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ABSTRACT

Objective: To conducted a spatial analysis for stratification of priority malaria control areas in Kahnuj County, as part of field exercise. **Methods:** Information of Health Centers of Kahnuj County has been used for stratification retrospectively. A knowledge, attitudes and practices (KAP) study was arranged to provide preliminary information about the knowledge, attitude and practice related to malaria in the area. **Results:** Numbers of malaria cases has been decreased in year 2008. There were five important vectors of malaria in this region including: *Anopheles stephensi (An. stephensi)*, *Anopheles dthali (An. dthali)*, *Anopheles superpictus (An. superpictus)*, *Anophels culicifacies (An. culicifacies)*, and *Anopheles fluviatilis (An. fluviatilis)*, but majority of malaria cases in this county was related to *Plasmodium vivax (P. vivax)*. Educational levels of community were 38%, 20%, 10% and 32% for illiterate, primary, secondary and university levels, respectively. KAP study revealed that about 37% of people have got malaria at least once and only 27% of people knew that mosquito is the vector of malaria. **Conclusions:** Malaria in Kahnuj represents a real threat. Transmission occurs in city center. *An. stephensi* can be suspected for the first peak of malaria cases in late spring in Kahnuj city. *An. fluviatilis* has a relatively high density in autumn while two malaria cases due to *P. falciparum* were reported in 2008. Based on KAP study, the knowledge of respondents seems good but the attitude and practice is low. According to the data such as API, main malaria vector, transmission rate, and foreign migrants, the Kahnuj County has been spatially divided into three strata based on various characteristics. The authorities should implement all the interventions based on stratification.

1. Introduction

At present about 100 countries in the world are considered malarious, almost half of which are in Africa, south of Sahara. More than 2400 million of the world's population is still at risk. The incidence of malaria worldwide is estimated to be 300-500 million clinical cases each year[1,2]. Despite of various control programs, malaria remained a main health problem in Iran especially in southeastern regions including Sistan and Baluchestan Province, Hormozgan Province and southern parts of Kerman Province[3,4]. Iran has been classified into four different strata according to the epidemiology of disease[5] A total of 11000 malaria cases has been reported in Iran in the last year. The disease is a major health problem in south-east of Iran. It is unstable with two seasonal peaks mainly in spring and autumn. Outbreaks usually occur after rainy season. South-eastern of Iran includes the provinces of Sistan & Baluchistan, Hormozgan and the tropical areas of Kerman provinces characterized by refractory malaria. Malaria remains a major public health problem in these areas where about

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80% of all malaria cases in the country occur. In this part of the country six anopheline mosquitoes including *Anopheles culicifacies (An. culicifacies)*, *Anopheles stephensi (An. stephensi)*, *Anopheles dthali (An. dthali)*, *Anopheles fluviatilis (An. fluviatilis)*, *Anopheles superpictus (An. superpictus)*, and *Anopheles pulcherrimus (An. pulcherrimus)* are known to be the malaria vectors[6-8]. The national strategy on malaria was revised in 2006, with the goal of eliminating of *Plasmodium falciparum (P. falciparum)* malaria in 3-4 years further reducing the number of autochthonous *Plasmodium vivax (P. vivax)* malaria in a period of seven years. 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 showed out of 11 460 malaria cases of Iran, 8% was due to *P. falciparum* while 90% were infected by *P. vivax*[4]. This study has been conducted to spatial analysis for stratification of priority malaria control areas in Kahnuj County, South of Iran.

2. Materials and methods

2.1. Study area

Kerman is one of the 30 provinces of Iran, located in the southeastern part of the country. It borders Yazd and South Khorasan provinces in the north, Sistan and Baluchistan province in the east, Hormozgan province in the south and Fars and Yazd provinces in the west. Kerman is the second largest province in Iran, with an area of 180 836 km^2 and the 9th most populous, with a population of 2 432 927 (2005). It has 14 counties and its center is the city of Kerman.

Kahnuj district, 29°59′45″N 57°14′22″E, is part of Kerman province which is situated 335 km south of the Kerman city. Its surface area is about 4 074 km^2. It has a very large jungle area of about 5000 hectare. It is bounded by: Jiroft to the north, Manujan to the south, Roudbar to the east, & Hormazgan to the west (see the map). The Kahnuj County is divided into two cities including Kahnuj city, which is subdivided into Houma & Nakhlestan, and Fariab city, with its three subdivisions: Hur, Kalashgard & Mahrowia. There are about 178 villages and two cities (Kahnuj & Fariab). The climate in the area is hot and dry with moderate degree of humidity.

2.2. Data collection

In addition to some works on gathering the epidemiological data, information of Health Centers of Kahnuj County has been used for stratification retrospectively. Other data such as meteorological and geographical data has been gotten from related organizations. As reported by the local health officials, nobody has studied the knowledge, attitude and practice related to malaria in the area. A mini-survey thus was arranged to provide preliminary information. This covered just one stratum (strata I urban area) and was limited to 29 responders due to limitation of time.

3. Results

3.1. District profile

The total population of the Kahnuj is about 104 360, of which 5% is Afghanian and the remaining Iranians. The male/ female ratio is 105:100. The majorities of the population are living in the rural areas working as farmers and shepherds.

Kahnuj with elevation of 490 m, is subdivided based on features such as mountains regions, permanent and seasonal rivers into two mountains regions with seasonal rivers; Faryab part and Hourani regions and plain regions with permanent river; central part of Kahnuj and part of Sahlawar region and Hurani part. Temperature in this district may reach 48 ℃ in summer (June, July and August) and decline gradually to 15 ℃ in January. Mean humidity in this district changed irregularly ranging between 31% in early summer and 56% in late autumn and early winter. Precipitation has an occasionally distribution in this district. The only rainfall takes place in May, December, January and February.

Kahnuj district population is composed of 60% shepherds (cattle keepers), mostly living in the rural areas with high level of illiteracy. Almost all of the populations are Muslims and speak Persian language with local accents of their main language (no language diversity and/or communication barrier among the population).

3.2. The health care system

The government is the only provider of the health care for malaria in the area, since all the health centers including health houses in the urban and rural areas are governmental. Some private clinics are also there but they deal with malaria through the public sectors (*i.e.* they just referred the patients). The health system in Kahnuj district is a form of network system in which the overall responsible person is the head of health network, followed by the head of health center and the third is known as head of health disease. Malaria medical office has two branches: lab, technical office and entomological technical office.

Kahnuj district has both public and private health care system including hospital (provincial), urban health centers, laboratories, pharmacies, health houses, malaria laboratories, health station, and delivery station. The flow of the health services delivery starts from the district health network and ends in the urban and rural health centers. Either urban or rural health centers have malaria labs responsible for case detection and treatment of malaria. Rural health centers cover health houses for passive case detection and mobile teams for active case detection.

3.3. Interventions for malaria control

Various interventions were deployed for controlling malaria in Kahnuj district in 2008. Two main activities were case management and vector control. Case management included active case detection mainly by mobile teams

and passive case detection by health houses (rural area), health centers (urban and rural) and hospitals (urban areas). Indoor residual spraying (IRS), Long Lasting Insecticide Treated Nets (LLITNs) distribution, and larval control methods have been mentioned as strategy of vector control in the district. Additionally space spraying with thermal fogging was deployed in epidemics. IRS in 2008 started on August by using 5% deltametrin in malaria infected area, Fariab, and Horani area, and last for 20 days. The target for residual spraying is to cover 836 villiages. Larviciding using biological insecticides such as *Bacillus thouringiensis* and larvivorous fish using *Gambusia* spp in the high risk areas were deployed additionally.

3.4. Malaria situation

3.4.1. History of malaria epidemiology

Some infectious diseases including malaria were very important public health problems in Kahnuj district in 2008. The parasite species existed in the area included *P. falciparum* and *P. vivax*.

3.4.2. Entomological information

There are five important vectors of malaria in Kahnuj county including: *An. stephensi*, *An. dthali*, *An. superpictus*, *An. culicifacies*, and *An. fluviatilis*. Figure 1 reflects the resting behavior the vector species. Surprisingly *An. dthali* and *An. fluviatilis* which are exophile species showed a relative high indoor density. Based on larval collections *An. fluviatilis* had the highest density in comparisons with other vectors (Figure 2).

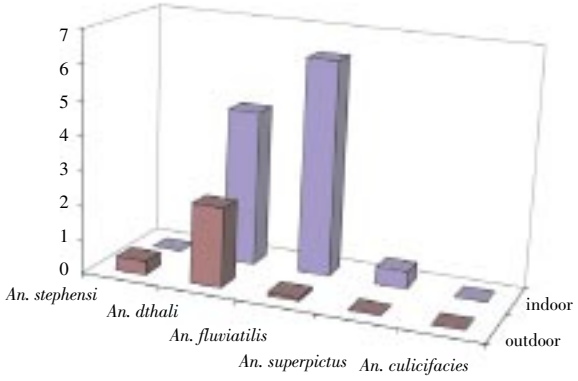

Figure 1. Relative abundance and behavior of vectors in Kahnuj district, 2008.

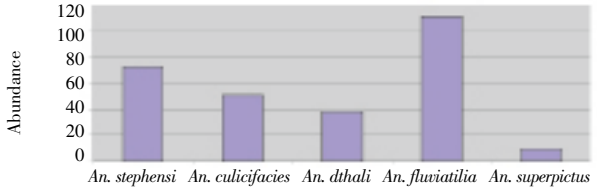

Figure 2. Relative larval abundance of Anophiline vectors in Kahnuj, 2008.

3.4.3. Malaria cases

About 38% of malaria cases reported in Kerman province were from Kahnuj district and the majority of malaria cases was reported from Ghaleganj and Roudbar counties which are neighboring with Kahnuj. People of these cities have high socialization and live together (Figure 3). Numbers of malaria cases in last years (Figure 4) had been decreased in year 2008. Monthly distribution of malaria cases showed two peaks, first in late spring and second in autumn (Figure 5). Majority of malaria cases in this county was related to *P. vivax* as shown in Figure 6. A few cases of *P. vivax* malaria were reported in late autumn, one case in October and another one in November. Study on age grouping of malaria cases revealed that majority of cases took place in age over 15 and merely 4 cases were under 4 years old (Figure 7). Based on the responsibility of case detection showed in Figure 8, it's cleared that majority of cases was detected in Health Care Center 1, 2 and 3. These are Urban Health Care Centers in Kahnuj city, therefore it can be believed that more malaria transmission took place around the city.

Comparison between temperature and monthly distribution of malaria showed that with increasing temperature malaria cases increased in late spring but decreased in early summer (Figure 9). Geographically Kahnuj district locates in a hot and dry area, therefore rainfall can not be expected to follow a predictable manner. In 2008 as well as other years in this district the rainfall was very occasionally and any relation between malaria cases and the rainfall can not be seen graphically (Figure 10).

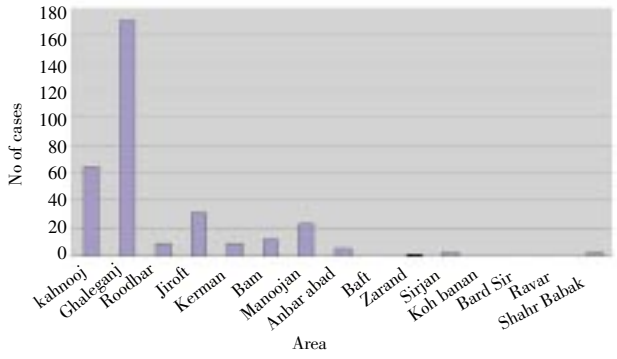

Figure 3. No. of malaria cases reported in Kerman province, 2008.

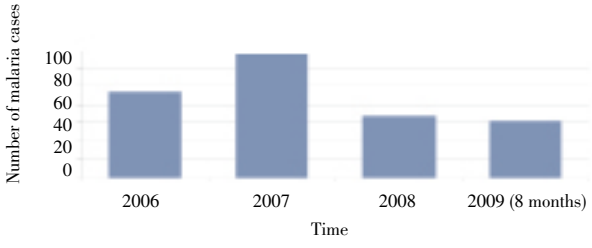

Figure 4. Number of malaria cases 2006-2009 (8 months), Kahnuj district.

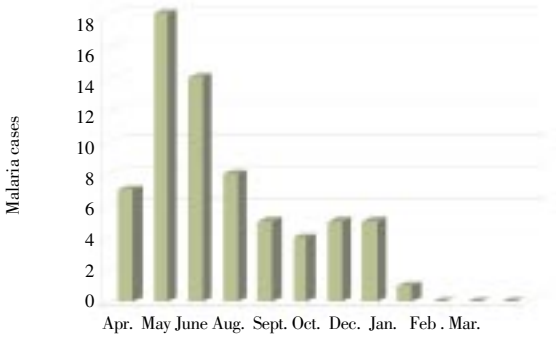

Figure 5. Monthly distribution of malaria cases, Kahnuj district, 2008.

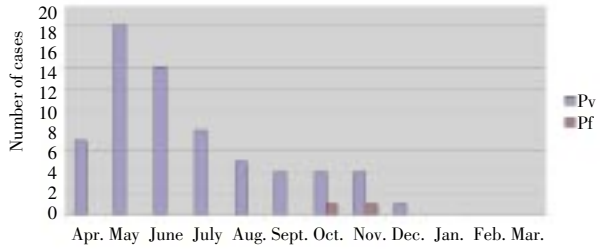

Figure 6. Monthly malaria cases based on species of parasites, Kahnuj 2008.

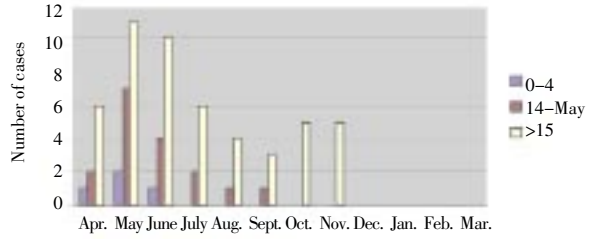

Figure 7. Monthly malaria cases based on age group distibution, Kahnuj 2008.

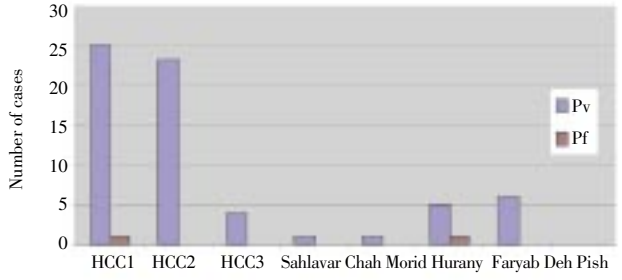

Figure 8. Malaria cases based on health facilities, Kahnuj 2008.

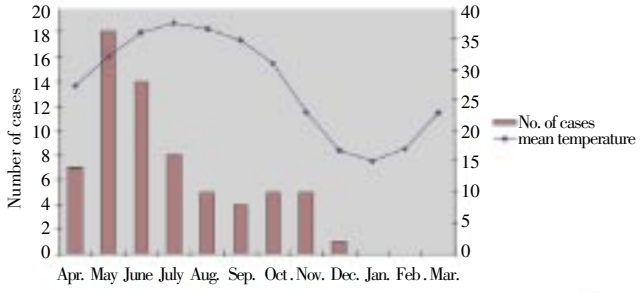

Figure 9. Comparison between trends of temperature and No of malaria cases in Kahnuj, 2008.

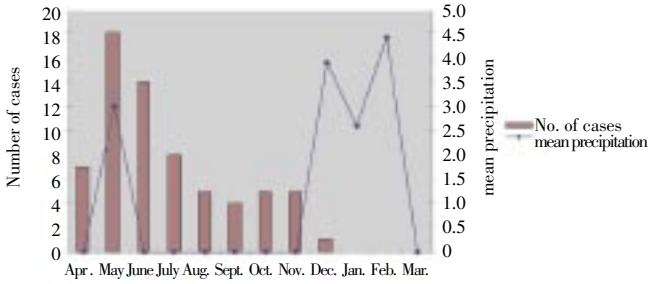

Figure 10. Trends of precipitation and reported cases of malaria in Kahnuj 2008.

3.5. Knowledge, attitudes and practices (KAP) results

Interviewer people included 44.8% male and 55.2% female. Among them 21% was single and 79% married. Education level of the community showed the illiterate was 38%, primary 20%, secondary 10% and the rest 32% were in university levels. ITN user were 80%. About 37% of people have got malaria. About 73% reported seeking treatment from health center, and 25% from hospital and the rest (2%) seeking treatment from private sector. Just 27% of people knew that mosquito is the vector of malaria.

4. Discussion

Malaria in Kahnuj represents a real threat. Transmission occurring in city center may be because of various kinds of breeding places in the city. Main breeding places in Kahnuj city are the permanent rivers without manipulation. The Health Care Center 1 and 2 situated near these rivers where most malaria cases were reported in 2008. *An. stephensi* as main vector of malaria in Iran as well as Kahnuj exists easily in urban breeding places in Kahnuj. Density of this species starts in March and increases until the summer. In autumn this species has very low density[7, 9]. Thus this vector can be suspected for the first peak of malaria cases in late spring in Kahnuj city. Naturally the breeding places in Kahnuj are also suitable for other vectors such as *An. fluviatilis*. However other vectors such as *An. culicifacies, An. fluviatilis, An. superpictus,* and *An. dthali* had relatively high density in hilly areas of the county such as in Faryab city[10]. Relatively high indoor density of exophil vectors, *An. fluviatili* and *An. dthali*[11], in some rural areas is very important and therefore can not be neglected. *An. fluviatilis* has a relatively high density in autumn[9] when the two malaria cases due to *P. falciparum* were reported in 2008. Long agricultural seasons and suitable weather for other works such as building constructions attract domestic and foreign workers. Domestic migration is between neighboring endemic malarious areas such as Manoujan, Ghaleganj, Iranshahr and Bandar Abbas. Foreign workers come in the country from poor areas of Pakistan and Afghanistan where have been mentioned as very endemic malrious areas of

the world. Other works in Iran revealed that in tempered area of Iran (such as Kahnuj) the anopheline vectors have two peaks in a year and their activity reduces in summer[12]. Our findings of increasing temperature more than 35 ℃ in summer resulted in decreased the malaria cases may be because of reduced activity of the vectors in summer. 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[13]. The national strategy on malaria is passing this stage and entering the elimination phase. Reducing the number of malaria cases related to *P. falciparum* and age distribution of the disease over 15 years old seem to be getting access to the first goal of eliminating this parasite in 3-4 years since 2006. Based on KAP study, the knowledge of respondents was good but the attitude and practice seemed to be moderate or poor. Therefore some educational interventions should be done in the area of Kahnuj.

Improvement of the health status in Kahnuj district through reduction of the morbidity and prevention of mortality attributed to malaria can be contributed as a main goal for this stratification. To pass the pre-elimination stage and get access to the elimination of malaria in Kahnuj some approaches are suggested including: early detection and prompt treatment of all cases, integrated vector management (IVM), and improving health education as reported elsewhere[14,15].

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

This study is a result of teamwork of Kahnuj Group which exercised field study on malaria situation analysis and stratification, in the 12th International Diploma Course on Malaria Planning and Management, conducted during November 2009- January 2010 in WHO Regional Malaria Training Centre in Bandar Abbas, Southern Iran. We are thankful for the staff of this centre. We would like to thank Dr. Motahhari, the director and Mr. Ahmadzadegan, the focal malaria person in Kahnuj Health Center for their kind collaboration and data providing.

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