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Some Ecological Aspects of Malaria Vectors in Saravan Area, Iran

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Background & Aims of the Study: The aim of this study was to determine the ecology of malaria vectors in order to select the vector control masseur in the future. This study was carried out on trend of malaria cases and malaria vectors in Saravan county, Sistan & Baluchestan Province, Iran.

Materials & Methods: The adult mosquitoes were collected by standard Pyrethrum space spray collection and larvae by dipping method twice a month in 2011 for 12 months. Samples were identified by systematic keys. The 5-year epidemiological data was collected from Malaria Control Centre, Iranian Ministry of Health and Medical Education.

Results: Four *Anopheles* species identified including; *An*opheles (*Cellia*) *stephensi* Liston, *Anopheles* (*Cellia*) *dthali* Patton, *An*. (*Cellia*) *culicifacies* Giles, *An*. (*Cellia*) *fluviatilis* James. *Anopheles stephensi* was predominant species whereas *An. fluviatilis* was the lowest species in adult collection. A minimum temperature of larval habitat was 14ºC for *An. fluviatilis* and maximum was 26°C for *An. stephensi*. Monthly peak activity of *An. stephensi* larvae found in April and October and in adult form found in May and October**.** Monthly peak activity of *An. culicifacies* larvae found in June and September whereas observed in July and November for adults. *An. dthali* larvae collected more in September and November whereas Adult form found more in July and November. The number of malaria cases between 2007 to 2011 showed the decrease in first 4 years and then increase in the last years.

Conclusions: The dominant species was *An. stephensi* comprised 54.07% of larvae and 49.16% of adults. We suggest studying on biological forms of this species with specific focus on the bordering areas between Iran and Pakistan in the future.

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Background

Malaria often occurs in tropical and subtropical areas of the world. The disease is one of the causes of illness and death in developing countries. About 3.3 billion people (half of the world) live in areas at risk of malaria transmission in 109 countries. An estimated 216 million clinical cases and 655,000 deaths occurred in 2011 (1,2). The disease is fifth leading cause of death from infectious diseases after respiratory infections, acquired immunodeficiency syndrome (HIV/AIDS), diarrheal diseases, and tuberculosis in the world.

Human malaria called intermittent fever, chills and frequently fever is an infective blood

disease caused by five protozoa species of the genus *Plasmodium* and transmitted by about 70 species of *Anopheles* mosquitoes. The disease can lead to economic losses and impact on human resources. Serious cases of *Plasmodium (P.) falciparum* can lead to death (3).

Early 1960s, only 10% of the world population was at risk of malaria, but with the emergence of mosquitos' resistance to pesticides and parasites resistance to medications, the disease risk reaches to 40%. Today malaria spread to areas that were previously free of the disease.

At the present, Sudan have been added to the 22 members of Eastern Mediterranean Regional Office (EMRO) of World Health Organization (WHO) and no indigenous malaria reported from Bahrain, Kuwait, Jordan, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Syria, Tunisia and United Arab Emirates during three years. Iran and Saudi Arabia are in elimination phase and Iraq is taking steps to protect against relapse phase. Afghanistan, Pakistan, Djibouti, Somalia, Sudan, South Sudan, and Yemen, where nearly half of the population in the EMRO are in the control phase (1).

At this time numbers of endemic foci of malaria have been identified in neighboring countries (Afghanistan, Pakistan) and potential vectors are widely dispersed. However, a rapid spreading of the disease is unlikely due to the lack of vector control program.

Iran located in the temperate zone of the North and East of the Eastern Mediterranean Region and have a varied climate and malaria endemic areas (4,5). According to the latest report, 90% of all malaria cases occur in Sistan & Baluchestan, Hormozgan and Kerman provinces, southern Iran. Totally, 3,271, and 528 cases of malaria were reported in 2011 and 2012, respectively.

The incidence of malaria from 4.1 per thousand populations in 2002 reached to 0.96 in 2010 in Sistan & Baluchestan Province. The incidence of malaria increased substantially as 9.2 in 2003 and as 5.8 in 2005 (6).

Malaria Epidemics have been occur in two neighboring countries at south-eastern Iran, Afghanistan and Pakistan, also precipitation, climate change, immigration and imported cases causes the increase of malaria cases in this areas (6,7).

By now, 490 *Anopheles* species identified in the world that only 40 species known as the malaria vectors in natural conditions (8,9,10). At the present, 33 *Anopheles* species consists of two sub genus, *Anopheles* and *Cellia*, and also sibling species, type and genotype forms. Out of 33 species, 18 species are listed as complex species and also three biological forms of *Anopheles (An.) stephensi* reported as type, intermediate and mysorensis (11-14).

An. superpictus X, Y, Z genotypes, *An. culicifacies* A, B sibling species *An. fluviatilis* T, U sibling species *An. maculepennis* complex including; *An. atroparvus*, *An. melanoon*, *An. messeae*, *An. persiensis*, *An. sacharovi*, *An. maculipennis*, and *An. dthali* reported as the malaria vectors. *An. Pulcherrimus* was reported as the suspected vector (12,15-24).

Despite the implementation of malaria control programs and cleanup the many parts of Iran, returning the disease is possible due to the presence of *Anopheles* breeding places.

Indoor residual spraying (IRS) is one of the routes to controlling of malaria vector and used in the malarious areas in south and southern Iran.

Based on the prospect of Iran's program that have been targeting top of economies situation in the middle east, therefore malaria elimination program is designed tile to 2025 (6). It is important the strategies of improve access to preventive services through strengthening integrated vector management (IVM) for malaria surveillance. Malaria elimination should be declared by WHO based on era of Iranian twenty-year program.

At the present, Sistan and Baluchestan Province in the southeastern of Iran is the most important center for malaria transmission. The incidence of malaria was reported 4.1 to 0.96

per thousand populations in 2002 to 2010. Epidemics occur in Afghanistan and Pakistan, two neighboring countries of Iran, climate change and the imported cases are considered as the most reasons to increasing the diseases in 2003-2004 (6,7). This information can be sufficient for planning and selection of appropriate strategy to controlling malaria. The recent study carried out on identification of arthropods and their role in the transmission of various diseases in different parts of the country.

Saravan County is located in the southeastern Iran. This is an important because of favorable weather to mosquitos' breeds, risk of malaria transmission, immigration, and incomplete malaria control. So, study on the ecology of malaria vectors in this area is necessary for the proper approach to malaria control.

Aims of the study: The aim of this study was to determine the ecology of malaria vectors in order to select the vector control masseur in the future. Also this study was carried out on trend of malaria cases and malaria vectors in Saravan County, Sistan & Baluchestan Province, Iran.

Materials & Methods

Study area: Saravan county (27°22′15″N 62°20′03″E), with 23,880 square kilometers area, 15.2% of the total area of the Sistan & Baluchestan province. This county bounded in East with Pakistan, North and North West to Khash County, West to Iranshahr county, and South to Sarbaz County. The information about the malaria cases were obtained from Center for Disease Control, Iranian Ministry of health and medical education.

Mosquitoes sampling and morphological studies: Three out of fixed villages, Mohammadi, Kaleh Pahlavan and Dashtook, and six variable villages randomly selected. In each village, 6, 5, and 2 variable places were selected containing human and animal shelters. Pyrethrum space spray collection and dipping method carried out every 15 days during the year 2011 (25,26).

The floor of places was covered with a white sheet and window, doors openings were closed, and the mosquitoes killed by aerosol pyrethrum 5%, and samples were collected during 6.30 to 9.30 AM (25,26). Mosquitoes were transferred to laboratory, pinned and identified by systematic keys (27,19).

Mosquito's larvae collected using the standard Dipper as 300 cm^3 capacity and 10 cm diameter. Larval collection was carried out in three fixed and variable villages from April to March 2011. Mosquitoes larvae mounted by lacto phenol solution and larval characteristics such as water temperature, larval type, number of samples and date of collection recorded. Mosquito's larvae were fixed by liquid-e-fore solution and identified by systematic keys mentioned above.

Number of patient cases from the villages and health centers were collected from Saravan Health Center. Also, villages were visited to collect the malaria vectors twice a month in 2011. The maximum and minimum temperatures of the water were measured using a thermometer.

Data analysis: Data were analyzed using chi-square test and SPSS statistical software, version 11.5.

Results

In this study, the maximum temperature of larval habitat of *An. fluviatilis* species was 16°C and the minimum found as 14°C. The average of temperature for *An. stephensi*, *An. culicifacies* and *An. dthali* calculated as 21.5±4.5, 20.5±3.5 and 18.5±0.5°C, respectively (Table 1).

An. stephensi was collected as the least 7 meters and a maximum range of 300 meters above sea level in three fixed villages. *An. culicifacies*, larvae were found as the minimum 7 and maximum range of 300 meters above sea

level. However *An. fluviatilis* only found in Dashtook village as range 180 to 190 meters latitude (Table2). Adult and larval mosquito collected in the Saravan County shown in Table 3 and 4. Four species identified as *An. stephensi*, *An. dthali*, *An. culicifacies* and *An. fluviatilis*. In adult and larvae collection, *An. stephensi* was predominant species. *An. culicifacies* comprise as 22.78% of adult and 26.65% of larvae, followed by *An. dthali* and *An. fluviatilis*.

Monthly peak activity of adult *An. culicifacies* shown in July and November and in larval stage found in June and September, respectively. Larval peak activity of *An dthali* found in September and November and in adult form found in July and January, respectively.

The monthly activity of *An. fluviatilis* larvae observed in October and January and found as October and January in adult form. However, *An. stephensi* larvae peak activity found in April- October and in adult form observed in May- October (Figure 3).

The number of malaria cases in 2007 to 2011 in the Saravan County during the 5 years reported as, 913, 517, 301, 175 and 260 cases, respectively (Table 5). Female and male malaria cases of Sarava County in comparison to Iran are shown in Table 5. Malaria cases were reported more in male than female in Saravan County as well as Iran.

Trend of malaria cases in Saravan County in comparison to the country in 2007 to 2011 is shown in Figure 1. Trend of malaria cases decreased during the period 2007 to 2010 in Saravan and the country. Female to male ratio of the cases at 5 years was shown in figure 2. Female to male ratio found as 1 to 3, however this ratio was the same of the country at the 5 years as shown in figure 3. The malaria cases in Saravan County in comparison of the country at the 5 years period was approximately 5% during the period 2007 to 2010, whereas found as 8% in 2011.

Table 1) Temperature of larval habitat in Saravan area, Sistan & Baluchestan Province, Iran, 2011

Species	No. of Collection	Temperature (°C) Average±SD
An.(Cel.) culicifacies	**13**	**20.5±3.5**
An.(Cel.) dthali	**12**	**18.5±0.5**
An.(Cel.) fluviatilis	**14**	**15±1**
An.(Cel.) stephensi	**16**	**21.5±4.5**

Table 2) The altitude of larval habitat in Saravan Area, Sistan & Baluchestan Province, Iran, 2011

Villages / Species	Dashtook	Mohammadi	Kaleh-Pahlavan
	Average±SD	Average±SD	Average±SD
An.(Cel.) culicifacies	185±10	290±10	8±1
An.(Cel.) dthali	185±10	290±10	8±1
An.(Cel.) fluviatilis	185±10	-	-
An.(Cel.) stephensi	185±10	290±10	8±1

Table 3) Number and density of *Anopheles* larvae in Saravan Area, Sistan & Baluchestan Province, Iran, 2011

Months	*An. stephensi*		*An. dthali*		*An. fluviatilis*		*An. culicifacies*	
	No✸	D☼	No✸	D☼	No✸	D☼	No✸	D☼
April	178	17.8	0	0	21	2.1	46	4.6
May	121	12.1	28	2.8	0	0	51	5.1
June	114	11.4	25	2.5	16	1.6	156	15.6
July	122	12.2	19	1.9	14	1.4	39	3.9
August	96	9.6	27	2.7	19	1.9	44	4.4
September	148	14.8	56	5.6	24	2.4	128	12.8
October	209	20.9	26	2.6	48	4.8	57	5.7
November	159	15.9	39	3.9	28	2.8	61	6.1
December	37	3.7	18	1.8	0	0	49	4.9
January	79	7.9	0	0	36	3.6	42	4.2
February	86	8.6	12	1.2	42	4.2	36	3.6
March	146	14.6	06	0.6	29	2.9	28	2.8
Total	**1495 (54.7%)**	**-**	**256 (9.26%)**	**-**	**277 (10%)**	**-**	**737 (26.65%)**	**-**
N.	**2765**							

✸No= Number
☼D= Density

Table 4) Number and density of *Anopheles* adults in Saravan area, Sistan & Baluchestan Province, Iran, 2011

Months	*An.culicifacies*		*An.dthali*		*An.fluviatilis*		*An.stephensi*	
	No✸	D☼	No✸	D☼	No✸	D☼	No✸	D☼
April	13	1.625	2	0.25	2	0.25	5	0.625
May	44	5.5	9	1.125	5	0.625	7	0.875
June	14	1.75	4	0.5	3	0.375	11	1.375
July	11	1.375	20	2.5	2	0.25	19	2.375
August	8	1	4	0.5	1	0.125	3	0.375
September	19	2.375	0	0	3	0.375	6	0.75
October	21	2.625	3	0.375	4	0.5	9	1.125
November	32	4	3	0.375	12	1.5	19	2.375
December	20	2.5	6	0.75	11	1.375	13	1.625
January	18	2.25	22	2.75	2	0.25	7	0.875
February	15	1.875	5	0.625	2	0.25	6	0.75
March	18	2.25	5	0.625	3	0.375	3	0.375
Total	**233 (49.16%)**	-	**83 (17.51%)**	-	**50 (10.55%)**	-	**108 (22.78%)**	-
N.				**474**				

✸No=Number; ☼D=Density

Table 5) Malaria cases based on the gender in Saravan area in comparison to Iran, 2007-2011

Places / Year	Saravan County		Iran	
	Male	Female	Male	Female
2007	651	262	10561	5281
2008	400	170	9817	4908
2009	203	98	3727	1894
2010	130	45	1430	715
2011	188	75	2181	1090
Total	**1572**	**650**	**27716**	**13888**
Total	**2222**		**41604**	

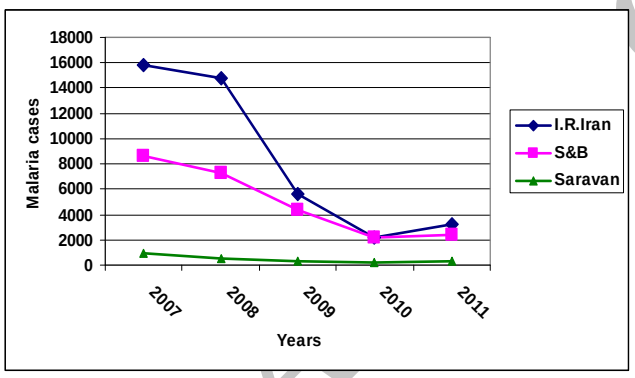

Figure 1) Trend of malaria cases in comparison with Sistan & Baluchestan Province and Saravan County, Iran, 2007-2011

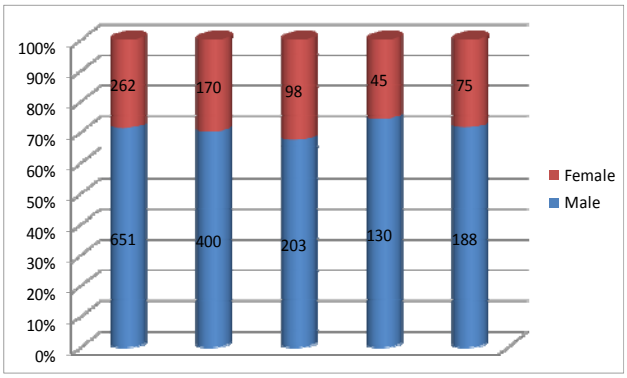

Figure 2) Female to male Ratio of malaria cases in Saravan area, Sistan & Baluchestan Province, Iran, 2007-2011

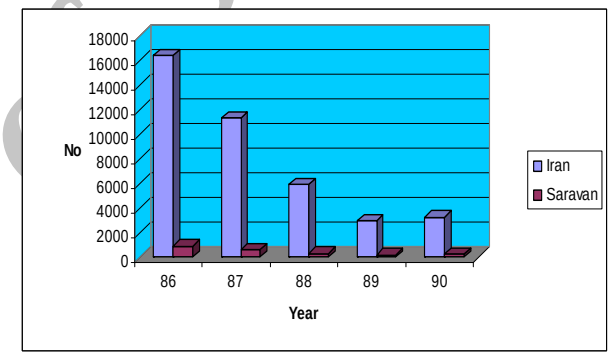

Figure 3) Female to male Ratio of malaria cases of Saravan area in comparison to Iran, 2007-2011

Discussion

In this study, the minimum temperature found for larval growth and development as range 17-26°C. Moreover, *An. stephensi* was collected in all months and its peak found in April and October, respectively.

An. stephensi larvae were collected as range 7 to 300 meters above sea level in the three selected villages. The larval peak activity found in April and October and in adult form showed in May and October. Further support to these results came from previous studies, Horsfall *et al.* (29) cited eggs and larval growth period as 3 and 7 days, respectively. Moreover, this species presented as the predominant species in coastal

regions of Chabahar area, southeastern Iran, and also noted its active all of the year with peaks in May and November, respectively (13, 14, 16).

An. stephensi found as predominant species. Three biological forms of this species reported as typed, intermediate and mysorensis. Moreover, Indian's type form of *An. stephensi* cited as the malaria vector in urban and mysorensis form in rural areas (30). In the past few years, type and intermediate forms reported as the malaria vector in urban and mysorensis found as the vector in rural area of Iran. However, pyrethroids excitability and irritable of these species reported (14). Manouchehri *et al.* reported the resistance of these species to DDT, Dieldrin and Malathion in Iran in 1976 (28).

The duration of Sporoghony cycle of *P. vivax* in *An. stephensi* reported as 18, 15, 11, and 9 days at 16, 21, 27 and 33 centigrade degree, respectively. Moreover, this period cited as 14, 10 and 9 days at 21, 27, and 33 centigrade degree for *P. falciparum*, respectively. Life span of this species was calculated as 32 days in 27°C and at least 55% humidity (29)

In our study, *An. culicifacies* larvae were collected as the abundant of 12.8 in September. The minimum and maximum temperature for the species found as 17°C and 24°C, respectively. However, *An. culicifacies* larvae found with two peak activity in June and September and adult found in July, November and December, respectively.

At the present, four sibling species, A, B, C and D stated for *An. culicifacies*. However, A, B, C, and D reported in central India, whereas A and B cited in northern and southern of the country. The sibling species of D noted sympatric with A, and B in India (30, 31). The sibling species of A has been stated in Oman and Iran. However, this species noted one of the main vectors in east Afghanistan (32). This species laid egg on the surface of water as 10 cm distant. Out of 23 and 92 percent of the eggs will hatch at 20°C and 32°C, respectively (29).

The larval period noted as range 82 to 105 days at 10 to 15°C, whereas cited as range 15 to 20 days in 25 to 28 centigrade degree (29).

In our research, the optimum temperature for larval growth found as 22±1°C. However, In our study, *An. culicifacies* found in all seasons and comprise as 22.78%, 26.65% of adult and larvae collection, respectively. In the past few years, this species found as Zoophagic behavior and anthropophagic index stated as 2.7% (3). However, blood feeding behavior on Cow stated as 47.07 % and on human as 4.9% using enzyme linked immunosorbent assay (ELISA) test (32). Furthermore, the sporozoite infection stated as 4.7% and 8 dila reported using the ovary dissection and Detinova method. Infection rate reported as 0.4% and 0.8% in Afghanistan and Pakistan, respectively (28).

In similar study, two adult peaks activity found in June and September, low excitability and irritability stated to Fenitrothion, Permethrin, Cyfluthrin and high irritability to DDT. Sporozoit rate reported as 0.25% and anthropophagic rate noted as 12.5% (12).

In this study, *An. dthali* found as 17.51% of adult and 9.26% of larvae. However, the minimum and maximum temperature for *An.dthali* larval habitat was 18°C, and 19°C, respectively. In parallel, larval habitat temperature reported range 13-28 °C and pH:6.9-8 in southern Iran(34).

In our study, *An. dthali* collected in various larval habitats. In similar study the larval habitat of *An. dthali* stated in small artificial ponds, beaches, rivers and ponds of water, mainly in freshwater with low vegetation, rice land plains (34).

In this study, the larvae of this species found with two peaks activity in September and November and adults peaks activity showed in July and December. Further support to these results also came from a previous study, *An. dthali* reported as the secondary vectors in Iran and collected as high as 1410 altitude. At the

first time Sporozoaite found in Kazeroun by Manouchehri *et al.* in 1972 (28, 31). In similar study, two peaks activity as May and September stated in Bandar-Abbas, southern Iran (31). However, two peaks activities also reported in August and September in Mamasani, southwestern Iran (33). The most abundance of this species has been reported in September and October in Hormozgan Province, southern Iran). Exophagy behavior of this species influenced by environmental conditions. Exophily and endophily behavior of *An. dthali* stated in warm and cold seasons respectively (31,33). Anthropophile index reported as a range 4-17.8% in the world and found as range 15.4%- 15.6% in Iran (10,11). *An. dthali* so far have been susceptible to all insecticides. According to the WHO resistance stated to Malathion, Choloropyriphos, Bromophos, Carbamate in Egypt and Temephos in Jordan (35).

In our study, *An. fluviatilis* larvae were collected 10% of the total mosquitoes collected. However, this species was active through the year except in May and November. In parallel, *An. fluviatilis* is known the malaria vector in Southeast Asia. Horsfall (1973) reported the zoophilic and anthropophilic behaviours (29). First time, salivary gland

In our research, the maximum and minimum of temperature in the larval habitat were 16°C and 14°C, respectively. In parallel, the optimum temperature for larval growth reported as the range 23 to 32 centigrade degree and average as 27°C. Moreover, pH as range 6.2-8 and brackish water cited as the best condition in larval habitat (29).

In our study, larval peak activity found in October and February and adult peaks activity showed in November and December, respectively. However, this species collected as the range 180 to 190 meters above sea level. In parallel, diversity of this species was reported from different parts of the country, Eshghi (1966) stated the diversity as range 50-1100 latitude. *An. fluviatilis* species collected from Kazerun and Khesht areas of Fars province, southern Iran reported as similar to species of U in India. The various samples collected from other parts of Iran showed a range between U and T using ITS2 gene and polymerase chain reaction (PCR) techniques (17). furthermore, various haplotypes as S, U, T1, T2, Y, X, V was reported of the samples using ITS2 region of the rDNA ribosomal gene in Jirofr and Saravan samples, southern Iran. It looks like the species of T distributed in Jiroft and U in Saravan (36). However, in India was introduced the sibling species of S, T, U using polyethen chromosome (37).

In our research, the malaria cases of Saravan area decreased from 2007 to 2010. The common parasite was *P. vivax*. In parallel, Moshfe *et al.* (2003) stated P. vivax is predominant parasite in Kohkiloyeh & Buyer-Ahmad province in south western Iran (38). Agrees with our study, Arshi *et al.* 2002 noted that 90% of malaria cases in Ardabil province, northwest of country caused by P. vivax (39). Podat *et al.* (2006) stated that 96.38% of cases caused by P. vivax in Bandar-Abbas city, southern Iran during 1998-2002 (40). In the same study was carried out in Moghan Plain, northwestern Iran during 1999 to 2000 showed that *P. vivax* was predominant parasite species in this area (41).

In another study carried out in Khorasan Province, northeastern Iran, over the past 20 years 1977-1997, showed 93.3, 4.4, 2.1, and 0.1 percent of parasites were *P. vivax*, *P. falciparum*, Mixed, and *P. malariae*, respectively (42). Similarly, 84% and 91% of cases caused by *P. vivax* in Iran, in years 2001 and 2007, respectively (44).

In our research, the number of malaria cases in 2007 to 2011 in the Saravan County during the 5 years reported as, 913, 517, 301, 175 and 260 cases, respectively. In parallel, Khalaji (2004) stated the trend of malaria cases increased in Iran from 1995 and has again increased from 2002 due to local transmission in the Sistan and Baluchestan Province,

southeastern Iran. However, 85% of malaria cases stated in this province during 2000 to 2002. In parallel, malaria cases increased in the country from 15,378 in 2002 to 16,467 in 2010 (44).

Annual parasite incidence (API) has been decreased and reached to 24 per 100,000 in Iran in 2007 (44). In parallel, the malaria study in a 10 years period (1993-2003) in the East Azarbayjan Province indicated that annual blood examination rate (ABER) from 0.85% decreased to 0.83%, whereas API and slide positivity rate (SPR) from 1.06, 0.32% increased to 22.7 and 0.5%, respectively (45). Flooding and rising water of Aras River have been responsible for the occurrence of malaria epidemics in the border of Iran and Azerbaijan Republic in 2003 (45). Total of 68% of cases stated in the Sistan and Baluchestan, Hormozgan and Kerman Provinces, southern Iran in 2002, which increased to 95% in 2007. Similarly, Raeisi *et al.* (2009) stated the API incidence of malaria cases were 0.24, 0.38, 0.20, 0.28, 0.23 and 0.34 in hundreds thousands population during 2002-2007 (44).

Based on Iranian ministry of health and medical education report, female to male ratio was 1:3. That was parallel to the ratio of the country at the 5 years. In parallel, Arshi *et al*. (2002) stated 90% of malaria cases occurred in the men in the age group 30 years and over in July, August and September, respectively, in northwest of the country (39). In a same study carried out in Bandar-Abbas city, southern Iran during 1998-2002, A total of 6905 cases of malaria stated comprise 74.6% Iranian and 25.4% are non-Iranian, 65.3% male and 34.7% female, 37.9% in urban and 62.1% in rural, area (45).

Further support to these results also came from a previous study, 78.1% of cases were indigenous that 79.2 % were Iranian and 15.2% from Afghanistan in southeastern Iran (44). In other study over a 10 years period 1992-2001, Arab Nejad *et al.* (2002) stated 73.9% of malaria cases were observed in males more than 9 year old in Torbat-e-Jam, north eastern Iran (46). Similarly, Malaria cases decreased from 71% to 60% in more than 15 years old whereas, increased from 22% to 30% in age group 5 to 16 years and 6.28% to 10% in less than 4 years during 2002-2007 (43) .Out of 56.2% of malaria cases were male and 24.6% living in urban areas and 38.4 % found indigenous in Torbat-e- Jam, north eastern Iran (46).

Also, malaria cases in Saravan County in comparison of the country was approximately 5% in 2007. This amount were 8% in 2011. It seems occurrence of malaria epidemics in the border of Iran and Pakistan in 2011 is due to immigrations. Further support to these results also came from a previous study, Mujtahedi *et al.* (2003), which showed about half of cases found were from Iran and the rest were from Pakistan and Afghanistan in Khorasan Province, northeastern Iran. Similarly, another study showed trend of malaria from 1995 increased and from 2002 has again upward due to local transmission in the southeastern province of Sistan and Baluchestan (46).

In another study carried out in Khorasan Province, northeastern Iran, over the past 20 years (1977-1997) showed more of the cases came from Afghanistan (42). Similarly, Malaria cases increased from 15,378 in 2002 to 16,467 in 2010 in Iran (43).

Conclusions: In order to archive the malaria elimination until 1404, improving access to prompt diagnosis, effective treatment for malaria, promote access to preventive services by strengthening the integrated management of arthropod vectors (IVM), strengthening the care of malaria and prompt with emphasis on the appropriate response are recommended. We suggest strengthen the development of interventions to eliminate malaria, monitoring of applied research. However, performing of similar studies in other parts of the country, especially south and south-east of the country are recommended.

Footnotes

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