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Community Medicine

ASSESSING RISK FACTORS OF MALARIA IN LAKHIMPUR DISTRICT OF ASSAM

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ABSTRACT Malaria is a life-threatening parasitic disease transmitted from person to person through the bite of a female Anopheles mosquito. The transmission of malaria can be determined by climatic and host factors. The objective of this paper is to trace the host factors of malaria incidence and also to determine the relationship between climatic factors and malaria incidence in Lakhimpur district of Assam. In order to examine the association between monthly malaria incidence rates and climatic variables, Pearson correlation analysis has been used. Also, Chi-square test for independence of attributes is performed to trace the host factors of malaria incidence. A fluctuating trend was observed for reported malaria cases during the years 2000-2011. Both positive and negative correlation have occurred between climatic variable and MIR. Also, we have observed that male is more affected by malaria incidence than female. Among the age groups, the age group 15-39 years was found most affected age group than other age groups. After Chi-square test for independence of attributes we reveal that malaria depends on sex and age.

SUMMARY: From our study, we suggest that even if the climatic factors play a primary role for transmission of malaria, sex and age are other important risk factors in characterizing malaria incidence in the district.

KEYWORDS : MIR, Risk factors, Lakhimpur district

1. INTRODUCTION:

Malaria is one of the deadliest infectious diseases. Even though the disease has been investigated for hundred years, malaria is endemic in 91 countries with about half of the world population are at risk of malaria. It is predominantly present in the tropical countries, causing 300 million to 500 million clinical cases and more than 1.5 million deaths each year [Park, 1997]. The exact statistics are unknown because many cases occur in the rural areas where people do not have access to hospital. Consequently, many cases are treated at home and are not documented.

Malaria is caused by the protozoan parasites of genus Plasmodium and is characterized by paroxysms of chills, fever, headache, pain and vomiting. The disease is prevalent in the plains, forests, forested foothill and hill, forest fringe areas and developmental project sites. Forest related malaria remains a serious problem causing 30% of all malaria causes in India [Park, 1997]. The parasites are transmitted to humans through the bites of infected female Anopheles mosquitoes. It is caused by Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae. Of these, even though Plasmodium falciparum is the most deadly form and it predominates in Africa but in India, Plasmodium vivax, has been the primary pathogen responsible for malaria [Park, 1997].

The annual reports provide evidence that the magnitude of malaria across the Assam is high and varies with location. It contributes more than 5% of the total cases recorded in the country annually. Based on the annual parasite incidence (API), defined as number of confirmed cases per thousand of population, ten districts reported less than two cases. Most of the districts in Assam (44% of the total population), API was > 2, a criterion which is considered to be sensitive malariometric indicator for residual spray interventions against vector populations. We have observed that as a whole the API of Assam is 2.75 [Dev et al., 2006]. Also, for the year 2003 we have shown that among the districts of upper Assam the API is the highest in Lakhimpur, which is 3.

To study transmission of malaria, a mathematical model was first developed by Ronald Ross. After developing mathematical model for measurement of malaria incidence on the basis of stratification of the population under study with respect to host (age, sex etc.) and environmental factors (Minimum temperature, Maximum temperature, Humidity and Total Rainfall) we need another model which is called statistical model.

Gomez-Elipe et al. [2007] developed a model to predict malaria incidence in an area of unstable transmission in Burundi by studying the association between environmental variables and disease dynamics. Wattanavadee et al. [2008] used of general linear regression and generalised linear regression model such as Poisson and negative binomial to identify the patterns of hospital-diagnosed malaria incidences by month, district and age-group for two North-western border provinces in Thailand. Among the models fitted, the best were chosen based on the analysis of deviance and the negative binomial generalized linear model was clearly preferable. Also, they developed regression models to identify the patterns of hospital-diagnosed malaria incidences in district and quarterly periods in the North-western region of Thailand in 1999-2004. The results of this study show that malaria incidence rates decreased substantially in most districts during the study period, but remained very high in border districts with Myanmar [Watanavadee et al., 2009]. Chetterjee et al. [2009] have developed a simple non linear regression methodology in modeling and forecasting malaria incidence in Chennai city (India), and predicted future disease incidence with high confidence level. Further, Kakchapati et al. [2011] performed a study to model malaria incidence rates during 1998 to 2009 in Nepal. He considered a negative binomial model to fit malaria incidence rates as a function of year and location, and provided a good fit, as indicated by residual plots.

Also, in Assam several researchers have studied malaria incidence. The works, which have been published in relevant publications, are done by Dev et al. [2004], Das et al. [2007] and Dev et al. [2006].Very recently, Nath et al. [2013] considered malaria incidence rates in Kokrajhar district of Assam over the period 2001-2010 for analyzing temporal correlation between malaria incidence and climatic variables. Associations between the two were examined by Pearson correlation analysis. Cross-correlation tests were performed between pre-whitened series of climatic variable and malaria series. Linear regressions were used to obtain linear relationships between climatic factors and malaria incidence, while weighted least squares regression was used to construct models for explaining and estimating malaria incidence rates. Annual concentration of malaria incidence was analyzed by Markham technique for obtaining seasonal index.

Malaria is influenced by various climatic and host factors. Various malaria studies in the world (of course including India) have established the impact of climatic factors on malaria incidence. The relevant publications of the work were done by Huang et al. [2011], Al-Mansoob et al. [2005], Chatterjee et al. [2009], Chattopadhyay et al. [2004] and Nath et al. [2013]. These studies revealed that climatic factors play an important role on malaria transmission. Similarly, the influence of host factors (age and sex) on malaria incidence has been studied by Wattanavadee et al. [2008], Dev et al. [2004] and Das et al. [2007] and accordingly various reports have been submitted.

Keeping all these points in view, the objective of this paper is to trace the host factors of malaria incidence and also to determine the relationship between climatic factors and malaria incidence in the study area.

2. MATERIALS AND METHODS:

2.1 STUDY AREA: In our present study, the study area is Lakhimpur district of Assam of North-east India. The district covers an area of

2277 sq. km. out of which 2257 Sq. km is rural and 20 Sq. km is urban. The district is divided into two sub divisions viz. North Lakhimpur and Dhakuakhana. There are 9 no's of Blocks Viz. Narayanpur, Bihpuria, Karunabari, Nowboicha, Telahi, Lakhimpur, Boginadi, Ghilamora and Dhakuakhana in Lakhimpur district. The blocks are consisting of 1675 number of villages. The study area comprised of six block level primary health care centres (PHCs) – Dhalpur, Bihpuria, Nowboicha, Boginadi, Ghilamora, Dhakuakhana with about 1,040,644 population's (2,11,098 no's of population are tribal) in Lakhimpur district. The PHC's are consisting of 156 number of sub centres. Most areas in the state have heavy rainfall, and floods occur annually.

2.2 DATA: A yearly malaria epidemiological data in the district was collected from the head quarter of Lakhimpur district for the year 2000-2011. But, monthly malaria incidence data over the period January 2008-December 2011 were collected from all block PHCs and head quarter of Lakhimpur district. From these data, 75598 fever cases were distributed by age and sex, from which we got 601 malaria positive cases. Here we also consider four environmental factors, namely, minimum temperature, maximum temperature, humidity and average rainfall for January 2008 to December 2011. These environmental factors were collected from regional meteorological centre, Guwahati.

2.3 METHODS: From the malaria data, malaria incidences for all block PHCs of Lakhimpur district were separately extracted. Monthly/yearly malaria incidence rate (MIR) or Slide positivity Rate (SPR) for all the PHCs was calculated by the formula-

$$MIR = \frac{\text{Total Positive for malaria}}{\text{Total cases tested for malaria}} \times 100$$

and then six respective MIR time series were obtained. A yearly variation of malaria incidence was determined by trend, which would provide us a better understanding of malaria disease in the district. These malaria incidence series were considered for analyzing their statistical relationships with climatic variables. In order to examine the association between monthly malaria incidence rates and climatic variables, Pearson correlation analysis has been used. For this analysis, statistical software SPSS is used. Also, Chi-square test for independence of attributes is performed to trace the host factors of malaria incidence.

3. RESULTS:

A fluctuating trend was observed for reported malaria cases during the years 2000-2011 (Figure 3.1). Over the period, the lowest malaria incidence occurred during the year 2010 and highest incidence occurred during the year 2006. The malaria incidence seemed to increase gradually from 2000 to 2002 and then decreases slowly. After 2004, again malaria incidence raised gradually, the highest occurred in the year of 2006 and then declined gradually to its lowest in the year of 2010. But a remarkable increase was observed in 2011.

Using Pearson's correlation coefficient analysis the relationship between the climatic factors and monthly malaria incidence rate has been examined for all block PHCs separately (Table 3.1). For Bihpuria PHC it is observed that there is negative significant correlation between maximum temperature and monthly malaria incidence rate. In all other cases, no significant correlation (either positive or negative) has been found out.

When the association between the monthly malaria incidence and climatic variables is analyzed in Boginadi PHC (which is the most affected area of malaria in Lakhimpur district) all the climatic variables, except humidity, exhibited significant correlation with monthly malaria incidence rate at 1% significance level. All climatic variables are positively correlated with MIR, which is the opposite nature of Bihpuria PHC. The highest correlation is found to exist between minimum temperature and MIR (coefficient=0.482).

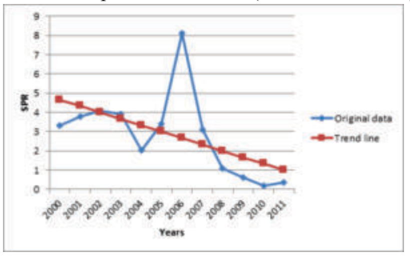

Figure 3.1: Annual trend of total malaria cases in Lakhimpur district, 2000-2011

In Dhakuakhana PHC (which is the less affected area as compared to another block PHC of Lakhimpur district), it is noticed that only minimum temperature is found with a significant correlation with MIR at 5% significance level. Minimum temperature, maximum temperature and rainfall are positively correlated with MIR, while correlation exhibited by humidity is negative.

None of the climatic variables is found to bear a significant correlation with MIR of the Dhalpur PHC. Temperature components (namely minimum and maximum temperatures) are positively correlated with MIR, where humidity and rainfall are negatively correlated with MIR. The nature of correlations between Ghilamora PHC with all the climatic variables is almost same as the correlations between climatic variables and MIR of Dhalpur PHC. In this block, insignificant correlation between climatic variables and MIR are found. Only difference is that the highest correlation is found between rainfall and MIR in Dhalpur PHC, while in Ghilamora PHC we have got highest correlation between humidity and MIR. The nature of the correlation (either positive or negative) between MIR and different climatic variables is the same for both the block PHCs - Nowboicha and Dhakuakhana. Notable difference is that minimum temperature of Nowboicha PHC is insignificant with MIR at 5% level of significance.

Table 3.1: Block wise correlation between MIR and climatic factors

Name of PHC	Variable	Coefficient
Bihpuria	Minimum Temperature	-0.203
	Maximum Temperature	-0.329*
	Humidity	-0.23
	Average Rainfall	-0.172
Boginadi	Minimum Temperature	0.482**
	Maximum Temperature	0.425**
	Humidity	0.49
	Average Rainfall	0.421**
Dhakuakhana	Minimum Temperature	0.326*
	Maximum Temperature	0.218
	Humidity	-0.174
	Average Rainfall	0.211
Dhalpur	Minimum Temperature	0.024
	Maximum Temperature	0.161
	Humidity	-0.122
	Average Rainfall	-0.172
Ghilamora	Minimum Temperature	0.046
	Maximum Temperature	0.093
	Humidity	-0.257
	Average Rainfall	-0.092
Nowboicha	Minimum Temperature	0.221
	Maximum Temperature	0.2
	Humidity	-0.026
	Average Rainfall	0.081

Table 3.2: Distribution of malaria cases in relation to age and sex in Lakhimpur district

Age group	Sex	No. of fever case	No. of malaria positive cases	SPR
0-4	Male	3876	9	0.23
	Female	3482	6	0.17
5-14	Male	11546	61	0.53
	Female	9305	41	0.44
15-39	Male	17901	306	1.71
	Female	15717	79	0.50
40^{+}	Male	8658	77	0.89
	Female	5113	22	0.43
Total	Male	41981	453	1.08
	Female	33617	148	0.44

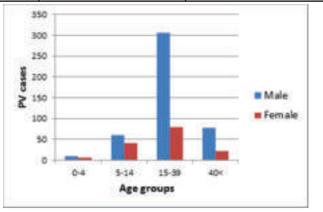

Figure 3.2: Age and sex distribution of PV malaria in Lakhimpur district

Malaria cases were observed in all age groups of both sexes (Table 3.2). Analysis of the data reveals difference in the incidence of malaria among males and females indicating the SPR 1.08 and 0.44 respectively (Table 3.2). Also, from figure (3.2-3.4), it is observed that for both PV and PF cases male is more affected than female. It is also seen that among the age groups, the age group 15-39 is most affected age group for malaria transmission. After testing independence of attributes we concluded that malaria is associated with sex, since calculated value of Chi-square (96.59) > tabulated value of Chi-square (3.841) at 5% level of significance. Similarly, we have observed calculated value of Chi-square (110.621) > tabulated value of Chi-square (7.815) at 5% level of significance to test independence of attributes of malaria and age. Therefore, we observe that malaria is also associated with age.

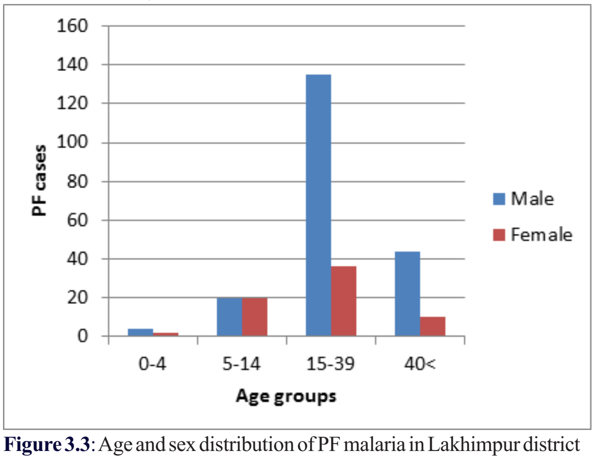

Figure 3.3: Age and sex distribution of PF malaria in Lakhimpur district

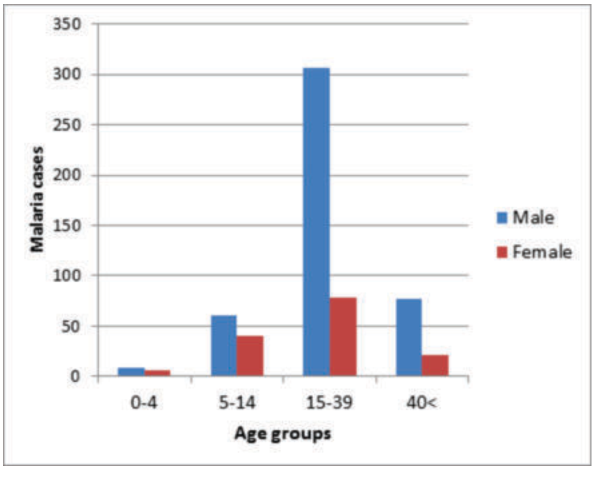

Figure 3.4: Age and sex distribution of total malaria cases in Lakhimpur district

4. DISCUSSION:

The malaria can be transmitted by climatic and non- climatic factors. The climatic factors include all the independent variables like temperature, rainfall, humidity, etc. and the non climatic factors are vector species in abundance, sex, age, socio-economic conditions, population immunity and so on. The incubation rate of plasmodium and breeding activities of Anopheles depend on climate variability. Temperature of 15^0C to 35^0C and humidity $\geq$ 60% are considered as favourable range for transmission of malaria [Bhattacharya et al., 2006]. The data of our study reveals that during the period 2000-2011, a fluctuation trend of malaria cases occur in Lakhimpur district. With the help of this trend, we have to determine and represent the direction of change.

The present study shows that all the climatic variables, except humidity, exhibited significant correlation with monthly malaria incidence rate in Boginadi PHC. Similarly, maximum temperature and minimum temperature are found in a significant correlation with MIR in Bihpuria and Dhalpur PHC respectively. Both positive and negative correlation have occurred between climatic variable and MIR. This implies that environmental variables can affect malaria transmission either positively or negatively. Similar correlation was observed by Alemu et al. [2011].But, this finding contradicts the findings in Dehradun, Uttaranchal, India [Devi et al., 2006] and Shuchen County, China [Bi et al., 2003], which concluded that only positive correlation of association occurred between MIR and all climatic variables. Here the correlation coefficient for the association between monthly malaria cases and some climatic factors is found to be greater than other meteorological factors. This indicates that one climatic factor plays greater role in malaria occurrence or transmission than others. This finding complies with the findings found by Alemu et al. [2011] and Huang et al. [2011]. Though, in this Chapter we have observed the impact of climatic variables on malaria transmission by correlation. But by fitting an appropriate regression model, we have obtained better result and predict the pattern of malaria transmission for future.

Here, we also consider two host factors namely sex and age. From our collected data we observe that male is more affected by malaria incidence than female i.e. the incidence of malaria is higher in males than females. Similar report was submitted by National Institute of Malaria Research [NIMR], Das et al. [2007] and Pathak et al. [2012].Males are more frequently exposed to the risk of acquiring malaria than females because of the out-door life they lead. Further, females in India are usually better clothed than males. Among the age groups, the age group 15-39 years was found most affected age group than other age groups. Similarly National Institute of Malaria Research [NIMR] reported that most of the malarial mortality was borne by the economically productive ages (15-54 years). But, different observation had been reported from Sonitpur district of Assam, which suggested that children between 5-14 years were affected more than adults [Das et al., 2007]. To get a significant conclusion about the host factors in our study area, we used Chi-square test for independence of attributes, from which it is revealed that malaria depends on sex and age. Therefore from our study, we suggest that even if the climatic factors play a primary role for transmission of malaria, sex and age are other important risk factors in characterizing malaria incidence in the district.

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