectively. The prevalence of cases in villages was more than city, except for 2008. More than 97.6% of indigenous malaria cases were caused by *Plasmodium vivax*, although *P. falciparum*, *P. ovale* and mix infection were also reported. *Anopheles stephensi*, *An. dthali* and *An. fluviatilis* are the main malaria vectors in rural area, while only the first species is distributed in the urban area.**Conclusion:** According to results and many variables including API, Bandar Abbas is divided in two strata. From the situation analysis of Bandar Abbas it is postulated that the main activities of this district could be accuracy of data, and malaria vector control.**Keywords:** Malaria stratification, Iran**Introduction**

Malaria disease is a worldwide problem that can be found in vast area of the world, where great portions of population are at risk. Unfortunately number of people lost their live because of this disease, and still it is one of the main problems in global health.

The disease is transmitted by a variety of female Anopheline mosquitoes (WHO 2009).

Iran is one of the countries that face this problem. Before starting any malaria control program in Iran about 60% of population of the country was living in endemic areas

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with 30 to 40% malaria morbidity (Edrissian 2006). Iran has been classified into four different strata according to the epidemiology of the disease (Raeisi et al. 2004). At present, malaria problem in Iran is mostly concentrated in southern part. More than 90% of cases are reported from Sistan and Baluchistan, Kerman and Hormozgan Provinces in south-east of the Country (Moosa-Kazemi et al. 2007). It is unstable with two seasonal peaks mainly in spring and autumn. Outbreaks due to *P. vivax* usually occur after rainy season (Manouchehri et al. 1992). In this part of the country six anopheline mosquitoes including *Anopheles culicifacies*, *An. stephensi*, *An. dthali*, *An. fluviatilis*, *An. superpictus* are known proven vectors. *Anopheles pulcherrimus* was mentioned as suspected malaria vector (Jalali-Moslem 1956, Manouchehri et al. 1972, Eshghi et al. 1976, Manouchehri et al. 1992, Zahirmia et al. 2001, Edrissian 2006). The national strategy on malaria was revised in 2006, with the goal of eliminating of *Plasmodium falciparum* malaria in 3–4 yr and only introduced cases of *P. falciparum* might occur, further reducing the number of autochthonous *P. vivax* malaria in a period of 7 yr. In the third stage of the new strategy, the objective will be a drastic reduction of local transmission of *P. vivax* in the residual and active malaria foci. At the end of the third stage only 500–700 autochthonous cases could be reported in the country per year.

Reported studies in 2008 show that out of 11460 malaria cases of Iran, 8% was due to *P. falciparum*, while 90% were infected by *P. vivax* (Minsitry of Health 2008). In WHO malaria report 2009, Iran showed evidence of a sustained decrease in the number of cases associated with wide scale implementation of malaria control activities. This country is classified as in the pre-elimination stage (WHO 2009).

The aim of conducting a situational analysis is to systematically understand the malaria epidemiology of an area in a very short

space of time and the health status, system and resource available for controlling the disease. In succession to planning to go to the district, there is need to use of the information that is already available and analyzing in such a way to understand the problems. The main objective of the situational analysis is to collect the data from respective references such as: health network office, hospital, health centers, communities, metrology department and others for conducting anti-malarial measures.

Bandar Abbas is the most important seaport of Iran in northern part of the Persian Gulf. This city has thousands of passengers from different parts of Iran, as well as shipmen and immigrants from malarious areas of different countries. Regarding to favorable conditions for malaria transmission, the city can be an important focus for the disease in southern Iran. The aim of this study was that the past five years data were collected to analyze the situation of malaria and health facilities in this area for better understanding malaria problem and to find solutions.

Materials and Methods

Study area

Hormozgan Province covers an area of 71139.62 km². It is located in south of Iran and north of the Persian Gulf. Bandar Abbas is the capital city of the province. It is located in southern part of this province between 54° 53'–56° 03' E and 26° 53'–27° 31' N on flat ground with an average altitude of 9 m above sea level. The nearest elevated area is Geno Mountain, 17 km north of Bandar Abbas. The city has a hot and humid climate. Maximum temperature in summers can reach up to 49° C while in winters the minimum temperature drops to about 5° C. The average of total annual rainfall was 118.44 mm during 2004–2008 and the mean annual relative humidity was 63.4% (www.weather.ir). In 2008 total population was 521657, from which 47% female and 53% male. About 77%

of population of this district is living in urban area and 23% in rural area. Foreign population in this year was 15087 (Management and Programming Organization 2008).

Data collection

This study was a retrospective survey conducted using data obtained from health network of Bandar Abbas, as well as published documents on weather, population, history of malaria and previous studies on malaria in this area. The data bank was created in Excel software. Situation analysis and stratification was conducted based on the obtained data.

Results

Health system and general health profile

Health care and public health services in Iran are provided through a national wide net. This network consists of a referral system starting from primary care center in the periphery going through secondary hospital in the capital and tertiary hospital in major cities. The public sector provide primary, secondary and tertiary health services and some of these services such as prenatal care and vaccination are free of charge (Table 1). The private sector plays a significant role in the health care focused on secondary and tertiary health care in urban areas. There are also many non-governmental organizations acting in health issue in Iran. They provide activities in special field like children with cancer, diabetes and thalassemia.

There is one university for medical sciences education in Bandar Abbas and health network is working under vice chancellor for health. Bandar Abbas health facilities during our study period are showed in Table 1 (Management and Programming Organization 2004-2008).

Malaria situation

Cases: Based on our findings the malaria cases in Bandar Abbas City are mainly

coming from rural areas and from other countries such as Afghanistan and Pakistan, but in rural area most of cases are due to local transmission. All these cases are diagnosed by taking blood and then examined microscopically, and then reported and treated in the public centers. All these activities are free of charge. Usually the cases from the health house reach the health centers within same day and about 80% of slide positive cases (slide examination take less 30 min) get treatment within 24 h according to national guideline. In those areas which are not covered by primary health care system, the anti-malaria activities carried by mobile team. The private sectors can investigate the cases but should refer them to the public sectors for treatment. Bandar Abbas is divided into 19 areas for malaria detection and treatment (Fig. 1).

During 2004–2008 a total of 1519 cases were reported to be positive out of 140620 taken slides (Table 2). Most of cases were Iranian (79.3%). The disease morbidity increased up to 2005 and after that had a decreasing trend to 2008. *Plasmodium vivax* was the main causative agent of malaria in Bandar Abbas (97.69%), followed by *P. falciparum* (2.17%). There was also one mixed infection case and a report of malaria due to *P. ovale* detected in an African football player came to Bandar Abbas in 2008. Cases reported in rural area of Bandar Abbas (64.3%) were more than urban area (35.7%). Most of cases (70.7%) had over 14 yr old. Males (64.5%) were infected more than females (35.5%). The transmission season was mainly between April and November (Fig. 2).

Vectors

Previous studies in the area show that Hormozgan Province has five *Anopheles* vector species, the most important of them are *Anopheles stephensi*, *An. fluviatilis* and *An. dthali*.

Anopheles stephensi is the main malaria vector in Bandar Abbas region, mainly can be

found in south urban part, flat and the coastal areas. It considers being endophilic, but biting outdoor during summer months. Its seasonal activity started at beginning of May reach the peak in August and gradually decrease up to December in the mountainous area, but in the coastal areas it is active all the year with two peaks one in the April–May and second in the August up to September (Manouchehri et al. 1976a). Another study reported the peak of activity in September in mountainous and October in coastal regions. This species is absent during the cold winter months, but has high density during spring and autumn in mountainous and coastal region, respectively (Vatandoost et al. 2006). The larva can be found in different bodies of water. In rural areas, it is found in pool streambeds at the margin of the streams, in the seepage and marshy area with gentle flow water, animal hoof print, and around the seepage marsh area (Vatandoost et al. 2004, Vatandoost et al. 2006). Sporozoite rates for *An. stephensi* were reported 0.2–1.8% from southern part of Iran (Jalali-Moslem 1956).

Anopheles dthali plays a secondary role as malaria vector in Bandar Abbas after *An. stephensi*. It is found mainly in Siahoo mountainous area, north of Bandar Abbas city. This *Anopheles* has two peaks of activity during autumn (December-February) and absent during cold winter and hot weather (June-August). The mosquito is resting outdoor in animal house as well as human dwelling (Vatandoost et al. 2007). In rural area of Bandar Abbas, the anthropophilic index and sporozoite rate in salivary glands for this species is reported 25% and 1.4%, respectively (Manouchehri et al. 1972).

The larvae of *An. dthali* are found in mineral water in high salinity with temperature of 13–28° C and pH of 6.9–8. The larva is most abundant in September and October which is the end of hot season in Bandar Abbas (Vatandoost et al. 2007).

Anopheles fluviatilis is also secondary vector with *An. dthali*, distributed in mountainous area from the east to west of Hormozgan Province. This species is exophilic, exophagic and zoophilic (Naddaf et al. 2003) with larval habitat in slow moving water on margin of river, stream with or without vegetation with high dissolved oxygen and pits around springs. The biting of this species on human bait started from 18.00 h and continued until 04.00 h, but most of bites on human and cow bait took place in the first half of the night, and there was no bite after 04.00 h (Manouchehri et al. 1975a). Seasonal activity of *An. fluviatilis* showed two peaks in November and May. This species was active throughout the night with one peak of blood meal, 22:00–23:00 h on animal and 24:00–01:00 h on human (Edalat and Moosa-Kazemi 2005). Sporozoite rate of this species is reported between 1.7–11% in south of Iran (Eshghi et al. 1976).

Vector control

The past program for malaria eradication in Iran was based on vector control using very large quantities of DDT started in 1949 which resulted in dramatic reduction in malaria incidence. Vector population recovery happens mainly due to resistant to DDT in *Anopheles stephensi* as well as DDT lack of selectivity affecting target population of mosquito (Edrissian 2006). Therefore, other insecticide belongs to organophosphate, organochlorine, carbamate and pyrethroid were used in following years. However, extensive use of chemical insecticides against mosquito vectors for about four decades has resulted in resistance to DDT, dieldrin and malathion (Maouchehri et al. 1992, Edrissian 2006). Susceptibility tests of insecticides against adult mosquitoes using standard impregnated papers provided by WHO showed *An. stephensi* was resistance to DDT, dieldrin and malathion, while *An. dthali* and *An. fluviatilis*

are susceptible (Mofidi et al. 1958, Mofidi et al. 1960; Manouchehri et al. 1975b, Manouchehri et al. 1976b, Vatandoost 2004; Vatandoost and Vaziri 2004; Vatandoost and Borhani 2004; Vatandoost et al. 2005). In recent studies, it was found that the field samples of *An. stephensi* from Bandar Abbas were resistant to DDT, dieldrin and fipronil, and susceptible to other insecticides including malathion in Bandar Abbas (Davari et al. 2006, Vatandoost et al. 2006.). There is also a newly report of tolerance to DDT and dieldrin from Kerman Province (Abai et al. 2008). Study on susceptibility status on *An. fluviatilis* to diagnostic dose of 10 insecticides including DDT 4%, dieldrin 4%, malathion 5%, fenitrothion 1%, propoxour 0.1%, bendiocarb 0.1%, permethrin 0.75%, deltamethrin 0.05%, lambda-cyhalothrin 0.05% and cyfluthrin 0.15% showed 100% mortality in all tests (Shahi et al. 2006). Evaluation of standard solutions of 5 larvicides against these 3 species from Bandar Abbas showed they were susceptible (Vatandoost et al. 2004, Vatandoost and Hanafi-Bojd 2005, Hanafi-Bojd et al. 2006).

Now the main measures in Iran for malaria vector control are: Indoor residual spraying using Lambda-cyhalothrin WP 10% and deltamethrin WP 10% in malarious areas, larviciding by Chlorpyrifos-methyl, *Bacillus thuringiensis* and some larvivorous fish like *Aphanius dispar* and *Gambusia affinis* and distributing LLINTs. At present, *B. thuringiensis* and larvivorous fish are using for larviciding in the area as well as impregnated mosquito nets. This measure have been welcomed by people at various level, it was been introduced in 2003 as ITNs and nowadays LLITNs are used in malarious areas of Iran (Moosa-Kazemi et al. 2007).

In Bandar Abbas district, the main measures for vector control are Indoor Residual Spraying (IRS), larviciding and LLITNs. During the period of our study, the vector control activity was restricted to some villages of mountainous area.

Treated mosquito nets were used in May 2005 as ITNs when epidemic started in the area, but now LLITNs are using (personal communications). They are distributed according to the following priorities: Villages without electricity, active foci and high population movement; villages with electricity, active foci and high population movement; villages with only one of the above mentioned factors; villages without electricity.

Larviciding using *B. thuringiensis* is another vector control measure in the area. It is also limited to the infected villages of mountainous area, north of Bandar Abbas. In addition some other measures are conducted for larval control.

Treatment and drug resistance

In Iran there is no recommended policy for chemoprophylaxis to the pregnant women and travelers. Quinine, chloroquine, fansidar, primaquine, artesunate, clindamycin, doxycycline and coartem are recommended for malaria treatment in Iran. They are used in different combinations based on severity of the disease, age of patient and *Plasmodium* type. There is also special recommendation for pregnant women (Saebi et al. 2006).

Several studies were carried out on drug resistant in the southern part of Iran. The results of studies during 1968–1976 (Manouchehri et al. 1973, Sutoso et al. 1978) by *In vivo* test showed that *P. falciparum* was sensitive to chloroquine, but in 1983 (Edrissian et al. 1985) *In vivo* and *In vitro* tests show chloroquine resistant with rate of 5.1% which increased to 51.1% by 1996 (Edrissian et al. 1999). This rate in Bandar Abbas was 32.5% in 1986, 64.8% in 1994–1996 and 68% to 84% by 1997 (Edrissian 2006).

Table 1. Health facilities in Bandar Abbas, 2004–2008, Bandar Abbas County

Health facilities	2004	2005	2006	2007	2008
Teaching hospitals	2	4	4	4	4
Total district hospitals	11	10	10	10	11
Private hospitals	7	6	6	6	7
Governmental hospitals	4	4	4	4	4
Urban health centers, polyclinics	54	58	66	73	66
Rural health centers	21	21	17	23	19
Health houses	128	131	106	106	107
Laboratories	33	33	36	37	39
Pharmacies	36	32	42	45	46

Table 2. Malaria information in Bandar Abbas County, Hormozgan Province, 2004–2008, Bandar Abbas County

Years	At risk population	Nationality		Sex		Age groups			Species			Total slides	Total cases	API	SPR	ABER	Re-checked slides	Positive from re-checked	Residence place		
		Iranian	Non-Iranian	Male	Female	<5	5-14	14<	<i>P. vivax</i>	<i>P. falciparum</i>	Mix								<i>P. ovale</i>	City	Village
2004	453658	160	147	243	64	7	60	240	309	1	0	0	41174	307	0.68	0.75	9.07	21414	28	147	160
2005	471816	556	64	362	258	28	166	426	609	11	0	0	34462	620	1.31	1.79	7.30	15465	26	164	456
2006	479040	355	30	213	172	35	118	232	378	7	0	0	27819	385	0.8	1.38	5.80	9203	17	110	275
2007	514450	95	24	81	38	4	20	95	116	3	0	0	17247	119	0.23	0.68	3.35	15078	32	53	66
2008	521657	38	50	81	7	3	4	81	75	11	1	1	19918	88	0.17	0.44	3.81	13260	11	68	20
Total	--	1204	315	980	539	77	368	1074	1484	33	1	1	140620	1519	--	1.08	--	74420	114	542	977

API = Annual parasite incidence, SPR = Slide positive rate, ABER = Annual blood examination rate

Table 3. Stratification of malaria in Bandar Abbas, Hormozgan Province, Iran 2004–2008, Bandar Abbas County

Variables	Stratum I	Stratum II
Geography	Mountainous	Coastal
Vector	<i>An. stephensi</i> <i>An. dhali</i> , <i>An. fluviatilis</i>	Mostly <i>An. stephensi</i>
Water source	Pools, rivers, and containers	Water pipe, rivers, swage
Population movement	No	Present
People behavior during transmission season	Sleeping out side	Sleeping in side
API	1%<	<0.5%



Fig. 1. Malaria registration centers of Bandar Abbas, Hormozgan Province, Iran, Bandar Abbas County

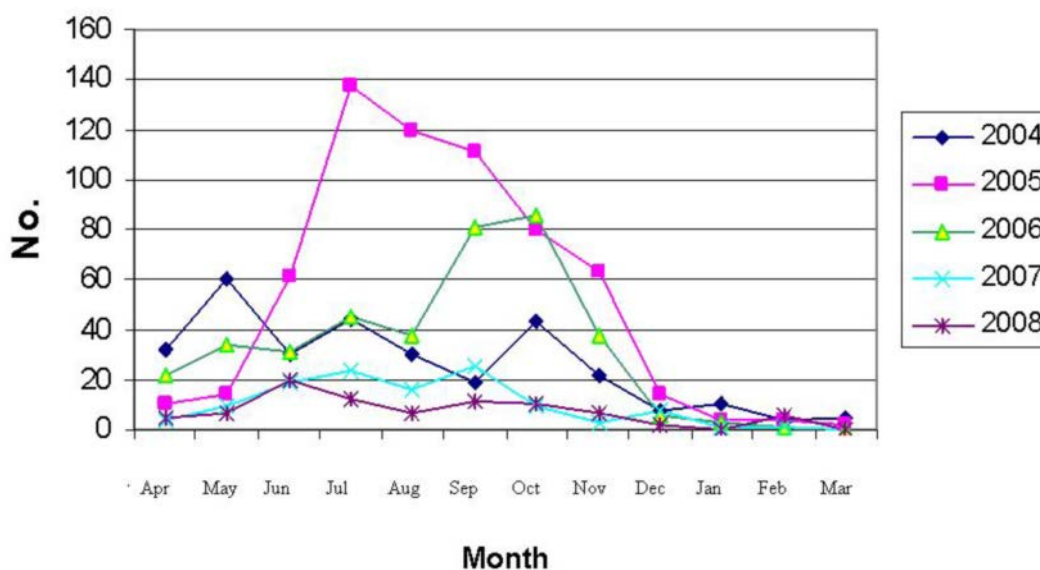


Fig. 2. Malaria cases in different months of year during 2004–2008, Bandar Abbas, Hormozgan Province, Iran

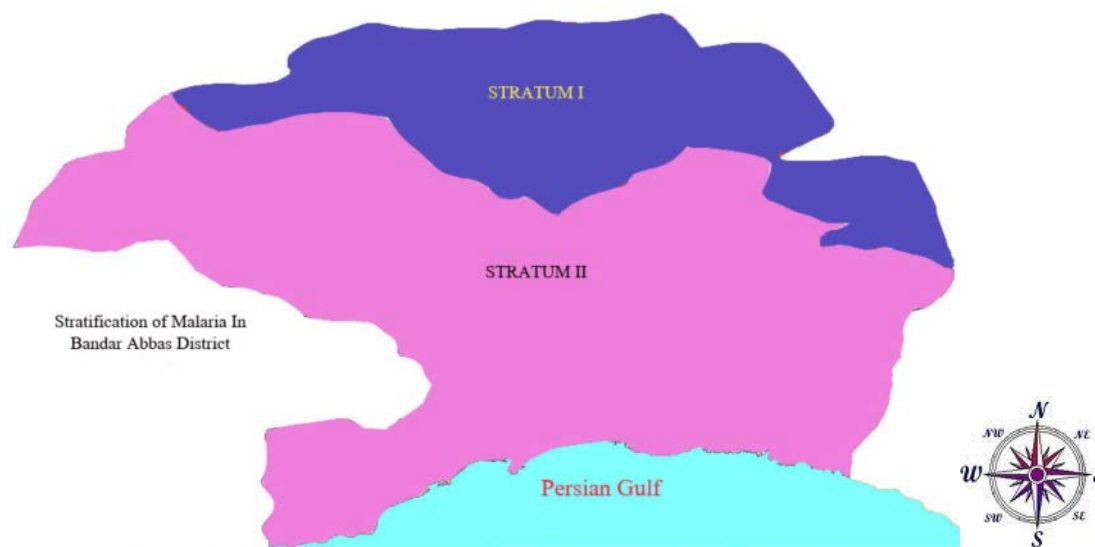


Fig. 3. Malaria stratification in Bandar Abbas, Hormozgan Province, Iran 2004–2008, Bandar Abbas County

Discussion

There was no considerable change in the number of health facilities during the study period (Table 1). The reduction of health houses that are the first step of the referral system is due to newly geographical changes that pass them to neighbor cities. There was a dramatic increase in malaria cases of 2005 compared to 2004. As showed in Table 2, during 2005–2006 the cases in rural area were more than two times higher than urban areas. There is a limited population movement in the rural area, so this epidemic occurred due to local transmission and this is attributed to the weakness of surveillance system in that years. As it can be seen in Table 2, the total slides taken decrease year by year. Also the amount of insecticides used during epidemic was very limited, e.g. only 400 kg of pyrethroid insecticides and 510 kg *Bacillus thuringiensis* as larvicide were applied during the epidemic of 2005 (Management and Programming Organization 2005), and the control program started after the first peak of the disease. We found that the entomological data in the area are poor and not enough and reliable for designing a control program. This

careless may be due to case reduction in previous years as well as poor entomological data. After this epidemic, different control activities such as LLINTs, IRS and larviciding were strengthened parallel to case detection and treatment resulted to drop positive cases in the area, so that in 2008 the local transmission that usually occurs in rural area was about one third of reported cases in urban area. Reports of health services showed most of cases in Bandar Abbas City in this year were imported.

Major determinates of malaria stratification in Bandar Abbas were: geography, vector, water sources, population movement, people behavior and API. Stratification is done based on the above determinates which are illustrated in table 3 and fig 3. So Bandar Abbas were divided into two strata.

From the situation analysis of Bandar Abbas we found the main problems of this township are: inaccuracy of data and malaria vector control activities. For elimination of malaria in Bandar Abbas it is suggested to do the following activities: Proper case management by early detection and prompt treatment, routine evaluation of drug resistance, biweekly

entomological survey during the transmission season in the high risk area, annual survey on susceptibility status of vectors to insecticides/larvicides, free distribution of the LLITNs to at risk groups including travelers and refugees, improving of housing condition at the rural areas, conducting training for entomological survey as larvicidal personnel, spraying workers and response team for epidemics, treatment of breeding site by effective larvicides and biological measures, participation of school children and community in environmental management by drainage and filling the major mosquito sources and small water resources, site selection (establishment of population away from reach of mosquitoes) and introduce of animal shelter between breeding site and human houses for exophilic mosquitoes, personal protection using insect repellents, early detection of epidemics and improvement of data collection, training of staff on computerization, data collection and excel management for updating malaria database, study the health aspect of any project by health authorities and anti malaria services and seek assistant to investigate advantages and benefits, evaluation of knowledge, attitude and practice of people in high risk area by KAP study, and training through mass media (TV, radio) and leadership (community leaders, schools, religious leaders).

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