

## Epidemiological Trends over a Ten-year Period of Malaria in a non-Endemic Area of Saudi Arabia

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### ABSTRACT

#### Keywords

Epidemiology,  
Malaria,  
*Plasmodium*,  
Al-Ahsa,  
Saudi Arabia

#### Article Info

Accepted:  
07 February 2016  
Available Online:  
10, March 2016

This study aimed to determine the epidemiological characteristics of imported malaria infections in Al-Ahsa, Eastern province of Saudi Arabia, based on a retrospective analysis of central laboratory records over the last ten-year period from 2005 to 2015. Records showing details of all positive slides for malaria blood films over a 10-year period were analysed. The focus was on identifying the common types of malarial parasites in the area, the nationality and the age of the patients. 631771 patients were screened for malaria during the 10-year period of which 692 slides (0.1%) were positive. Mean annual positivity was 63 slides/year. Out of the positive slides 527 (76%) showed *Plasmodium vivax*, 79 (11.5%) showed *Plasmodium falciparum*, 71 (10.5%) showed *Plasmodium malariae* and 15 (2%) showed a combination infections. The prevalence of malaria continues to be low in Al-Ahsa. Among the affected patients, the vast majority are expatriates indicating that most of the infections are imported cases.

### Introduction

Malaria is a serious public health problem, is a worldwide health risk leading the death of millions of people (Leandro *et al.*, 2016). The number of malaria cases globally fell from an estimated 262 million in 2000 to 214 million in 2015, a decline of 18% (WHO, 2015). Most cases in 2015 are estimated to have occurred in the WHO African Region (88%), followed by the WHO South-East Asia Region (10%) and the WHO Eastern Mediterranean Region (2%).

The incidence of malaria, which takes into account population growth, is estimated to have decreased by 37% between 2000 and 2015 (WHO, 2015). In humans, the disease is induced by different species of protozoa parasites from the genus *Plasmodium*. The most severe form of the disease is related to *Plasmodium falciparum*, which is responsible for many deaths every year (World Health Organization, 2014). Malaria-associated symptoms appear during the blood stage of the disease with infection

of erythrocytes. Erythrocyte invasion by *Plasmodium* has always been credited to parasitic mechanisms and host-cell participation regarded as passive (Leandro *et al.*, 2016). In humans, *Plasmodium falciparum* is the most dangerous species responsible for severe disease. Resistance to existing drugs has developed in several strains and the development of new effective compounds to fight these parasites is a major issue. Despite all efforts to establish the pathogenesis of malaria, it is far from being fully understood.

Malaria is the most important disease transmitted by mosquitoes (WHO, 2015) of the genus *Anopheles*, with 482 species identified in the world (Harbach, 2015). Almost 70 species of *Anopheles* have been incriminated as the vectors of malaria in the world (Sinka, 2013), among which about 41 species are considered as the most important vectors (Enayati *et al.*, 2010). Mosquitoes (Diptera: Culicidae) are a big and plentiful group of insects that occur all over the temperate and tropical areas of the world. Based on the current classification, mosquitoes include two subfamilies, 112 genera and 3,543 species (Harbach, 2015). Genus *Anopheles* includes seven subgenera; also genus *Culex* includes 26 subgenera (Harbach, 2015). There are a few reports on indices of association between larvae of mosquito species in various habitats in the world (Service, 1968; Wooster and Rivera, 1985; Marcondes and Paterno, 2005; Nagm *et al.*, 2007). Accurate assessments of the levels and time trends in malaria burden are crucial for the assessment of progress towards goals and planning national health services and focusing future efforts (Murray, *al.*, 2010; Cibulskis, *et al.*, 2010). The study provides scientific evidence that would be an important database of local, national, and global relevance in advancing current knowledge on malaria situation. It is also useful to policy makers and program

planners at each level for assessing progress and focusing future efforts while providing evidence-driven public health action in preventing and controlling malaria incidence.

The aim of this study is to determine the trend of malaria prevalence in the last ten-year's period from 2004 to 2014 and describing malaria occurrence in Al-Ahsa, Eastern province of Saudi Arabia. One of the primary goals of our study was to assess the load of imported malaria in our sample.

## **Materials and Methods**

### **Study Area and Period**

The study was a retrospective analysis of all recorded cases of malaria over a ten-year period from 2004 to 2014 based on records kept by the Saudi Ministry of Health for Al-Ahsa region in the Eastern province.

### **Source Population**

A total of 631771 records of patients in Al-Ahsa province was the source population of the study. All available records of reported cases were analysed and the focus was on the type of malarial parasite identified and on the age and nationality of the affected patients. 631771 records of patients presenting with fever and who had blood films prepared to rule out malaria were screened. We also attempted to study the pattern of the nationalities of the expatriates affected. The study also attempted to analyse the common mosquito species isolated from the region under study based on records of light traps and larval screening.

### **Data Collection Procedure**

Medical laboratory technicians or nurses collected Blood sample. Malaria report data

collection form including name of Hospital, year, month, date, sex, age, and nationality of each record.

### **Data Processing and Analysis**

Different data including age, sex, hospital name, year, and country was entered by date. Data and analysis were performed by Excel program. Line graphs are used to depict the overall as well as specific trends of malaria prevalence in the last ten years.

### **Data Quality Management**

National standard of malaria diagnosis and laboratory examination of blood films was respected.

### **Results and Discussion**

Out of 631771 patients, were screened for malaria during the 10-year period, 692 slides (0.1%) were positive for malarial parasite. Mean annual positivity was 63 slides/ year. The number of infections recorded showed a general upward trend in recent years (Figure 1), though there was a decline in the incidence during the years 2007 (21 cases) and 2008 (23 cases). From 44 cases in 2004, the number has approximately tripled to 131 cases in 2014 (Figure 1).

The predominant parasite identified was *Plasmodium vivax*. Out of 692 positive slides, 527 slides showed *Plasmodium vivax* (76%). The second most common was *Plasmodium falciparum* (Figure 2). Out of 79 slides, eight slides (11%) showed *Plasmodium falciparum*. In the remaining 71 slides, (10%) showed *Plasmodium malariae*, and 15 (2%) showed a combined infection (Figure 2).

As far as nationalities were concerned, the overwhelming numbers of cases were expatriate patients. Only 12 out of 692

(1.7%) were Saudi patients. All the rest 680 (98.3%) were expatriates. The break-up of nationalities was analysed for the year 2012. Of the 131 cases showing slide positivity, a majority were from the Indian sub-continent, of which 59 were Indians (45.3%) and 48 were Pakistani (36.9%). The other expatriate nationalities included 11 Ethiopians (8.4%), 9 Sudanese (6.9%) and one Yemeni (0.7%) (Figure 3).

A screening of the mosquito species in the same year found that the major species of mosquito in the region was *Culex* mosquitoes (79%, which signify 457) and the second common species was the *Anopheles* (21%, which signify 121). Screening of larval breeding sites showed *Aedes* species as well, but light traps /adult mosquito screens did not show any *Aedes* mosquitoes. Out of 5811, we had 3843 cases (66.1%) were Culicine larvae, 1940 (33.3%) were Anopheline and 28 (0.4%) were *Aedes* larvae. As far as age, distribution was concerned, the vast majority (683) of cases were above 15 years of age and symbolise 98.6%, and only 9 (1.4%) pediatric cases being recorded.

An effective malaria control program, which started in 1948, has ensured that indigenous cases of malaria are rare in the Eastern province of Saudi Arabia. The incidence of malaria in Saudi Arabia is highest in the Southwestern regions of Jizan and Asir. However, cases of imported malaria continue to occur in the Eastern province. This study describes the epidemiological trends related to malaria in Al-Ahsa region of the Eastern province over a ten-year period (2004-2014). The malaria control program in Saudi Arabia started in the year 1948 and the strict implementation of the program has ensured that the incidence and spread of malaria in the Eastern province of Saudi Arabia remains low. As of now active malaria transmission in Saudi Arabia is

mainly localized in the South and South-Western areas of the Kingdom, especially Jizan area (Alkhalife, 2003). The last major analysis of the epidemiology of malaria in the Eastern province was that of Al-Tawfik (Altawfiq, 2006) who had conducted a retrospective analysis of the epidemiology of malaria over a period of 10 years (1994-2005) in Dhahran (Altawfiq, 2006). This study was based at the Saudi Aramco Medical Services Organization. Of a total of about 370000 individuals screened for malaria, 56 cases positive for malarial parasites were seen, with a mean annual incidence of 3.5. In this study, also the majority of cases showed *Plasmodium vivax* (54.4%). All infections were presumed to be imported cases and the most frequent countries of acquisition were Pakistan, India and the Sudan. In our study, also the major nationalities were Indian and Pakistani (Altawfiq, 2006). Our study also showed a significant number of Ethiopian expatriates, besides the Sudanese nationals. The importance of screening all expatriates for malaria to control the introduction of imported malaria and further complications like drug resistant malaria needs to be highlighted in future malaria control programs. The type of parasite appeared to follow the area of acquisition as the only Saudi patient during the year 2014 had *Plasmodium falciparum*, while *Plasmodium vivax* was the main parasite amongst the expatriates. *Plasmodium falciparum* has been shown to be the most common parasite in the endemic areas of Saudi Arabia (Alhassan and Roberts, 2002), while *Plasmodium vivax* is the most common in the Indian sub-continent (Eliades *et al*, 2005). The Sudanese patients in our study had an almost equal incidence of *Plasmodium falciparum* and *Plasmodium vivax* even though the predominant species in Sudan is *Plasmodium falciparum* (Adam, *et al.*, 2005). A study from Riyadh, Saudi

Arabia, by Alkhalife (Alkhalife, 2003) based on the records of the malaria referral laboratory over a 6-year period from 1996 to 2001 also showed a high percentage of slide positivity among expatriates, in this study, positive slides included Saudi (36.6%), Sudanese (30.9%), Indians (13.9%), Pakistanis (8%) and Yemenis (5%). The majority of the affected patients in the aforementioned study were adults unlike in our study where a significant number of cases were below the age of 10 years (25% of the total cases) (Altawfiq, 2006). The other major study conducted in the Eastern region of Saudi Arabia was a clinical, epidemiological and haematological profile of laboratory diagnosed malaria cases at a tertiary care university hospital in Al Khobar, Saudi Arabia by Bashawri (Bashawri, *et al.*, 2001). In this study, there were 602 cases with a mean age of 25.8. The majority of the cases were expatriates (58%). *Plasmodium falciparum* was the most common species among Saudi, Sudanese and Yemeni patients, while *Plasmodium vivax* was predominant among other expatriates. Most of these cases had a history of travel to their home countries. The most common clinical features of the malaria cases in this study included: fever (97%), splenomegaly (9%) and jaundice (8%). Anaemia (60%) and thrombocytopenia (53%) were the most common haematological findings (Bashawri, *et al.* 2001).

A previous study by Alahmed (Alahmed, *et al.*, 2012) has shown that all species of mosquitoes are seen in Al-Ahsa. The predominant species was found to be *Culex* mosquitoes but there were a significant number of *Anopheles* mosquitoes also. Our study corroborates these findings. *Culex* mosquitoes were identified as the majority species both in adult and larval screening, while *anopheles* mosquitoes were the second most common.

Figure.1 Annual Malaria Cases in Al-Ahsa from 2004 to 2014

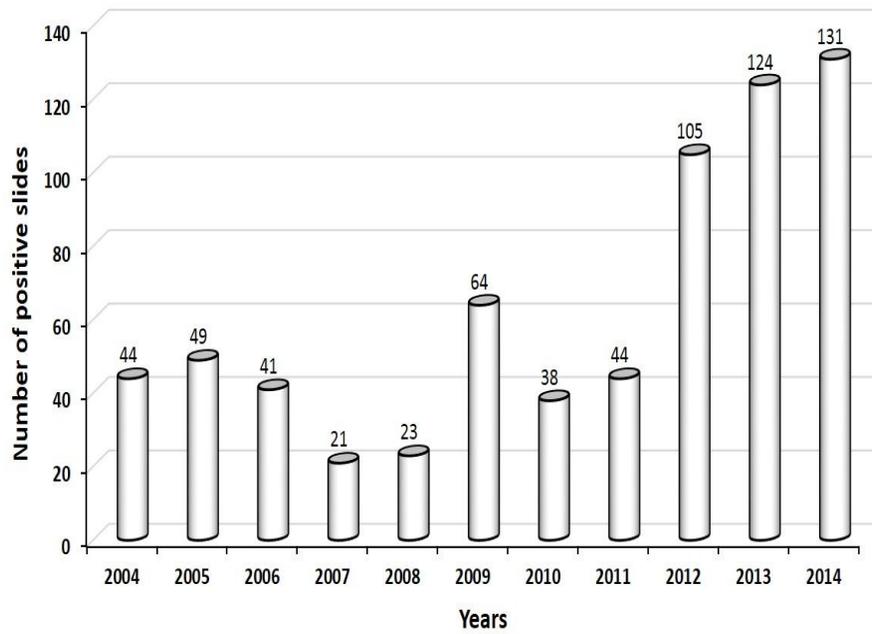


Figure.2 Distribution of the Identified Malarial Parasites (692 Cases) for the Period Between 2004 and 2014 in Al-Ahsa, Eastern Province of Saudi Arabia

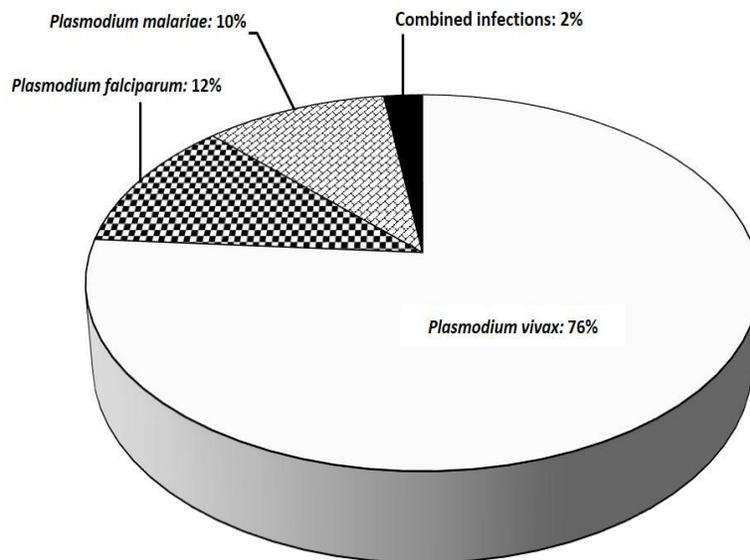
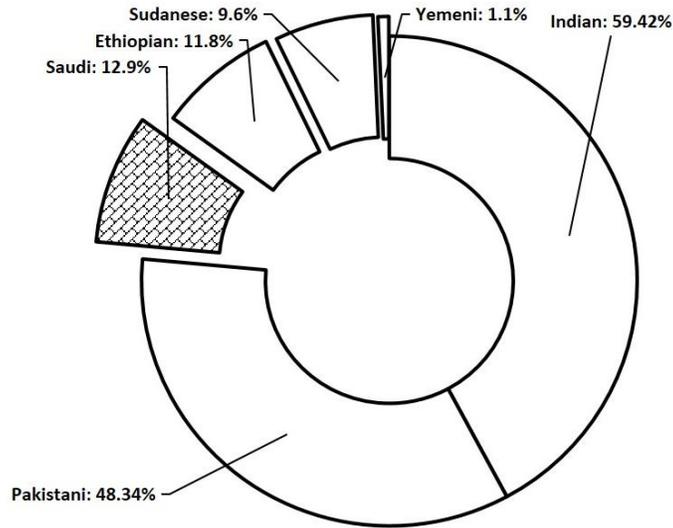


Figure.3 Number of Aes of Malaria by Nationality from 2004 to 2014



*Aedes* mosquitoes were seen in larval screening sites but not in light traps/adult screens. Considering that there is a viable presence of the vector mosquitoes and the presence of active malaria cases, continuing active surveillance for the effective control of malaria in this region is essential. It should be noted however that the ambient temperature and high aridity may be a significant contributing factor for limiting the spread of malaria in the Eastern province, which is characterized by relatively high extremes of temperature with summer temperatures frequently crossing 50°C. Ambient temperature can affect the transmission of human malaria based on its relationship with the duration of sporogony of the parasite in the mosquito. Extreme aridity adversely affects Anopheline development and survival (Almaza, *et al.*, 1999; Snow, *et al.*, 2013).

A challenge to the successful implementation of the malaria control program in Saudi Arabia is the high influx of expatriates and visitors to the holy places from malaria endemic countries. Though this is mainly a problem in areas like the

South-Western region of Saudi Arabia, careful monitoring of important malaria and associated spread of drug resistant strains needs to be under regular surveillance. Screening of all expatriates during the initial entry into the Kingdom and strict screening before procedures like blood transfusion should also be implemented (Saeed, *et al.*, 2002; Alkhalife, 2003). A study by Al-Farsi (Alfarsi, *et al.*, 2012), has suggested that the primary source of drug resistant cases of *P. falciparum* in the South-Western area of Saudi Arabia is most likely from East Africa (Alfarsi, *et al.*, 2012). The Eastern province has also a very high number of expatriates, including from malaria endemic countries, who could be a potential source of imported malaria.

The main limitations of our study include a lack of clinical correlation, as we did not have sufficient data regarding the clinical presentation of the positive cases. Detailed patient history regarding the acquisition of the disease was not available, hence we could not confirm if all the cases were indeed true imported cases. We also did not have data for the treatment details.

In conclusion, the prevalence of malaria continues to be low in Al-Ahsa area of the Eastern province of Saudi Arabia. Among the affected patients, the vast majority are expatriates indicating that most of the infections are probably imported cases. Considering the large number of possibly imported cases, effective vigilance for cases of malaria needs to be strictly continued. Malaria remains as a public health problem in the study area with relatively high slide positivity rate.

### **Recommendation**

According to our results, we strongly forward the following recommendations: exceptional attentions need to be reflected for visitors to the Kingdom. Further studies should be conducted to determine or forecast potential epidemic patterns in the study area; public awareness conception could be implemented; strong emphasis should be given to malaria prevention and control; performance plans and achievements should be regularly and strictly reviewed and evaluated at each level.

### **Acknowledgement**

Authors would like to thank the Deanship of Scientific Research King Fiasial University for financial support of this project.

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**How to cite this article:**

Hamdan, I. Al-Mohammed, Mounir, Ferchichi, S. 2016. Epidemiological Trends over a Ten-year Period of Malaria in a non-Endemic Area of Saudi Arabia. *Int.J.Curr.Microbiol.App.Sci*. 5(3): 1-8. doi: <http://dx.doi.org/10.20546/ijcmas.2016.503.001>