Original Paper

Effects of Climate on Sandflies and Leishmaniasis in Endemic Areas of Bangladesh

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Abstract

Introduction: Kala-azar is a climate-sensitive disease, a public health problem and historically endemic in Bangladesh, nurtured in temperatures ranging from 7 to 37°C, with relative humidity above 70%. Longevity and survival of vector of Kala-azar has been geographically controlled by the climate which is hard to manoeuver.

Objective: To observe the relationship of climate and its effects on the development of sandflies and Leishmaniasis in the endemic areas in Bangladesh.

Materials and Methods: This cross-sectional study was conducted at the endemic areas of, Bangladesh during the period of 2014-2017. Information on climate like rainfall, humidity and temperature were collected from local respective Upazilla Live Stock Office and Bangladesh Meteorological Department, Agargaon, Dhaka. Month wise data of Kala-azar cases were collected from Directorate General of Health Services.

Results: Temperature, rainfall and humidity are important for survivability and activity of sandfly as well as leishmaniasis. Mean temperature at the study areas was found at around 20°C in the month of January, February, November and December. Round the year the maximum and minimum temperature was maintained at neither too high nor too low (between 7 to 36.5°C). Annual average humidity of these study area was found over 70%. In the study areas maximum rainfall 300 to 500 mm was from May to September where peak was in June to September. Annual average rainfall was recorded 1434 to 1584 mm at Pabna and 2084 to 2182 mm at Mymensingh. Study findings correlated that rainfall may or may not have effects with sandfly and leishmaniasis. This study depicted distinct peaks of Leishmaniasis seen in pre monsoon February, monsoon September and post monsoon November period which dictated the plethora of sandfly from June to October and also from January to February.

Conclusion: Manoeuvring the climate is difficult and it does not change each year, it will play its own role. We can manoeuver the harbour and the vector of leishmaniasis. Within this climatic condition National Kala-azar Elimination Programme has been fighting since 2008 but Kala-azar has not come to Zero. Further resurgence can it be outweigh?

Key-words: Climate, Endemic areas, Leishmaniasis, Sandflies

Introduction

Less often addressed is how climate change will affect developing countries and specifically the public health of those countries. India is already expressing concern about rapid melting of the Himalayan glacier[1] which are expected to reduce to 80% by the year 2035. Malaria vectors, if the overall temperature were to rise as predicted, their habitat may be reduced, leading to a possible decrease with climate change. But in case of Visceral leishmaniasis (VL), it is in turn expected to favour and may result increasing cases of VL in Bangladesh[1]. Climate change has already established its impression through various extreme climatic events around the world[2]. Climate change is a reality and no longer a future concern, and our mother climate has undergone an abnormal human induced change, various climatic parameters such as rainfall, temperature, humidity, sunshine hour etc. of various regions of the world have shown significant trends[3].

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Ericksenet al[4] reported that since climate change is a dynamic phenomenon, changes will occur over time, and implications will only be understood in future[4,5]. VL commonly known as Kala-azar was prevailing in Bangladesh[6] as one of the public health problem up to late 1950. The disease almost disappeared due to the effect of DDT spraying on the sandfly vector in early 1960. Historically Kala-azar is endemic in Bangladesh. In the sixties and very early seventies DDT spraying under the malaria eradication programme successfully controlled VL transmission in Bangladesh, in the late 1970s, Kala-azar reappeared in Bangladesh sporadically, since then Kala-azar cases have been increasing and from 8 upazilla reporting Kala-azar during 1981-85 period[7]. Between 1968 and 1980, only 59 cases were reported in the country[8]. But since the 1980s, following the suppression of DDT spraying, there has been a resurgence of VL, with 73,467 cases reported[9] between 1994 and 2004. At present, Kala-azar cases have been reported from 139 upazillas in 45 districts of Bangladesh. More than half of total cases (54%) are from Mymensingh districts. Another 3 districts Pabna, Tangail and Jamalpur will add 25% cases[10]. Kala-azar is a climate-sensitive disease basically due to preferred breeding of sandfly vectors in alluvial soil with high sub-soil water table, in temperatures ranging from 7 to 37°C, and Relative Humidity (RH) above 70%[5]. Thomson et al[11] have found that mean annual maximum temperature and soil type were the determining factors for distribution. The longevity and survival of vector populations of Kala-azar has been geographically controlled by the climate (temperature, relative humidity, saturation deficiency, and rainfall), soil types and soil moisture[12]. As climate-related changes in life-cycle dynamics of pathogens (Leishmania) may increase or decrease the potential rate of transmission of disease[13]. The rises in temperature in day time and humidity level during night time have greatly influenced the growth of flies and the distribution of Leishmaniasis[14]. As such this study had been undertaken to see the relationship between climate and its impact on Leishmaniasis (Kala-azar) and human health in the endemic areas in Bangladesh.

Materials and Methods

This descriptive cross sectional study was conducted at the endemic areas of Trishal, Fulbaria of Mymensingh and Chatmohor upazilla of Pabna district during the period covering January 2014 to December 2017. Locally month wise temperature information of the study area Trishal, Fulbaria and Chatmohor were collected from temperature record register (Max Min Thermometer) of respective Upazilla Livestock Offices (ULO). Besides, information on climate variables rainfall, humidity and temperature were collected from Bangladesh Meteorological Department, Climate Division, Agargaon, Dhaka but only rainfall and humidity were used in this study. Climate variables of Mymensingh were utilized for Trishal and Fulbaria and that of Ishwardi were used for Chatmohor, Pabna.The climate variables of Mymensingh is almost similar to that of study area but the temperature of Ishwardi, Pabna during summer is higher than other places nearby, as such, locally collected temperature was used. Since Meteorological department has its office at Ishwardi so rainfall and humidity data were used in this study. Ishwardi and Chatmohor is around 40 Kilometer apart, so it is usual having variation in temperature. The month wise data of Kala-azar cases of 2014, 2015 and 2016 were collected from Directorate General of Health Services, Dhaka and it was compared with the climate variables. Data were analysed with Microsoft Excel programme.

Results

The local temperature of Chatmohor Pabna, Fulbaria, Trishal, Mymensingh were almost similar in 2015 and 2016 though Mymensingh enjoys a little lower temperature. The temperature was collected from respective ULO. The highest temperature (36°C-36.°C5) noted in Pabna Chatmohor was almost same in the month of May in both 2015 and 2016. Highest temperature (35.5°C-36°C) found in Fulbaria, Mymensingh was noted in Aug/Sep in 2015 and 2016. In Trishal Mymensingh highest temp 36°C was found in May 2015 and in 2016 in August. In both district the temp gradually rises from March (33°C-34°C) to October (33°C-35°C) with highest in May 36°C to 36.5°C in Chatmohor, 35.5°C to 36°C in Aug/Sep in Fulbaria Mymensingh and 35°C to 36°C in Trishal from April to September. In case of minimum temp it varies from 8°C-24.6°C in Fulbaria, Mymensingh, 7.5°C to 24.5°C in Trishal, Mymensingh and 7°C-25.5°C in Pabna Chatmohor. For Chatmohor in 2015, the minimum most temperature was 7°C in January and 25°C in August. In 2016 minimum most temperature was 7.6°C in January and 25.5°C in July and August. For Mymensingh Fulbaria in 2015 the minimum most temp was 9°C in Jan and 24.6°C in Aug and in Trishal the minimum most temp was 7.5°C in Jan 2015 and 8°C in January 2016.

It was also found that the minimum temperature of Chatmohor, Pabna and Fulbaria, Mymensingh and Trishal, Mymensingh followed almost the same line on graph. Minimum temp ranges from 7°C to 9°C in Jan with the peak of 25.5°C in July, August and September. Regarding maximum temperature in Chatmohor, Fulbaria and Trishal it was 23°C to 25°C in January and in Dec it was 25°C-27°C with the peak of 36.5°C in May and 36°C in August. From January to May temperature took an increasing curve upto May but during monsoon due to rainfall weather gets cool and does not take increasing curve rather keep almost static within 34°C to 36°C. And from September it took downward curve to

8°C-9°C in Dec. Overall the temperature varies from 7°C to 36.5°C in these three Upozillas and the graph follows the same line in its Maximum and Minimum temp.

Table-I: Climate variables of Chatmohor, Pabna

Months	Max Temp °C		Min Temp°C		Rainfall mm		Humidity %	
	2015	2016	2015	2016	2015	2016	2015	2016
January	25	23	7	7.6	0	30	58	56
February	30.5	28	8	10.2	8	12	77	77
March	34	33.6	13	14	38	91	75	79
April	34.5	35.5	18	18	111	90	75	70
May	36	36.5	20.5	21.5	147	213	77	77
June	35	35.8	23	23.5	332	137	82	82
July	35.5	35.3	24.5	25.5	394	284	85	85
August	34	34	25	25.5	254	294	79	82
September	34.5	34	24.5	25	213	188	82	79
October	34	33.5	18	19	82	82	68	68
November	30	29	15	16	3	10	65	62
December	27	25.8	8.5	7.7	2	3	69	65

Source: Temp collected from ULO office, Rainfall Humidity from Meteorological, Dept Dhaka

From Table-I it is evident that the temperature of 2015 and 2016 was almost similar and Max temp ranged 23°C to 36.5°C but highest was in May 36°C to 36.5°C. Regarding Minimum temperature it ranged from 7°C to 25.5°C and highest was 25.5°C in Jul/Aug. Overall temperature varies within 7°C to 36.5°C. Total rainfall in 2015 was 1584 mm and in 2016 was 1434 mm almost same. The pattern of rainfall was in Jan, Feb it was near to nil and from March it increased gradually Maximum rain was from May to Sep and peak was in Jun, Jul, Aug from 300 to 400 mm. Again from from Sep it decreased gradually and in Nov Dec it comes almost no rain. So Monsoon rain actually becomes remarkable from March to Oct. Humidity in Chatmohor keeps low in Jan but from Feb to Oct it increases gradually and takes peak in Jun, Jul, Aug, Sep upto 85%. In Nov Dec it remains low around 62% to 69%. And the average annual humidity was 73%.

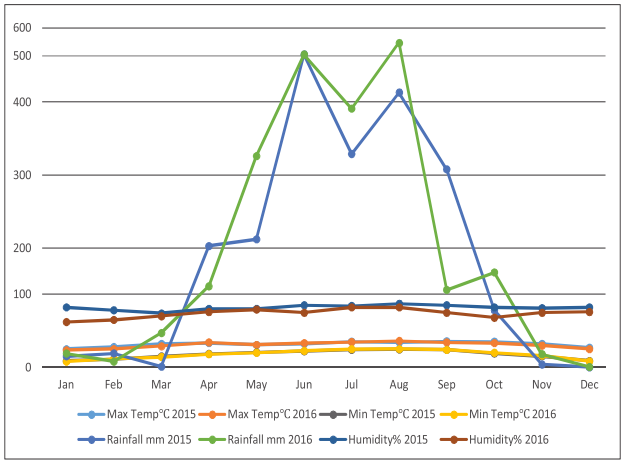

Fig-1: Climate variables of Fulbaria

Source: National surveillance data DGHS and other sources

Figure-I, it is evident that in Fulbaria the temperature of 2015 and 2016 was almost similar and Max temp ranged 23.5°C to 36°C but highest was in Jul, Aug, Sep varied from 35°C to 36°C. Regarding Min temperature it ranged from 8°C to 25°C and highest was 25°C in Aug. Overall temperature varies within 8°C to 36°C. Total rainfall in 2015 was 2084 mm and in 2016 was 2182 mm almost same, but more than Chatmohor, Pabna. The pattern of rainfall in January, February and March was near to nil from March it increased gradually and maximum rain was from May to Sep where peak was in Jun to Sep from 300 to 500 mm. Again from Sep it decreased gradually and in Nov Dec it comes almost no rain. So monsoon rain actually becomes remarkable from Jun to Oct. Humidity in Fulbaria in 2015 and 2016 was almost kept high round the year of which in 2015 it was high from 74% to 87% with the highest in April to Oct and in 2016 it was a bit low comparing with 2015 and ranged from 62 to 87% with highest in Jun to Sep, low in Jan but from Feb to Oct it increases gradually and takes peak in Jun, Jul, Aug up to 87%. In Nov Dec it remains low around 62%. Average humidity was 76%.

Table-II: Climate variables of Trishal, Mymensingh

Months	Max Temp°C		Min Temp°C		Rainfall mm		Humidity%	
	2015	2016	2015	2016	2015	2016	2015	2016
January	24	25	7.5	8	15	19	82	72
February	29	28	8	12	19	8	78	68
March	33.5	30	14	13	1	47	74	70
April	35	34	16.5	18	203	111	80	82
May	36	33.5	20.5	20	212	326	80	79
June	35	34	22	23	502	502	85	80
July	34.5	34	25	24.5	329	391	84	82
August	35	36	24	24.5	413	518	87	82
September	35.5	34.6	24.5	23	308	106	85	75
October	34	33	19	18.5	78	130	82	68
November	29	30	18.5	15	4	18	81	75
December	26	26	9	8	0	0.6	82	76

Source: National surveillance data DGHS and other sources

From table-II it is evident that in Trishal the temperature of 2015 and 2016 was almost similar and Max temp ranged between 24°C to 36°C but highest was in May to Aug and varied from 35°C to 36°C. Regarding Min temperature it ranged from 7.5°C to 25°C and highest was 25°C in Jul. Overall temperature varies within 7.5°C to 36°C. Total rainfall in 2015 was 2084 mm and in 2016 was 2182 mm same in greater Mymensingh area, but more than Chatmohor, Pabna. The pattern of rainfall in Jan, Feb and Mar it was near to nil from March it increase gradually and maximum rain was from May to Sep, where peak was in Jun to Sep from 300 to 500 mm. Again from Sep it decrease gradually and in Nov Dec it comes almost no rain. So monsoon rain actually becomes remarkable from April to Oct. Humidity in Trishal in 2015 and 2016 was almost kept high round the year of which in 2015 it was high from 74% to 87% with the highest in Jun to Oct and in 2016 it was a bit low comparing with 2015 and ranged from 42% to 82% with highest in Jun to Sep.

Humidity was found low in Jan but from Feb to Oct it increases gradually and takes peak in Jun, Jul, Aug up to 85. In Nov Dec it remains low around 50%. And average humidity was 75%

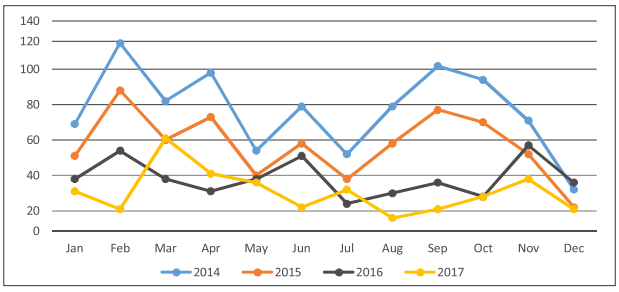

Fig-II: Month wise Kala-azar cases

Source: National surveillance data DGHS

From Fig – II it is delineated that Kala-azar actually prevails all around the year and have seasonal variations. In pre-monsoon season Kala-azar cases seemed to be more and its peak in Feb and March where from gradually it goes down upto Jul, thereafter it again goes up and reach to its peak in Sep and Nov from 21 to 106 cases; thereafter further goes down in Dec to 21 to 32 cases. A peak is also noticed in Jun from 22 to 79 cases. The graphs of 2014 and 2015 are strangely alike but of 2016 and 2017 has been a bit disfigured though main features were near alike which may be due to the elimination programme. From Jul/Aug Kala-azar cases gradually increase to a peak in Sep and Nov in post monsoon time.

From Table – I, Fig- II, Table - II and Fig - III, it is clear that rain starts from Mar, April to Oct , Nov and reach upto 300 to 500 mm and thereafter decreases gradually in the month of Oct Nov. In the rainy season from March April Kala-azar decreases to 24 to 52 cases and from July it increases upto a peak of 21 to 106 cases in Sep thereafter it starts decreasing up to 21 to 32 cases in Dec. So from these graph it can be seen that at initial part of rainy season incidence of kala-azar decreases and at the later part of rainy season, the incidence of Kala-azar increases.

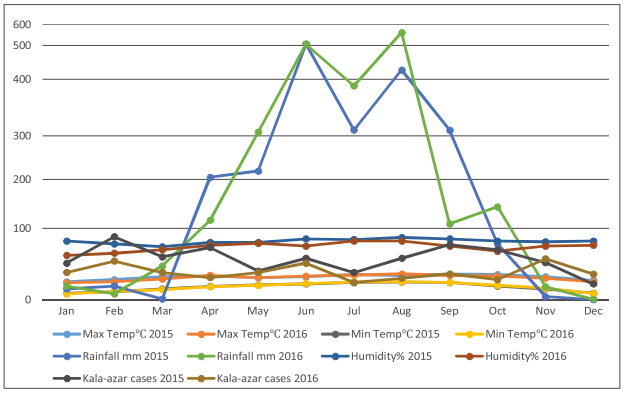

Fig-III: Climate variables and Kala-azar cases of Fulbaria

Discussion

Climate variables Temperature, Rainfall and Humidity are important for sandfly development, breeding activity and epidemiology of leishmaniasis. Temperature affects the bleeding activity and growths of parasite. The worldwide distribution of sandflies is considered to be confined to areas that have at least one month with a mean temperature of 20°C [5,14]. In this study the mean temp at Chatmohor, Trishal and Fulbaria in Jan, Feb and Nov, Dec was found almost at around 20°C, suitable for sandfly bleeding (Fig-I, Table-I, Fig-II, Table-II).

Kala-azar is a climate-sensitive disease occuring during the period when temperatures ranges from 7 to 37°C and Relative Humidity (RH) above 70%[5]. The vector of VL (sandfly) has been found abundantly in the months between June and September; with *P. argentipes* most active profusion when the temperature is ranged between 27.5°C and 31°C[15].The predictive climate model for leishmaniasis shows the best fit with average annual mean temperature (15°C-30°C), annual rainfall (274 mm-1212 mm) for *P. martini* and average annual rainfall (I80mm-1050 mm), annual mean temperature (16°C-36°C), both for *P. orientalis* and *P. papatasi*[16]. It is obvious from this study that in three study Upozillas round the year the temp is keeping 7 to 36.5°C and is very favourable for sandfly breeding and leishmaniasis (Fig-I, Table-I, Fig-II, Table-II). In this study, the annual average humidity of three study area Trshal, Fulbaria and Chatmohor keeps over 70% that is suitable for sandfly and leishmaniasis.

In a study by Amin et al, it was found that in Mymensingh and Pabna, annual average maximum and minimum temp was negatively correlated but positively correlated with rainfall and humidity for sandfly and leishmaniasis[5,17]. In this study it was quite evident that round the year the maximum and minimum temp was maintained at not to high nor to low (7 to 36.5°C) which was favourable for sandfly and leishmaniasis. Also the difference between maximum and minimum temp was not that big and almost steady round the year. Regarding association with rainfall it was assumed from this study, upto July Kala-azar cases were decreasing and after July up to Oct it was increasing (Fig – I, Table – II, Fig II, Fig – IV). Rainfall may or may not have correlation with sandfly and leishmaniasis.

Orshan L in their study found, a few specimens were trapped in winter (January–March) close to rock crevices. Sandfly numbers were relatively low in the spring (April) and late autumn (November and December) where 30–100 specimens collected per trap. From May to July and October, there were >250 specimens, including per trap. The highest densities were in August and September (>600 specimens per trap)[18]. In this study there were distinct peaks of Kala-azar seen in pre monsoon Feb, monsoon Sep and post monsoon Nov period which dictated the plethora of sandfly from Jun to Oct and also from Jan to Feb as Kala-azar cases were found high in these

period. In another study in Thailand, the sandflies were most abundant late in the hot season and early in the rainy season (April to June), with a marked population increase between two rainfall peaks. The highest number of sandflies was collected in June[19]. In the same study at Thailand, the temperature range was 27 to 29 °C with 65 to 85% humidity favourable for sandfly which is consistent with this study.

Conclusion

It is hard to manoeuvre the climate and it does not change each year, it will play its own role. We can manoeuver the harbour and the vector of leishmaniasis. Historically Kala-azar is endemic in Bangladesh and is still uncertain whether it can be eliminated to the root or not. Between 1968 and 1980, only 59 Kala-azar cases were reported in this country and was due to massive anti-malarial DDT spraying. Not many years after, this Kala-azar resurged and National Kala-azar Elimination Programme has been fighting since 2008 but has not come to zero. Further resurgence of leishmaniasis will not happen that is expected. In the terrain there are so many inaccessible places in endemic areas where sending the elimination measure becomes impossible. Scientist's apprehension, Himalayan glacier expected to reduce to 80% by 2035 which may lead to rise up of temp may be suitable for leishmaniasis. This study recommends relentless and continuous strive and research till Kala-azar ends, otherwise it will flare again.

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