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SHORT REPORT

Prevalence of Malaria reported during Summer and Winter at a Tertiary Care Hospital in Karachi, Pakistan

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Abstract

This study was designed to determine the prevalence and type of malaria cases that presented throughout the year 2014 in a tertiary care hospital in Karachi, Pakistan. A total of 1099 cases, (377 females, 722 males) were reported. Plasmodium vivax (P. vivax) was discovered in 93.7% cases compared to 6.3% Plasmodium falciparum (P. falciparum). Based on the highest and lowest weather temperatures, in summer (June, July and August) and in winter (December, January and February) were differentiated. The number of cases were greater during summer months compared to winter. Interestingly, the ratio of P. falciparum to P. vivax during winter was greater compared to summer. Finally, there was a strong correlation between increasing humidity and number of malaria cases. These findings show that even though the incidence of malaria is higher in summer, malaria cases are still reported in winter. Furthermore, the probability of finding P. falciparum (which causes cerebral malaria) is higher in winter.

Keywords: Malaria, Plasmodium Vivax, Plasmodium Falciparum, weather, humidity. **doi: 10.5455/JPMA.7805.**

Introduction

Climate change has a large impact on human health. It alters the geographic distribution of vectors and vector borne diseases and may exacerbate the morbidity and mortality.[1] The influence of climatic variables like temperature, rainfall, wind speed and relative humidity has a significant effect on the life cycle of the mosquitoes, the species that carries and aids in the development of the parasite responsible for the transmission of malaria.[2] Malaria is endemic and a major health concern for developing countries like Pakistan where 4.5 million malaria cases are reported annually.[3] Furthermore, studies have shown that malaria is found in almost all provinces of Pakistan.[3]

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It has been previously reported that temperature affects the dynamics of arthropod biology. To assess the developmental rates of poikilothermic arthropods, various comparative models like linear and nonlinear models have been created. Linear models showed lower developmental threshold (i.e. the temperature at which developmental rate approaches zero), but it does not predict developmental rates at extreme low and high temperatures.[4] Nonlinear models accurately describe the usually curvilinear relationship between arthropod developmental rate and temperature over the whole temperature range.[5]

Malaria transmission is considered to be inconsistent, with predominately Plasmodium vivax (P. vivax) transmission during warm, humid and rainy season hot weather.[7] The major transmission for Plasmodium falciparum (P. falciparum) in the north-western region of Pakistan is observed in cold temperatures i.e. between August and December.[6] We have previously reported that malaria cases reported in the 1st and 4th quarter of 2014 at a medical hospital of Karachi, Pakistan, of which 89.4% were infected with P. vivax while 10.6% by P. falciparum.[8] This study was designed to determine the characteristics and changes in patterns of malaria infection in cases reported at one medical hospital of Karachi, Pakistan, during the entire year of 2014.

Methods and Results

This retrospective study was conducted at the Aga Khan University Hospital, Karachi Pakistan, after receiving approval from the Ethical Review Committee (4834-Pat-ERC-17) on patients diagnosed with malaria during the year, 2014. A total of 1099 cases (377 females and 722 males) of malaria were reported. Average age of patients was 29.3 ± 18.4 years. Blood samples were collected from patients suspected to be suffering from malaria. Thick smears were made from peripheral blood and reviewed under microscope. Thin smears were also made and stained with Leishman's stain for identification of Plasmodia species. In order to identify the species of

Table: Data retrieved from http://climatevo.com showing weather profile of all 12 months of the year 2014 in Karachi. All characteristics of temperature and humidity have been reported.

Weather characteristics	January	February	March	April	May	June	July	August	September	October	November	December
Average temperature	19°C	19°C	24°C	27°C	30°C	31°C	30°C	29°C	29°C	27°C	24°C	19°C
Minimal temperature	14°C	11°C	18°C	24°C	24°C	29°C	28°C	28°C	27°C	23°C	19°C	13°C
Maximal temperature	29°C	28°C	32°C	38°C	39°C	40°C	34°C	34°C	38°C	38°C	32°C	29°C
Day average temperature	22°C	24°C	28°C	32°C	34°C	35°C	32°C	32°C	32°C	33°C	30°C	24°C
Night average temperature	16°C	18°C	23°C	26°C	29°C	31°C	29°C	28°C	28°C	26°C	23°C	18°C
Day minimal temperature	17°C	11°C	21°C	28°C	32°C	32°C	29°C	29°C	30°C	23°C	28°C	19°C
Night minimal temperature	14°C	14°C	18°C	24°C	24°C	29°C	28°C	28°C	27°C	23°C	19°C	13°C
Day maximal temperature	29°C	28°C	32°C	38°C	39°C	40°C	34°C	34°C	38°C	38°C	32°C	29°C
Night maximal temperature	20°C	22°C	27°C	29°C	31°C	33°C	30°C	30°C	32°C	31°C	27°C	23°C
Average humidity	33%	43%	51%	63%	65%	67%	70%	69%	67%	55%	50%	45%

Plasmodium involved in these cases, thick and thin blood films were made. Thick films were reviewed for confirmation of malaria, while thin films were stained with Leishman's stain for identification Plasmodia species. A significantly greater number of P. vivax cases were discovered (1051 cases; 93.7%) compared to P. falciparum (72 cases; 6.3%) (p value <0.001).

Information regarding weather was obtained online from http://climatevo.com. Humidity was lower in winter months of January (33%), February (43%), and December (45% while considerably higher in summer, months of June (67%), July (70%) and August (69%) (Table). We saw a strong correlation between humidity and the number of malaria cases (Spearman rank; r = 0.74; p value = 0.006).

Next we wanted to see the distribution of malaria cases in each month during the year 2014. Majority of the cases were reported in September (n=200) while the least number were reported in February (n = 28) (Figure 1A). Furthermore, the three months of June, July and August that had the highest temperatures and the three months of December, January and February that had the lowest temperature were declared as 'summer' and 'winter' respectively (Table). The number of cases reported in summer (n=426 cases) were significantly greater compared to winter (n=116 cases) (p value <0.001).

Humidity was lower in winter: January (33%); February (43%); December (45%) and considerably higher in summer: June (67%); July (70%); August (69%) (Table). We saw a strong correlation between humidity and the number of malaria cases (Spearman rank; r = 0.74; p value = 0.006).

Next, the type of malarial species diagnosed in patients throughout the year, 2014 was determined (Figure 1B). Although, the number of malaria cases presenting in

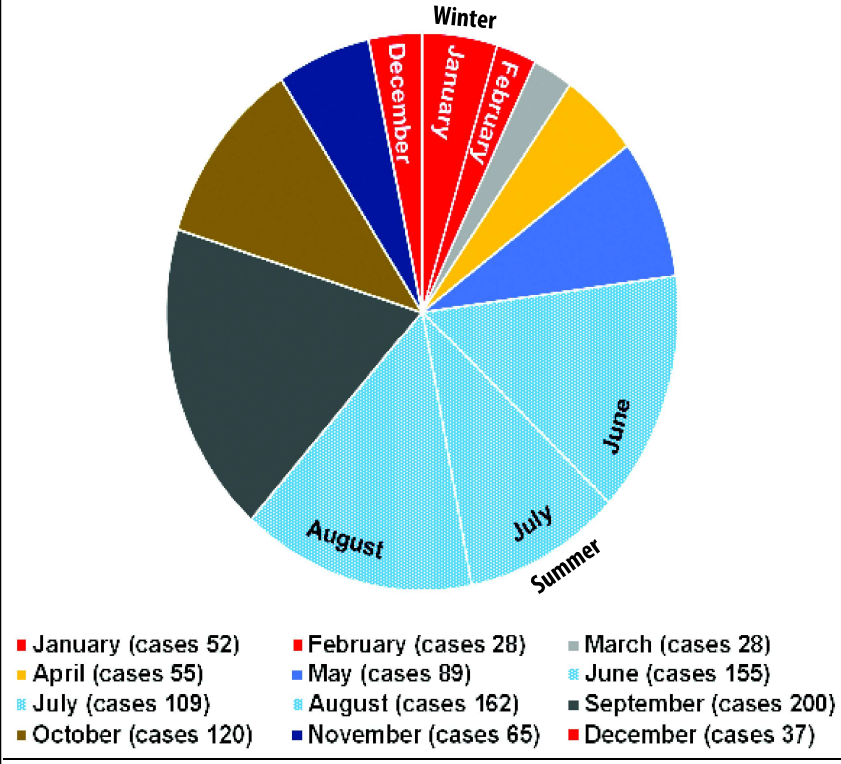

Figure 1 A: The number of cases diagnosed with malaria in each month is written next to its name. The months declared as winter (December, January and February) and summer (June, July and August) are differentiated on the basis of temperature during the year 2014.

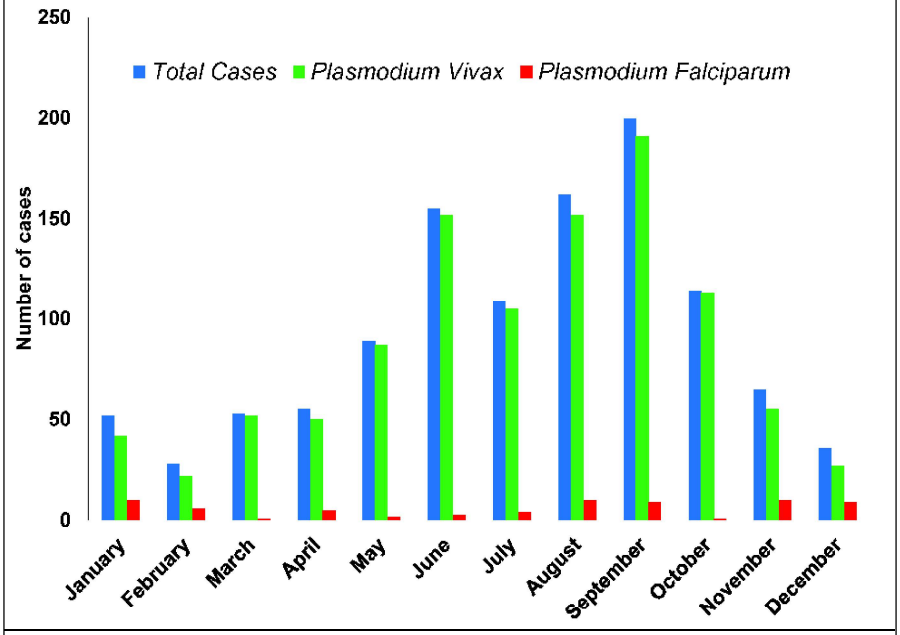

Figure 1 B: The total number of malaria cases, P. vivax cases and P. falciparum cases in each month of 2014 is shown here.

winter was significantly lower than in summer, the average ratio of P. falciparum to P. vivax cases during winter (0.28 ± 0.03) was significantly greater than that during summer (0.04 ± 0.01) (p value = 0.001). In other words, even though the chances of getting infected with malaria is lower in winter, the possibility of the infecting species being P. falciparum is greater in winter then in summer.

Discussion

Malaria causes a huge burden of disease globally, particularly in low middle income countries. A number of environmental factors play an important part in its prevalence, both geographical and environmental. Traditionally malaria is considered a disease of hot and humid weather. The results of this study show that the disease transmission occurs throughout the year with varying severity. This study investigated effects of climatic factors like temperature and humidity to decipher the malaria infection frequency during different seasons. This study reports 116 cases of malaria presented during winter, which are significantly less compared to the cases reported in summer. The reason for this might be that during winter at lower temperatures, the larval and pupal stages of mosquito development take a little longer to complete. However, a small increase in temperature shortens the duration of these phases. Similarly, the duration of the sporogony cycle is shortened with increasing temperatures. In addition, raised temperature increases the frequency of mosquito feeding and may raise the probability of transmission of infection. All of these factors clearly present a justifiable cause of greater prevalence of malaria during summer.

Findings of this study are consistent with previous reports. However, here a high number of malaria cases are also reported during winter. This is a unique finding reported from Karachi, a coastal city of Pakistan, as it shows that the frequency of malaria cases reported here are greater than those reported from cities situated in the northern part of Pakistan.[9] Hence costal proximity can be a factor in the frequency of malaria infection, along with weather.

A predominance of Plasmodium vivax over Plasmodium falciparum cases was observed in this study. This may be due to several factors like parasitic load, vector's microenvironment, host parasite interaction or recent introduction of P. vivax from nearby areas by means of migration to this area. Interestingly, the ratio of P. falciparum to P. vivax cases was found to be higher during winter compared to summer, indicating a higher probability of cerebral malaria during winter. What can be the cause of this climateric change? Could it be that P. falciparum is more resistant to temperature changes and survives in winter better than P. vivax? Further research needs to be conducted to answer these crucial questions. Malaria can cause significant mortality and morbidity and constitutes a major health hazard in developing countries. Incidence of malaria is significantly higher in summer compared to winter. However, malaria cases also presented in winter and among them the average ratio of P. falciparum to P. vivax was significantly greater compared to summer. Our findings show that malaria should not be considered 'a disease of summer', but in fact a disease that occurs throughout the year.

Disclaimer: This abstract has not been presented or published at any conference, or published in an abstract

book or in any other relevant form. It is not part of any PhD thesis.

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