Research Paper Medical Science

# Seasonal Variation in Spread, Morbidity and Mortality of Malaria in an Endemic Area of Bangladesh

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**ABSTRACT**

*A retrospective study was conducted in Cox's Bazar district of Bangladesh collecting all the records of malaria cases from the UHCs (Upazila Health Complex) and district hospital during January 2008 to December 2011. The records of temperature, rainfall and humidity of the corresponding months were collected from the Department of Meteorology, Bangladesh. Humidity and rain fall showed significant association between incidences of all three types of malaria. Linear regression models were consistent in reporting the association. Pearson correlation matrix between weather parameters and malaria during January 2008 – December 2011 showed temporal trends in malaria occurrence.*

**Keywords : Malaria, Cox's Bazaar, Rain fall, humidity**

## INTRODUCTION

Malaria is the most widespread parasitic disease in the world today and a major health burden in many tropical and sub-tropical regions of Africa, the Americas, Eurasia, and Oceania. It is endemic in 106 countries, putting half of the world's population (3.3 billion people) at risk (WHO 2010). In 2009, an estimated 225 million cases of malaria worldwide accounted for approximately 781,000 deaths (WHO 2010). In Bangladesh, malaria is endemic in 13 of the 64 administrative districts (WHO 2010).

In temperate regions, seasonal interruptions and temperature fluctuations provide a perennial source of instability. Climate change is likely to affect the patterns and spread of malaria transmission in different countries, other drivers of the disease include, social economic status of the country, type of vectors available, population immigration and vector dispersal. Africa will continue to carry the greatest burden of the disease and in particular Eastern and Southern Africa (Garnham 1948). In all malaria endemic countries, temporal variation in spreading, morbidity and mortality of malaria should be exhibited. This is also pertinent for Bangladesh. The study was conducted with the aim to determine the pick season of malaria infection along with rain fall, temperature and humidity and period of lower spreading of malaria in Bangladesh.

## MATERIALS and METHODS

All the records of malaria cases of January 2008 to June 2012 were collected from the district hospital and from all 8 upazila hospitals (UHC) of Cox's Bazar district. The data were also collected from the NGO offices operating malaria health care services. Care was taken to prevent duplication of cases from different centre. All cases were confirmed as uncomplicated malaria presumptive (UMP), uncomplicated malaria confirmed (UMC), as well as SM (Severe Malaria) and VM (Vivax Malaria). Neither microscopy nor rapid diagnosis tests (RDT) were performed for UMP, but for the others either microscopy or RDT was used for diagnosis of malaria. All collected data were checked and verified thoroughly to reduce any inconsistency. Then were edited into computer, processed, and were tabulated to get a master sheet.

## RESULTS

During the preceding four years of the study (2008-2011), 530 malaria patients of different types were diagnosed and treated from all the UHCs, NGO offices and district hospital of Cox's Bazaar. Month wise reports of temperature (both maximum and minimum), humidity, rain falls were collected from Bangladesh Meteorological Department. The number of malaria cases was then analyzed with temperature, humidity and rain fall.

**Table 1: Distribution of the malaria cases in upazilas of Cox's Bazar**

| | Statistics | UMC | S.M | V.M |
|---|---|---|---|---|
| Chokoria | Mean | 97.8 | 19.7 | 9.2 |
| | Median | 89.0 | 15.0 | 6.5 |
| Sadar | Mean | 21.1 | 0.0 | 3.5 |
| | Median | 16.5 | 0.0 | 2.0 |
| Maheshkhali | Mean | 4.8 | 1.9 | 1.1 |
| | Median | 5.0 | 1.0 | 0.0 |
| Ramu | Mean | 133.0 | 20.0 | 20.7 |
| | Median | 115.0 | 13.5 | 13.0 |
| Teknaf | Mean | 66.8 | 0.1 | 1.2 |
| | Median | 70.5 | 0.0 | 0.0 |
| Ukhia | Mean | 49.1 | 4.3 | 8.4 |
| | Median | 35.5 | 3.0 | 6.0 |
| Pekua | Mean | 55.3 | 0.2 | 11.8 |
| | Median | 47.0 | 0.0 | 9.0 |
| District Hospital | Mean | 427.9 | 46.3 | 55.9 |
| | Median | 399.5 | 35.5 | 40.5 |

Table 1 shows the summary distribution of malaria cases in upazilas of Cox's Bazaar district. In Cox's Bazaar district mean monthly reported UMC was 428, MS was 46.3 and VM was around 56.

**Table 2: Correlation between weather parameter and malaria occurrence**

| | UMC | | SM. | | VM | |
|---|---|---|---|---|---|---|
| | r | P Value | r | P Value | r | P Value |
| Humidity | .400** | .005 | .475** | .001 | .360* | .012 |
| Max Temperature | -.221 | .131 | -.107 | .469 | -.029 | .844 |
| Min Temperature | .254 | .082 | .331* | .022 | .278 | .056 |
| Rain | .490** | .000 | .362* | .012 | .463** | .001 |
| **. Correlation is significant at the 0.01 level . | | | | | | |
| *. Correlation is significant at the 0.05 level (2-tai). | | | | | | |

**Table 3: Correlation between weather parameter and malaria occurrence between January 2008 – December 2011.**

| Year | r | Humidity | | Tmax | | Min_T | | Rain | |
|---|---|---|---|---|---|---|---|---|---|
| | | p | r | p | R | p | r | p | |
| 2008 | UMC | .641* | .025 | -.141 | .662 | .452 | .140 | .869** | .000 |
| | SM. | -.133 | .679 | -.372 | .234 | -.290 | .361 | -.286 | .368 |
| | VM | .748** | .005 | .249 | .435 | .744** | .006 | .864** | .000 |
| 2009 | UMC | .220 | .493 | -.807** | .002 | -.177 | .583 | .414 | .181 |
| | SM. | .810** | .001 | -.114 | .723 | .591* | .043 | .836** | .001 |
| | VM | -.007 | .983 | -.278 | .382 | -.131 | .684 | .153 | .634 |
| 2010 | UMC | .275 | .387 | -.353 | .260 | .206 | .521 | .557 | .060 |
| | SM. | .686* | .014 | -.100 | .757 | .413 | .182 | .809** | .001 |
| | VM | .712** | .009 | .015 | .964 | .616* | .033 | .640* | .025 |
| 2011 | UMC | .548 | .065 | .000 | .999 | .454 | .138 | .287 | .367 |
| | SM. | .656* | .020 | .171 | .595 | .642* | .025 | .504 | .095 |
| | VM | .580* | .048 | -.170 | .598 | .468 | .125 | .518 | .085 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | | | | | | |
| *. Correlation is significant at the 0.05 level (2-tailed). | | | | | | | | | |

Pearson correlation was drawn through correlation matrix between weather parameters and malaria incidences separately in four years from January 2008 – December 2011 for assessing temporal trends. Humidity and rain fall showed statistically significant association between incidences of all three disease parameters.

**Table 4: Regression model for Malaria occurrence based on climatic parameters**

| Regression model for UMC | | | | | | |
|---|---|---|---|---|---|---|
| Model B | | Unstandardized Coefficients | | Standardized Coefficients | t | p |
| | | Std. Error | Beta | | | |
| | (Constant) | 5.661 | 3.323 | | 1.704 | .096 |
| | LgHum | .785 | 1.177 | .210 | .666 | .509 |
| | LgTmax | -3.375 | 1.553 | -.481 | -2.174 | .035 |
| | LgTmin | .481 | .540 | .335 | .890 | .379 |
| | LgRain | .003 | .028 | .021 | .097 | .923 |

| Regression model for SM | | | | | | |
|---|---|---|---|---|---|---|
| Model B | | Unstandardized Coefficients | | Standardized Coefficients | t | P |
| | | Std. Error | Beta | | | |
| | (Constant) | -8.198 | 9.783 | | -.838 | .407 |
| | LgHum | 7.489 | 3.466 | .652 | 2.161 | .036 |
| | LgTmax | -1.433 | 4.572 | -.067 | -.313 | .755 |
| | LgTmin | -1.914 | 1.591 | -.434 | -1.203 | .236 |
| | LgRain | .093 | .083 | .233 | 1.128 | .266 |

| Regression model for SM | | | | | | |
|---|---|---|---|---|---|---|
| M I B | | Unstandardized Coefficients | | Standardized Coefficients | t | p |
| | | Std. Error | Beta | | | |
| 1 | (Constant) | 1.895 | 5.925 | | .320 | .751 |
| | LgHum | 2.173 | 2.099 | .340 | 1.035 | .306 |
| | LgTmax | -3.258 | 2.769 | -.272 | -1.177 | .246 |
| | LgTmin | .522 | .964 | .213 | .542 | .591 |
| | LgRain | -.014 | .050 | -.062 | -.274 | .786 |
| a. Dependent Variable: LgVM | | | | | | |

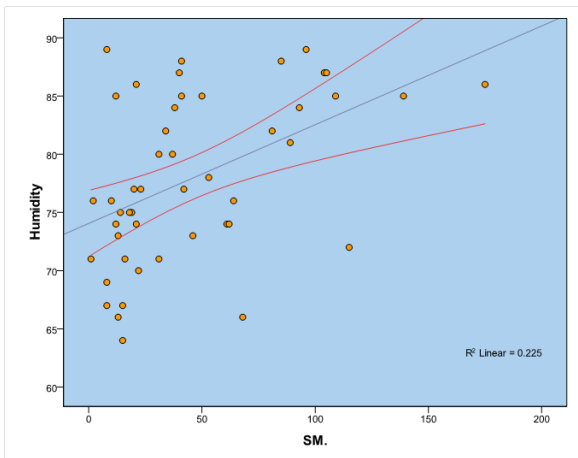


**Figure 3: Scatter plot showing correlation between humidity and UMC.**

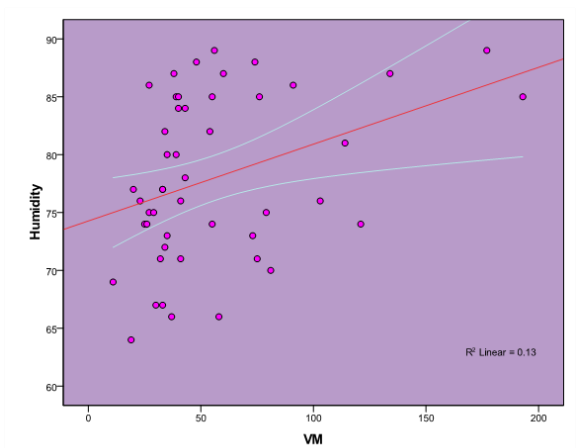


**Figure 4: Scatter plot showing correlation between humidity and SM.**

## DISCUSSION

Humidity and rain fall showed statistically significant association between incidences of all three types of malaria. Linear regression models were consistent in reporting the

association. Pearson correlation matrix between weather parameters and malaria during 2008 – 2011 showed temporal trends in malaria occurrence. The relationship between climate parameter and malaria occurrences were examined in this study. This study showed that the highest geometric mean parasite density was observed in midyear to august. The month prior to these is known as a period of sudden mosquito population outburst due to frequent rainfall with fairly long periods of sunshine which increase the opportunity for mosquitoes' prolific breeding. Findings of this study are valuable contributions to an already existing pool of baseline data. It could guide in designing of control programs that are locally adapted and technically/financially feasible such as Malaria Early Warnings Systems which is extremely relevant where malaria transmission is unstable. Indicators such as temperature, humidity and rainfall, Pearson correlation matrix between weather parameters and malaria during 2008 – 2011 showed temporal trends in malaria occurrence. Humidity and rain fall showed statistically significant association between incidences of all three disease parameters adjusted got other related parameters. Linear regression models were consistent in reporting the association.

The outcome of this study agrees with the results of the earlier studies by Thomson and Ayanlade that the seasonality of climate greatly influences the seasonality of malaria transmission (Thomson et al., 2005). This study has further confirmed that malaria parasitemia in the Sahel varies with a clear seasonal pattern in climate. This is in agreement with Pull (Pull et al., 1976) and Molta *et al* (1995) that the relatively dry area demonstrates strong seasonality in malaria transmission.

Oguche (2001) further demonstrated this strong seasonality in a study with cerebral malaria of the pattern of childhood cerebral malaria in northeastern Nigeria. Ninety-five percent of the patients presented between June and November had malaria with a peak in October. In Africa studies reported that that seasonal fluctuations in rainfall affects the occurrence of malaria. Molta (1995) observed that the monthly figures of malaria among in-patients in the Sahel showed seasonal fluctuations and that low values are characteristic of the dry season and high values are of the rainy season.

Malaria remains the world's most important tropical parasitic disease, and one of the major public health challenges in the poorest countries of the world, particularly in sub-Saharan Africa. With the new move towards malaria eradication and the scaling-up of malaria control interventions, there is a renewed energy and drive to maximize the impact of control tools in each epidemiological context. Where malaria transmission is seasonal, optimal timing of control becomes particularly important. Most malaria endemic settings have "seasonal peaks" of malaria cases, which are usually described in terms of the duration and timing of the rains during a given study period. However, this may vary from year-to-year, giving a variety of subjective descriptions of seasonality for a single site.

To date, several attempts have been made to describe the seasonality of malaria endemic areas. More recently, a different approach to define seasonality was carried out by Mabaso and others who aimed to predict seasonality from environmental covariates. They defined a seasonality concentration index to model the relationship between environmental covariates and seasonality in malaria incidence and EIR data (Mabaso et al., 2007). The authors reported that sites tended to show stronger seasonality of clinical malaria in all-year round transmission settings than in areas with shorter duration of malaria transmission, but no investigation was made on variations between years to look at consistency of findings (Mabaso et al., 2005). To develop robust definitions, several years of data from each place are needed as there are annual variations, both in rainy seasons and in the intensity and timing of peaks in malaria.

Few discrepancies found between the concentrated period of malaria and the rainy season corresponded to those sites reporting two peaks of rain. A better fit was usually observed between the concentrated period of malaria and the rainy season in sites where the source of information on the rainy season was the paper that reported the monthly malaria data. This is likely to be due to year-to-year variation in the onset of the rainy season, resulting in a better fit when the onset of the rainy season is matched to the period of data collection.

With the rapid scaling up of malaria control interventions, continued surveillance is needed to monitor changes in transmission intensity levels and in the burden of malaria disease. Several authors have already reported a drop in hospital malaria admissions after analyzing several years of surveillance data (Ceesay et al., 2008). Further work is needed however to assess whether changes in seasonality may occur with declining transmission intensity in areas of perennial transmission. Although results from these analyses are encouraging for assessing seasonal variation, in practice there is little reliable monthly data on clinical and severe malaria, questioning its utility on a wide scale.

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Linear regression models were generated to assess possible relation of uncomplicated malaria confirmed (UMC), as well as SM and VM (vivax malaria) with weather parameters. Maximum temperature is found to be associated with UMC incidence and, Humidity is found to be associated with Humidity.

**Figure 1: seasonal pattern of weather parameters.**

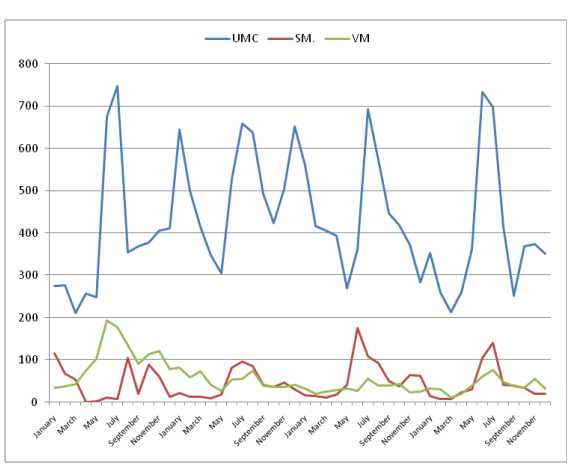


Figure shows the distribution of average monthly weather parameters of Cox's Bazaar district from the Department of Meteorology from January 2008 – December 2011.

**Figure 2: seasonal pattern of Malaria cases.**
Figure shows the distribution of average monthly reporting of UMC, SM and VM of Cox's Bazar district from the department of meteorology from January 2008 – December 2011.

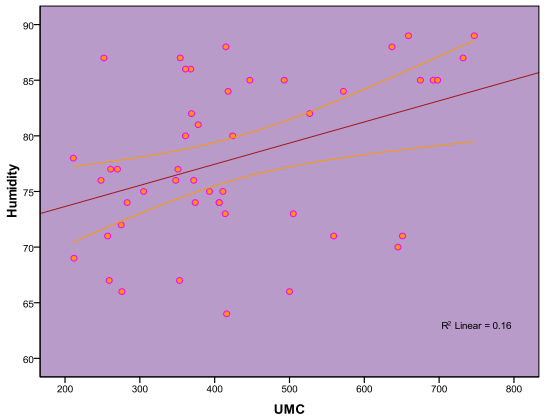


Figure shows the distribution of average monthly reporting of UMC, SM and VM of Cox's Bazar district from the department of meteorology from January 2008 – December 2011.

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