ORIGINAL ARTICLE

COMPARATIVE STUDY OF CLIMATE RELATED TARGET DISEASESIN THE COASTAL AND PLAIN AREA OF SOUTHERN BANGLADESH

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ABSTRACT

Climate change affects human health by altering the proliferation and distribution of pathogen, vectors and allergen. The objective of this study was toestimate the magnitude of climate related diseases in coastal areas in contrast to the plain area and also to determine their relationship with environmental factors.Thisprospective cross sectional study was conducted in southern part of Bangladesh from April 2012 to March 2013. Two Upazilla for this study were Dakope in coastal area and Terokhada in plain area. Patients of all ages attending the Upazilla Health Complex (UHC) with target diseases were enrolled. Nine target diseases were: water borne (diarrhea, typhoid, viral hepatitis); vector borne (malaria, kalazar, dengue) and systemic diseases (asthma, hypertension, arsenicosis). Target diseases were observed in 1042 patients in Dakope and 1296 cases in Terokhada. Diseases were lowest (20%) in monsoon and highest in winter (42%). Large bulk of patients (31-32%) in both areas were young adult (16-30 years). Diarrhoea was highest (49-53%) in frequency in both areas. A few case of dengue (1%) in Dakope and kala-azar (2%) in Terokhada was found. Hypertension (19% Vs 13%) in Dakope and asthma (11% Vs 16%) in Terokhada was more frequent. Diarrhoea, was significantly higher ($p<0.001$) in patients with pond water consumption. Bushes/ditches (47%) were more prevalent in dengue prone area and cattleshed/poultry (55%) in kala-azar affected area. Diarrhoea, dengue and hypertension were more frequent in coastal area, conversely kala-azar, asthma was more common in plain area. Water consumption, environment and economy had significant influences over them.

***Key words**: Climate related disease, Water borne, Vector borne, Coastal area, Plain area, Bangladesh*

INTRODUCTION

WHO estimates that 25% of global disease burden including more than one third of children is related to environmental factors.[1] In an attempt to quantify the risk of premature morbidity and mortality in 2000, WHO had shown that, climate change has caused a loss of 1,60,000 lives annually.[2]Intergovernmental Panel on Climate Changes (IPCC) in 2007 had shown some evidence favouring effect on human health due to climate changes such as altered distribution of infectious disease vectors, altered distribution of allergenic pollens and increased heat wave related death.[3] More than half of world population lives within 60 km of the sea andmost vulnerable regions are Nile delta in Egypt, Ganga-Brahmaputra delta in Bangladesh and small islands like Maldives.[4-6]

Climate change affects human health both directlyand indirectly. The direct effect causes through increase in frequency, intensity and duration of extreme weather events. Indirect effect occurs through changes in water, air, food, agriculture and economy.[5]Climate change can influence the seasonal pattern of vector, water and food borne diseases - malaria, kala-azar, dengue and cholera.[7] It also disrupts the relationship between predator and prey that prevents the proliferations of pests and pathogen.[8] Outbreaks of diarrhoeal diseases are intimately associated with heavy rainfall and increased temperature.[9-11]The burden of allergic diseases has increased in developed countries in the last two decades and the increase in prevalence of asthma may be an early indicator of climate change.[12]Sea level rise is linked with increased salinity of drinking water in coastal area which is a potential threat for developing hypertension.[5] The large scale withdrawal of ground water in dry season for irrigation has increased the threat for arsenic contamination.[13]

According to Global Climate Risk Index 2009 of German Watch, Bangladesh is the topmost vulnerable country in the world.[14,15]High population density (950 people/square kilometer), low percapita income (US$1400/year), inadequate nutritionand sanitary condition, as well as low lying topography increases its vulnerability.[16] Those in the lowest socioeconomic strata and children will suffer the most.[17]More than 95% drinking water in Bangladesh comes from ground water and presence of toxic pesticide is potentially dangerous to human health.[18]Children are particularly vulnerable to health impact of climate change because of their potential greater exposure to changing temperature, more sensitivity to certain exposure and dependence on caregivers.[19]

The primary solutions to the resurgence of climate related diseases include improved surveillance for climatic health hazards and education of public for taking appropriate preparation.[20,21]It is necessary to undertake scientific research to confirm the relevant findings and to build institutional capacity to handle the adverse consequences of climate change which will take the highest toll in coastal population. [22-24]Sothis study was initiated to

quantify the magnitude of the target diseases in coastal area in contrast to plain area which will eventually help as a baseline data to comparewith the changing scenario in the coming years and also determine the relationship of diseases with the environmental factors.

PATIENTS AND METHODS

Design

A prospective cross sectional descriptive study for a period of one year was done to estimate the magnitude of the target diseases both in children and adult. After an interview with the panel of expert for grant selection, plan of retrospective data collection was abandoned for poor data record. It was modified to a prospective study for theprevalence of target disease with the expectation of developing primary data base for further study afterwards. Research grant for the study was approved by Ministry of Science, Government of Bangladesh (No. 2011-274/13)

Population and Climate

Total population of Khulna district **is** scattered in 14 upazilla with 10 in the plain area and 4 in the coastal area. Due to time and resource constraint, only one upazilla from each group wasselected as a sample. One Upazilla (Dakope) was on the seacoast, adjacent to Sundarban and60-70 kilometers away from Khulna Medical College Hospital (KMCH). Another Upazilla (Terokahada) was on plain area, furthest from sea and 10-20 kilometerson the opposite way from KMCH. Data for climate change was collected from meteorology department and limited to four indicators- average temperature, average rainfall, sea level and extremes of weather (Tornado, Flood, Tidal surge).

Procedure

The research team, at the start, went to the two upazilla (Dakope and Terokhada) to ascertain the feasibility of the study and to select the appropriate doctors, interested in this study for one year extending from April 2012 to March 2013.Upazilla Health Complex (UHC) is the only health care centre and catches most of the patients in the Upazilla. All the patients attending the out-patient department (OPD) of two UHC were taken into account. Three doctors (Field Investigator) from each UHC were recruited for data recording which would be sent to the research centre at the end of each month. The preliminary form was pre-tested in the two upazilla for its completeness and relevance. The comments of the field investigators after pretest were reviewed by the research team in KMCH and the final record form was developed.

The target diseases were water borne diseases (diarrhoea, enteric fever, viral hepatitis); vector borne diseases (malaria, kala-azar, dengue) and systemic diseases (asthma, hypertension, arsenicosis). Diagnosis was mostly clinical except some minor investigations like widal test, rapid antigen test and x-ray chest. Data for patients was limited to 9 target diseases on age, sex, residence, economy, environment and outcome. Monthly family income of 125-250 dollars was taken as middle class and figure above and below it was taken as rich and poor.After each month, the designated messenger collected the forms and submitted those to the chief investigator in KMCH. The research teamreviewed the data sheet for its reliability and completeness and gave appropriate feed back to the field investigator over telephone. The research team from KMCH,visited the two UHC every 3 months for direct observation of the disease pattern and discussed it with the local physicians there to validate the information in the data forms. They have also noticed the potential environmental factors which can modify the disease pattern in the long run.

Data analysis

All data in the proforma were rechecked by co-investigators to clean the redundant information, to ensure homogeneity and to fill up missing data after discussion with field investigators. Thereafter, data was coded and enteredintoSPSS-14 for analysis. Student T test was performed for normally distributed continuous variable and chi square test was done for categorical variable. Statistical significance was considered at the 5% probability level.

Ethical implications

This study neither causes any physical disturbance nor ithurts any confidentiality. However ethical clearance wasapproved by Thana Health Administrator of two UHC and also from the Ethical Review Committee of the Khulna Medical College Hospital.

RESULTS

Total population of Dakope Upazilla in coastal area is1,58,908 and that in Terokahada Upazilla is 1,26,514. Hospital attendance in Dakope (25,488) was less than that of Terokhada (49,965) in one year. Nine target diseases were observed in 1042 patients in Dakope and the figure was 1296 in Terokhada. Average temperature (^{0}C) of Khulna division in 2012-13 varied from winter (15) to summer (35) and monsoon (27). Similarly average rainfall (mm/month) increased from Winter (10) to Summer (73) and monsoon (327).[25] The linear mean sea level rise in the Bay of Bengal in 2012-13 was 1.45 mm/year.[26] Extremes of weather were not noticed during the study period.

Little seasonal variation (31-35%) of target disease was noticed in coastal area (Figure-1). However it was distinctly different in plain area being lowest (20%) in monsoon (July-October) and highest (42%) in winter (November-

February). Seasonal variation, when compared between two areas, was significantly different ($p<0.001$). Age distributions of the patients were nearly similar in both UHC (Figure-2). Most of the patients (31-32%) belonged to young adult group (16-30 years). Female patients (52-55%) were more than male in both the areas.Hindu patients were four times higher in Dakope (36%) than that in Terokhada.

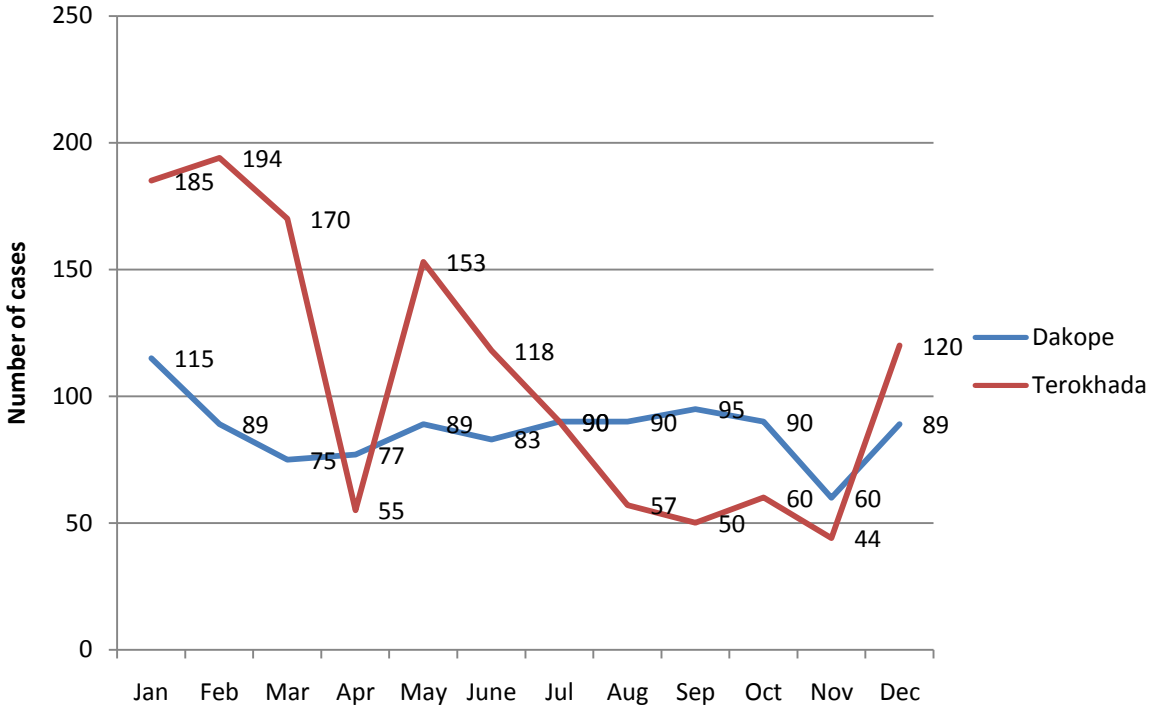

Figure 1 Month wise distribution of patients

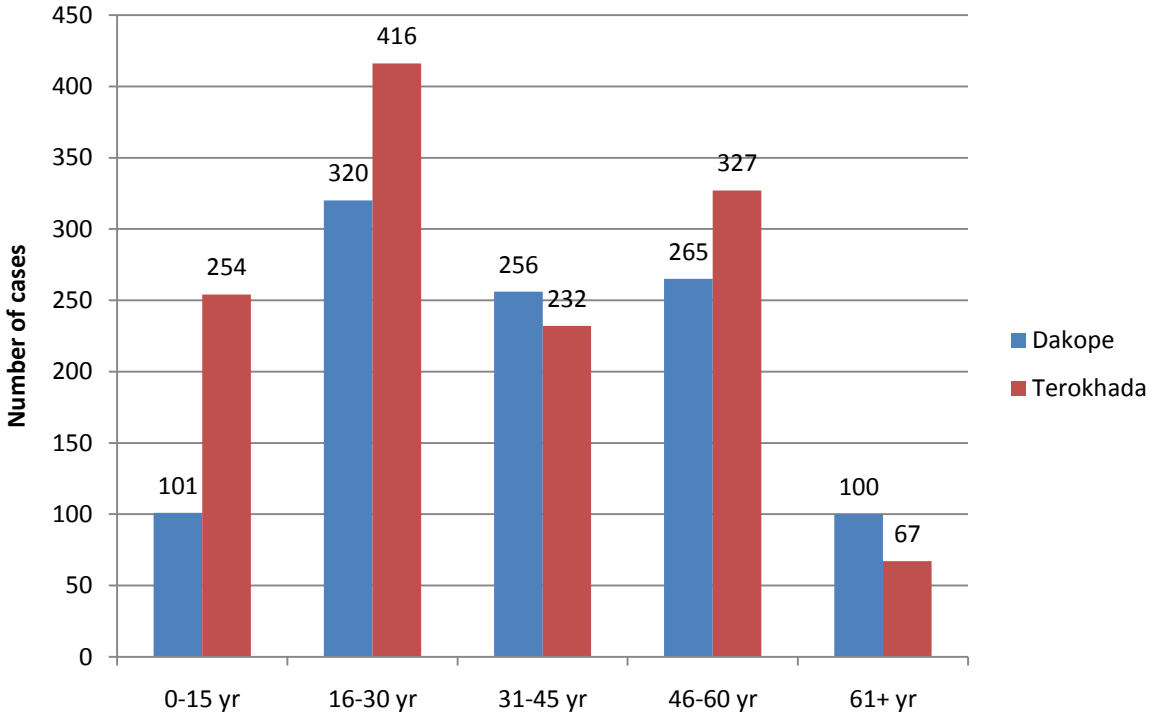

Figure 2 Patient distribution on age group

Among the target diseases, diarrhoea was most common and nearly similar (49% Vs53%), but typhoid prevalence was little higher in Dakope (19% Vs 12%) (Table-I). No case of malaria was diagnosed in anyarea. A few case of dengue (1%) was found in Dakope, whereas a number of Kalazar (2%) was found in Terokhada. Asthma and hypertension was fairly common but hypertension (19% Vs 13%) was more common in Dakope and reverse picture was seen for asthma (11%Vs 16%) in Terokhada. Arsenicosis (1%) was found in Terokhada only.

Table 1 Disease pattern of study population

Disease	Coastal area		Plain area	
	Number	Percentage	Number	Percentage
Diarrhoea	515	49.4	684	52.8
Typhoid	194	18.6	161	12.4
Hepatitis	12	1.2	23	1.8
Malaria	0	0.0	0	0.0
Kala-azar	0	0.0	31	2.4
Dengue	15	1.4	0	0.0
Asthma	111	10.7	213	16.4
Hypertension	195	18.7	172	13.3
Arsenicosis	0	0.0	12	0.9
Total	1042	100.0	1296	100.0

Table 2 Association of Water borne disease with Drinking water consumption

Disease/ Water source	Coastal Area Number (%)	Plain Area Number (%)	Significance p value*
Diarrhoea			
Tube well	3 (0.6)	136 (19.9)	<0.001
Well	123 (23.4)	446 (65.2)	
Ponds	389 (75.5)	102 (14.9)	
Typhoid			
Tube well	20 (10.3)	55 (34.2)	<0.001
Well	31 (15.9)	73 (45.3)	
Ponds	143 (73.7)	33 (20.5)	
Hepatitis			
Tube well	0 (00)	7 (30.4)	<0.001
Well	1 (8.3)	14 (60.8)	
Ponds	11 (91.7)	2 (8.6)	

**Significant at the level <0.05*

Majority of Dakope people drank pond water (57%) but Terokhada people mostly drank water from well (50%). Frequency of water borne disease was compared between two areas in relation to drinking water consumption (Table-II). Diarrhoea was significantly high ($p<0.001$) with pond water consumption in coastal area (76% Vs 15%) in contrast to plain area. Similarly, typhoid was much higher in coastal area (74%Vs21%) in comparison to plain area.

Table 3 Association of vector borne disease with Environmental condition

Disease/ Environment	Coastal Area	Plain Area
	Number (%)	Number (%)
Malaria		
Clean	0	0
Cattleshed/Poultry	0	0
Bushes/Ditches	0	0
Kala-azar		
Clean	0	5 (16.1)
Cattleshed/Poultry	0	17 (54.8)
Bushes/Ditches	0	9 (29.0)
Dengue		
Clean	1 (6.7)	0
Cattleshed/Poultry	7 (46.7)	0
Bushes/Ditches	7 (46.7)	0

Table 4 Association of Systemic diseases with economic status

Disease/ Economy	Coastal Area	Plain Area	Significance p value*
	Number (%)	Number (%)	
Asthma			
Rich	11 (9.9)	11 (5.1)	
Middle	53 (47.7)	111(52.1)	<0.001
Poor	47 (42.3)	91 (42.7)	
Hypertension			
Rich	23 (11.8)	24 (13.9)	
Middle	128 (65.6)	90 (52.3)	<0.001
Poor	44 (22.6)	58 (33.7)	
Arsenicosis			
Rich	0 (00)	1(8.3)	
Middle	0 (00)	8 (66.6)	--
Poor	0 (00)	3 (25.0)	

**Significant at the level <0.05*

Most (51%) of the patients in Dakope live in cottage, but the home of Terokhada patients was mostly tinshed (61%). Environmental condition of Dakope was also poorer. Association of vector borne diseases with environment was compared between two areas (Table-III). While bushes/ditches (47%) was more frequent in dengue affected area (Dakope), cattle shade/poultry (55%) was more common in kala-azar prone area (Terokhada).

Economic condition of Dakope people was comparatively low as the proportion of poor peoplewas higher (54%Vs 48%) than those in Terokhada. Association of systemic disease was correlated with economic condition of the patients (Table IV). Hypertension (66% Vs 52%) was higher in Dakope among the middle classpeople and asthma (48% Vs 52%) was higher in Terokhadain the same group. Although poor people were larger in proportion, disease prevalence were significantly higher (p<0.001) in middle class.

DISCUSSION

Population of South East Asia regions is disproportionately more vulnerable to the impacts of climate change.[27]Coastal area and plain area will be affected differently due to several different reasons.[23,24] Current study noted the target disease prevalence in two upazilla with different characteristics. We observed that hospital attendance in Dakope(16%) was much less than that in Terokhada (40%) and the difference was

attributable to living standard and health awareness of the people. However, target diseases among outdoor patients weremuch higher in coastal (Dakope) area (41%) in comparison to plain (Terokhada) area (26%).

Seasonal variation between two areaswas not significant except monsoon when frequency was highest (35%) in coastal area and lowest (20%) in plain area. Young adult was the most affected people (31-32%) in both the areas.Hectic weather events are usually felt (floods and precipitation) in monsoon and low lying coastal area might had contributed to the seasonal variation.[9]High population density, inadequate nutrition and sanitary condition has made Bangladesh very vulnerable to climate change and children would suffer the most.[17]Perhaps choice of target diseases had shifted our findings from children to young adult.

In category based diagnosis, there was sharp difference between two areas regarding vector borne diseases and systemic diseases, but the water borne diseases were almost similar.Half of the target diseases were water borne diseases particularly diarrhea (49-53%).According to environmental scientists, climate plays an important role in the seasonal pattern and temporal distribution of water borne and vector borne diseases and it is expected to increase the diarrhoeal diseases in low income countries by approximately 2-5% by 2020.[5]Air pollution results from stagnant weather conditions which trap both warm air and pollutants, leading to smog episodes with significant health impacts by cardiovascular, respiratory and allergic diseases.Hypertension and asthma has reportedly increased in recent years which corroborates with present findings.[28]

We found that diarrhoea and typhoid was significantly high ($p<0.001$) in coastal area, in comparison to plain area, where pond water is the major source of drinking water. Outbreaks in coastal region of Bangladesh has been linked to increased sea surface temperatureand abundance of plankton which is believed to be the reservoir of Cholera bacilli.[29,30] An increase of rota virus diarrhoea in Dhaka was also observed by 40% for each 1^0C increase in temperature above 29^0C.[31] Outbreaks of parasitic diarrhoeal disease are associated with heavy rainfall events.[32] Source of drinking water might be related with increased diarrhoea episodes in the study areas.

Among the vector borne diseases, dengue in Dakope and kala-azar in Terokhada was attributed to environmental condition. Ecological disturbances exert an influence on the emergence and proliferation of malaria and zoonotic parasitic diseases, including leishmaniasis, giardiasis, flariasis etc.[33,34]Dengue has already become a regular disease in major cities of Bangladesh.[35]Kala-azar has emerged since the cessation of DDT spraying operations and 20 million people in 27 districts of the countrywas at risk. It prompted emergency control measures of kalaazar in 1995.[23]Water stagnation for tidal waveandembankments for high sea level might have favoured dengue and leishmanias is in the coastal and plain area respectively.[16]Our observation on malaria was in agreement with another hospital based study in Bangladesh which showed sufficiently uncommonmalaria prevalence outside hilltracts.[36]

Hypertension and asthmawas higher in coastal and plain area respectively and the difference in relation to economy was significant. A number of arsenicosis were also observed in Terokhada. Increase salinity in drinking water increases the risk for skin diseases and renal disease.[37,38] Increased frequency of hypertension in coastal area also supports the view by other scientist.[5]During dry season, 96% irrigation water in Bangladesh comes from ground water which aggravates the declining ground water level in many parts of the country resulting in vulnerability of ground water to arsenic contamination. Large number of population in Bangladesh is suffering from arsenicosis and situation will aggravate due to climate change.[13]

Principle limitation of this study was small catchment area and short duration in respect to climate related diseases. A number of patients is believed to have taken health care from traditional healer, thus total patient could be little more than present estimation. Moreover, compounding factors had not been taken into consideration during comparison of target disease between two areas.

CONCLUSION

This small scale study had explored significantdifference in disease pattern in coastal and plain area. While diarrhoea, dengue and hypertension were more frequent in coastal area, kala-azar and asthma were more prevalent in plain area. This differencewas related to the location, water consumption, environment and economy. Since, the impact of environmental changes occurs very slowly, a surveillance project covering a wide area is necessary to explore the gradual impact of climate changes.

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