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Demonstration of malaria situation analysis, stratification and planning in Minab District, southern Iran

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ABSTRACT

Objective: To demonstrate malaria situation analysis, stratification and planning for an endemic area in southern Iran. **Methods:** Data on health system, population, meteorological parameters, malaria cases, anopheline vectors, and control activities during 2005-2007 was obtained from Minab Health Center, Minab Meteorological Station and published documents about malaria elements in the study area. A datasheet was created in excel 2003 for analysis. **Results:** There were 644 health staff working in Minab District including 99 health staff in malaria control program. The health facilities are distributed as follow: 1 hospital with 96 beds, 23 health centers including private centers (10 in Minab city and 13 in rural area of Minab District) and 119 health houses in rural areas of Minab District. *Anopheles stephensi* was the dominant species in Minab District, however, *Anopheles dthali, Anopheles superpictus, Anopheles fluviatilis, Anopheles multicolor, Anopheles pulcherrimus* and *Anopheles turkhudi* can also be found in the area. *Anopheles stephensi* was reported susceptible to malathion, propoxur, primphos-methyl, lambda-cyhalothrin permethrin and deltamethrin, and resistant to DDT and dieldrin in the area. During the study period a total of 10 665 positive cases were reported, mainly due to local transmission (99.6%). *Plasmodium vivax* was the main causative agent followed by *Plasmodium falciparum*. There were reports about drug resistance of *Plasmodium falciparum* in the area. **Conclusions:** Using different parameters, Minab was classified into 3 strata. A plan was designed based on described goal, objectives and targets. The approaches of this plan were categorized into: health education, early detection and correct treatment, and vector control. Main constraints of these approaches are population movement between Iran, Pakistan and Afghanistan; vector control challenges at district, inadequate skilled medical staff in malaria case management and weak inter-sectorial coordination for malaria control, especially in urban areas.

1. Introduction

Malaria is a complex disease that varies widely in epidemiology and clinical manifestation in different parts of the world. This variability is the result of factors such as the species of malaria parasites that occur in a given area, their susceptibility to commonly used or available anti-malarial drugs, distribution and efficiency of mosquito vectors, climate and other environmental conditions and the behavior and level of acquired immunity of the exposed human populations.

In Iran, the total population at risk of malaria is about 3 million that mainly live in the southeast provinces[1]. Since 1988, malaria control activities have been integrated in primary health centers of Iran. The national strategy on malaria was revised in 2004, with the goal of eliminating *Plasmodium falciparum (P. falciparum)* malaria in 3-4 years, and further reducing the number of autochthonous *Plasmodium vivax (P. vivax)* malaria in a period of seven years. The malaria elimination strategy is aimed at the elimination of *P. falciparum* malaria in all areas of the country. Only introduced cases of *P. falciparum*

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might occur, and there will also be a reduction of *P. vivax* transmission. 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 annually in the country[2].

Situational analysis helps 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, it is needed to analyze the information that is already available[3]. On the other hand, the main point of the beginning of the situational analysis is to collect the data from respective references such as health network office, hospital, health centers, communities, meteorology department, published documents, master and PhD thesis.

The basis for selection of objectives and stratification of the plan is the incidence of autochthonous cases of malaria in different epidemiological settings per one thousand population exposed to risk [annual parasitic incidence (API)/1 000] as follows:

–Areas in which API is > 5 cases and which require intensified control of malaria;

–Areas in which API is 1–5 and are qualified for implementation of pre–elimination activities;

–Areas in which API is less than and could be included under elimination activities.

Areas in which no new indigenous cases were reported during last 3 years are considered free of malaria. These areas require a development of a plan to prevent them from re–establishment of local transmission. Based on predisposing factors for malaria transmission like high–rate of migration, importation of malaria reservoirs, favorable weather conditions, and high density of vectors in exposed areas, these areas are divided into two sub categories: –High risk areas: areas with high potential of malaria transmission and recurrence; –Low risk areas: areas with low potential of malaria transmission (mainly by importation) and recurrence.

Malaria remains an important public health concern in Minab District, southern Iran, where transmission occurs regularly and some factors are mainly considered and have direct effect on incidence of the disease. The general objective of this article is to facilitate the development of friendly–user implementation plan for Minab District to identify malaria–relevant gaps with its possible solutions.

2. Materials and methods

2.1. Study area

Minab is located in 27°09′N 57°04′E about 90 km east of Bandar Abbas city, the capital of Hormozgan Province in the southern part of the Islamic Republic of Iran (Figure 1). The population of Minab District is about 300 000 in 2010 which 34% are inhabitant in urban area as well as 66% in rural residence places. The northern and eastern parts of this city are mountainous and central and western parts are plain. The altitude of Minab city is 27 meters from the surface of Persian Gulf and the district has 5 180 km square land. Agricultural lands, gardens and orchards are irrigated by Minab River and Esteghlal Dam (Figure 1). Minab District has a warm and humid weather. The averages of minimum and maximum temperatures are 12 ℃ in January and 42 ℃ in June, respectively. The rainfall has mainly occurred in November through March with an annual average of 129.6 mm for these 3 years. The minimum of relative humidity is found in June (40%) and the maximum in November (70%).

2.2. Data collection

Malaria information including number of positive cases, type of parasite, nationality, sex and age of patients, treatment results, population at risk, monitoring activities, entomological data on malaria vectors, control measures, and also data about health system facilities during a period of 3 years (2005–2007) were obtained from Minab Health Center, as well as published documents on different malaria aspects in the area. Climatology data were provided from Minab Meteorological Station and website of Iranian Meteorological Organization (www.weather.ir).

2.3. Data analysis

Excel 2003 was used for data analysis.

Figure 1. Minab District location in Iran (left) and aerial view of the city and Esteghlal dam from Google earth (right).

3. Results

3.1. Health System

There are 644 health staff working in Minab District including 99 health staff in malaria control program. The health facilities are distributed as follows: 1 hospital with 96 beds, 23 health centers including private centers (10 in Minab city and 13 in rural area of Minab District) and 119 health houses in rural areas of Minab District.

3.2. Malaria situation in Minab District

3.2.1. Case detection activity

The malaria history is shown in Table 1 and Figure 2, which indicate the actual result of malaria in Minab District in 3 years of 2005, 2006, and 2007. During these years Bashagard district, the most important malarious area of Hormozgan Province, was a part of Minab health system for registering of malaria cases. So the malaria information in Table 1 and Figure 2 includes Minab and Bashagard data.

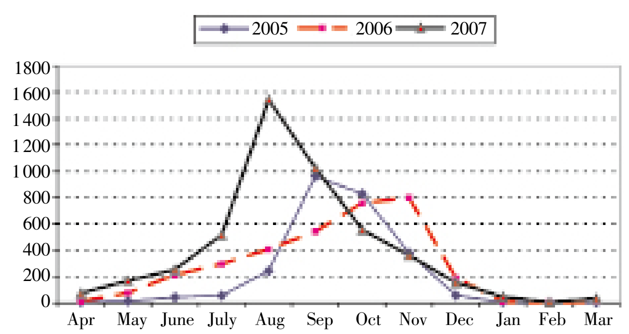

Figure 2. Malaria cases in Minab District, 2005–2007.

3.2.2. Malaria vectors and insecticide resistance

Anopheles stephensi was the dominant species in Minab District, however, *Anopheles dthali, Anopheles superpictus, Anopheles fluviatilis, Anopheles culicifacies, Anopheles multicolor, Anopheles pulcherrimus* and *Anopheles turkhudi* can also be found in the area[4,5]. Results of PCR detection of malaria parasites in *Anopheles stephensi* collected from Minab showed an infection rate of 0.97% with *P. vivax*, while 0.32% had mixed infection with *P. vivax* and *P. falciparum*[6]. This species had different biological forms in Hormozgan Province[7] and was reported as the main malaria vector in coastal area of the province, while *Anopheles dthali, Anopheles fluviatilis* and *Anopheles superpictus* were introduced as secondary vectors in southeastern part of Iran[8-10]. *Anopheles culicifacies* was also introduced as effective vector of malaria in Baluchistan area, east of Minab District[11]. These mosquitoes had different larval habitats[12], and surface water bodies especially river of Minab Dam, provided suitable places for their breeding.

Susceptibility status of *Anopheline mosquitoes* in Minab area showed 100% mortality to 0.1% propoxur, 5% malathion, pirimiphos-methyl at 0.1 mg/cm^2, 0.1% lambda-cyhalothrin, 0.25% permethrin and 0.025% deltamethrin, but it was resistant to DDT and dieldrin[13-16]. Other studies in Hormozgan province[17,18] showed at diagnostic doses recommended by WHO, *Anopheles stephensi, Anopheles dthali* and *Anopheles fluviatilis* were susceptible to 5 larvicides: *Bacillus thuringiensis*, chlorpyrifos-methyl, fenitrothion, temephos and methoprene. There was no resistance to insecticides in *Anopheles dthali* and *Anopheles fluviatilis* in the area[9,19].

3.2.3. Parasites and drug resistance

About 80%-90% of the Iranian cases are caused by *P. vivax* and the rest by *P. falciparum*. Distribution and delivery of drugs were carried on by Iran government through primary health care (PHC) system. About 80% of all slides were examined and received the treatment according to available guideline in less than 24 hours[20]. In those areas which are not covered by PHC the anti-malaria activities were carried by mobile teams.

Resistance of *P. falciparum* to Chloroquine was first observed in Iran in 1983[21,22]. In a recent study of the *in-vivo* response of *P. falciparyum* to chloroquine carried out in the malaria endemic areas in southeast parts of Iran the treatment failure by the day 28 was 78.5% and only 21.5% showed adequate clinical and parasitological response to chloroquine[23]. Artesunate-sulfadoxine-pyrimethamine is now the recommended first-line treatment, with artemether-lumefantrine used for second-line treatment. The efficacies of these combination therapies are currently being evaluated and monitored[20].

3.2.4. Knowledge, attitude and practice status of people

A survey by Zaim *et al*[24] assessed the knowledge and practice with respect to malaria in endemic urban and rural areas of Hormozgan, Kerman and Sistan & Baluchestan provinces of Iran. They found that knowledge of inhabitants was relatively poor in the study area. A case control study was performed in Hormozgan province, including Minab, in 2001 to assess how different determinants affect malaria morbidity[25]. This study indicated that several factors including low socio-economic and undeveloped conditions affect on malaria control program.

3.3. Stratification

Malaria remains an important public health concern in Minab District where transmission occurs regularly and the malaria cases were higher in 2007 than previous years. The outbreak occurs year by year due to some concern points which are including:

Climatic conditions; population movement from hyper-endemic foci of malaria Iran (Bashagard), Pakistan and Afghanistan to Minab District; vector control challenges at district; low socio-economical status of those who live there; treatment failure due to internal displace people as well as drug resistance; weak inter-sectorial coordination for malaria control, especially in urban areas; lots of breeding sites around the river which flows from Minab Dam; activity of different vector species with different habitats and behaviors in the area.

Major determinates of malaria transmission in Minab District which used for stratification were found to be: Epidemic potential, vector density, breeding sites, socio-economic level, literacy level, transportation, population movement, immigration, API, weather, relative humidity, rainfall and transmission season. So stratification was done based on the above determinates which were illustrated in Figure 3. As showed in this figure, Minab District had 13 rural districts in 3 strata. Stratum I (Darpahn, Senderk, Hoomeh) had a high epidemic potential with API>50. Stratum II (Tookahoor, Karyan) included area with moderate potential of epidemic and 10<API<49. Finally, stratum III (Sirik, Bemani, Bandzark, Tiyab, Gourband, Biaban, Cheraghabad, Bandar) with API<10 showed a mild epidemic potential during the study period.

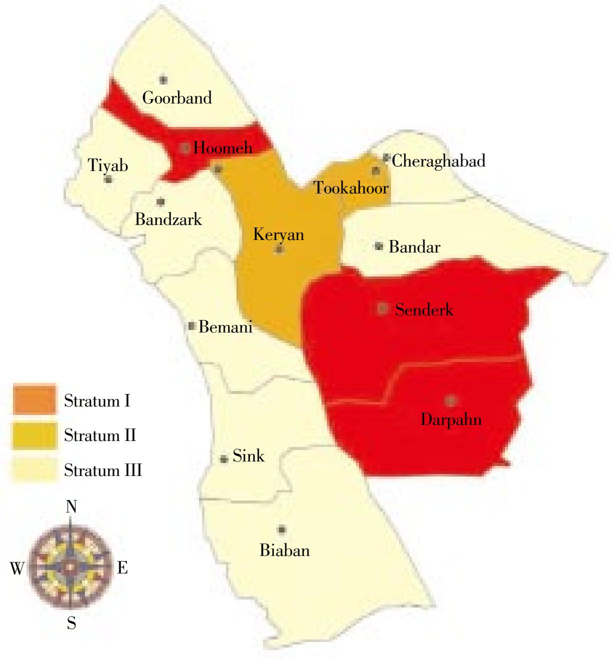

Figure 3. Malaria strata in Minab District, Southern Iran, 2005-2007.

4. Discussion

To clarify our plan, it is necessary to describe goal, objectives and targets. The goal of our planning for Minab District was to eliminate malaria and prevent its re-introduction. We suggested the following objectives based on this goal:

- To reduce local malaria transmission to less than 5/10 000 by 2010
- To prevent malaria morbidity and mortality.

Finally, targets were prepared as follow:

By the end of 2010: 70% of health personnel will have health education regarding to malaria control; 95% of uncomplicated malaria cases will be managed according to national diagnosis and treatment guidelines; 80% of malaria epidemics will be detected and controlled within 2 weeks; 80% of targeted groups will have at least one Long Lasting Impregnated Nets (LLINs); an integrated vegetation management (IVM) strategic plan based on a comprehensive vector control should be applied. The approaches of this plan were categorized into: health education, early detection and correct treatment, and vector control.

Health education in our plan will cover general physicians and health assistants of health system, private physicians, health workers (Behvarz), students, community, directors and councillors. Educational methods include workshops, seminar and booklet, developing malaria clips, and TV/Radio spots. Subject and level of each education is different based on target group and pre-test results. The second approach, early detection and correct treatment, includes weekly surveillance for stratum I, biweekly for stratum II, and reduce period between preparing blood smears and diagnosis, as well as supervision and evaluation for all strata. Finally, activities for vector control approach include indoor residual spraying, space spraying, and biweekly entomological investigation for stratum I; distributing LLINs for strata I and II; larviciding and mosquito breeding source reduction for all strata.

The priority areas for this plan will be: strengthening malaria surveillance system in the district; developing integrated vector management strategy; strengthening vector control activities at district level, implementing new malaria drug policy; capacity buildings on case management; support cross border coordination with Afghanistan and Pakistan; strengthening malaria early warning and early detection system and developing malaria epidemics and preparedness plan.

Main constraints of these approaches are population movement between Iran, Pakistan and Afghanistan; vector control challenges at district; inadequate skilled medical staff in malaria case management and weak inter-sectorial coordination for malaria control, especially in urban areas.

Many efforts have been done to control the malaria transmission and decrease the number of malaria cases in Minab District, but in accordance with reported cases in 2005-2007, the malaria cases have increased in 2007. It was in contrast to Bandar Abbas County, the capital of Hormozgan province[26]. Thus, the epidemic report in 2007 showed that cases of malaria remained high in comparison with previous years.

It is mainly attributed to following causes: Epidemic in Bashagard area, close Massive immigration from neighbor countries which imported cases; e.g. 72 Pakistani illegal immigrants were actively detected in Minab District; lots of breeding sites around the river which flows from Minab Dam; low socio-economical status of those who live there; treatment failure due to internal displace people our drug resistance; vector species composition: *Anopheles stephensi* is easily growing in small amounts of water and most of them are endophilic and anthropophilic. Meanwhile, Anopheles *fluviatilis*, *Anopheles dthali* and *Anopheles superpictus* have important role to maintain malaria cycle during indoor residual spraying (IRS), because their exophilic habitat and pass it to *Anopheles stephensi* after recovery its population that decreased due to spraying.

The malaria disease burden is increasing in many countries despite the existence of effective preventative strategies. An understanding of community perspectives and practices is one of the essential components of a successful malaria control program. The KAP study in Minab District shows that the knowledge of people was poor to moderate[24,25]. Also positive practice of the people in treatment and prevention was moderate. More studies are needed to evaluate the real malaria situation in this district.

There are significant points in our study, which can be divided in two parts. The first part includes strong points that we encountered in this survey:

Appropriate surveillance system in Minab District (active case detection); good health system at each levels of district; strong political commitment; having good reporting and recording system; collaboration of health workers; and quality control system is satisfied.

The second part is points to be improved: Improving the socio-economical status of people; preparing educational lectures to be included school curriculum; carrying out periodic tests for early detection of vector or parasite resistance; conducting systematic initial and refresher courses for malaria control workers such as parasitology, entomology and others; providing timely feedback from top to low levels; data discrepancies should be decreased;

Table 1

Results of Minab District malaria program during 2005-2007.

Year	Total slides examined	Total positive		SPR	ACD	PCD	At risk population	ABER	API
		Pv	*Pf*						
2005	127 933	2 590	12	2.03	1 773	829	278 714	45.90	9.34
2006	130 306	3 315	7	2.55	2 423	899	286 831	45.43	11.58
2007	137 691	4 738	3	3.44	3 783	958	294 948	46.68	16.07
Total	395 930	10 643	22	2.69	7 979	2 686	---	---	---

SPR: Slide positive rate = Total positive ×100/Total slides examined; ACD: Active case detection; PCD: Passive case detection; API= Total No. of positive slides for parasite in a year × 1 000/Total population; ABER: Annual blood examination rate= Smears examined in a year × 100 / Total population; *Pv: P. vivax*, *Pf : P. falciparum*.

encouraging community participation in malaria control by rewarding people; mobile teams should be extended and supported; and any other procedures may assist the malaria control.

Finally, we prepared some recommendations that can help to improve malaria control program in Minab District: strengthen human capacity on malaria control activities at different levels of health personal; to develop an integrated vector management at district level; to develop and implement plan for malaria epidemics preparedness and response; strengthen malaria surveillance system with appropriate epidemic thresholds in epidemic-prone settings; improving actions of surveillance system regarding to reporting, passive case detection and active case detection in all endemic areas for early diagnostic and treatment; acting environmental modification of breeding sites that close to inhabitants areas; continuing of the vector control methods which are previously examined and had good impact; ssupport operational research.

Conflict of interest statement

We declare that we have no conflict of interest.

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