Impact of Climatic Variation on Parasitic Infections – Short Review

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Abstract: Climate variability have been shown to exert rising cases of parasitic infections in humans. Both natural phenomenon and human interventions can lead to Climate change and environmental disturbances. Through natural condition or human interventions alter the environmental conditions and parasites and their vectors in which they develop and transmit the diseases. Multifactorial conditions such as deforestation, urbanisation, water control projects, bodies of water in disrupted area, globilisation and natural condition (Floods, Earth quake, Tsunami) can singly or in combination can lead to ecological disturbances, survival of parasites, their spread and in turn incidence of parasitic infections. The cited climatic parameter affect breeding and development of specific parasite and host and their transmission pattern of diseases. Therefore, improved surveillance and monitoring is needed so that one should make better use of early warning information to make early action towards epidemic preparedness due to ecological disturbances. The leaders of health sector must stand hand in hand with climate negotiators to confront climate change. Further, leaders from government, private sectors and civil society are encouraged to take action towards climatic change.

Keywords: Climate, parasite, Environment, Natural condition, Man-made

1. INTRODUCTION

Climate is average pattern of variation in Temperature, humidity, atmospheric pressure, wind, precipitation in region over long periods of time. Both natural phenomenon and human interventions can lead to Climate change and environmental disturbances. Climate variability have been shown to exert rising cases of parasitic infections in humans. Only a handful of studies have attempted to predict the effect of climate change on the distribution or transmission.

The First part of article explains about the types of Climatic conditions and changes, implicated in rising incidences of parasitic infections in humans. The second part explains about the emerging parasitic infections due to climatic variability and which constitutes morbidity in human populations.

2. CLIMATIC CONDITIONS AFFECTING TRANSMISSION OF PARASITIC INFECTIONS

Through natural condition or human interventions alter the environmental conditions and parasites and their vectors in which they develop and transmit the diseases. Multifactorial conditions such as deforestation, urbanisation, water control projects, bodies of water in disrupted area, globilisation and natural condition (Floods, Earth quake, Tsunami) can singly or in combination can lead to ecological disturbances, survival of parasites, their spread and in turn incidence of parasitic infections.

Deforestation –

Deforestation is an important condition that affect vector and their parasites. When the forest is cleared, it is converted in to crop farming, grazing land, settlement of migrant populations or left as open plots can create a favourable ecological niches for new vector/existing vector and their parasites survival and diseases transmission.
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**Bodies of water –**

Forest soil is acidic in nature and cleared lands with alkaline pH are prone to formation of puddles with water, which is favourable environment for survival of anophiline larva (1-3). Conversion from acidic to alkaline pH due to reduction of water salinity favours the growth of vectors such as snails and transmission of diseases by their parasites (4).

**Urbanisation –**

As for settlements humans are migrating from rural to densely populated urban area, which increases the vector and host interaction and transmission of parasitic infections. In addition if anthropophilic vector is present, migrant population act as reservoir for transmission of zoonotic parasitic infections. Indigenous population have developed immunity to parasites. However, new settlers have not developed immunity and resulting in increased vulnerability to vectors and transmission of diseases.

**Water control projects-**

Construction of irrigation canals, dams and reservoirs can lead to change in ecological niches of vector such as mosquitoes, snails and their parasites. These canals provide suitable breeding sites for mosquitoes and transmission of diseases. The habitat of mosquitoes vary with their species. Some mosquitoes prefer moving stream, clean water, reservoirs; other inhabit coastal areas.

**Globilisation –**

New roads construction provides acceleration of tourism, construction of irrigation canal, dams and new settlements with all there in singly or combination can lead to environmental disturbances. Due to such construction non-immune population are exposed to indigenous vector and new settlements lead to introduction of new vector to those areas (5-7). Road construction in previously forested area can lead to erosion and formation of bodies of water in disrupted areas. These water bodies then serve as breeding ground for vector (8).

**Components of climatic system –**

Interaction among different climatic component such as temperature, humidity, rainfall, precipitation can lead to change in climate and ecological imbalance. In earlier times, natural phenomenon was solely responsible for disturbances in ecological niches but today man made activities are also responsible for climatic change: Forest clearance and land coverage, industrial activities, fuel combustion, stratospheric ozone depletion, freshwater depletion and contamination. These factors in singly or in combination can lead to environmental changes and ecosystem impairment which further lead to diverse health consequences (9, 10)

**Temperature and rainfall -**

Rising global warming causes alteration in hydrological cycle leading to more droughts and floods resulting in poor hygiene, fresh water depletion and contamination leading to adverse health consequences. Heavy rainfall lead to collection of water in water bodies providing breeding site for mosquitoes. Rain provides a favourable environment to vector, which prolongs their life. Transmission of many parasitic diseases found during rainy season (11, 12). However, climate change and associated impacts will vary from region to region around the world.

### 3. **ENVIRONMENTAL CHANGES AFFECTING PARASITIC DISEASE TRANSMISSION**

The above stated climatic parameter affect breeding and development of specific parasite and host and their transmission pattern of diseases. Some of examples of parasitic diseases affected by environmental change has been discussed below-

**A. Malaria –**

Malaria is diseases of tropical regions. The Vectors and Parasitic species of malaria changes sharply due to change in ecological niches. The minimum temperature (16 – 19°C) and maximum temperature (33 – 39°C) with relative humidity (40 – 80 %) required for breeding of anophiline vector (13). When a climate is changed, indigenous anophiline vector are not able to survive due to changed ecological niches, it will disappear and replaced by different anophiline species may occupy the area. Environmental factors such as climate, deforestation, vegetation, water bodies can lead to increase in transmission of malaria. For example, malaria outbreak have occurred in Western Kenya due to
average rise in temperature and heavy rainfall, provide breeding site to mosquitoes and prolong their life. Similarly, in 1987, due to rise in temperature and rainfall was associated with rise in malarial cases at higher altitude. Climatic conditions such as El Nino, Tsunami, Hurricae have been shown to increased transmission of malaria. El Nino affected area such as in parts of East Africa due to heavy rainfall resulted in rise in malarial cases in Southwestern Uganda (14). Tsunami can result in smashed sewer lines, contaminated fresh water supplies, overcrowded refugee camps, create a breeding ground for mosquitoes and precipitate the malarial outbreak. Similarly, Combination of flooding, loss of shelter, and destruction of infrastructure after hurricane provide breeding site for mosquitoes and result in increase transmission of malaria. After deforestation in Malaysia, vegetation of erithrinia tree (bromeliads on their branches), are preferred breeding site for anopheles mosquitoes resulted rise in malaria cases due to *A. bellator* (15).The prevalence of malaria returned to previous level after removal of bromeliads from those area. Unplanned urabinastion is responsible for intermittent water supply and improper sewage and solid waste disposal provide breeding site for mosquitoes. Construction of hydroelectric dams, irrigation canals in Brazil, Africa, India there was increase in malaria transmission rate (16).

**Kala-Azar:**

Kala-Azar is caused by Leishmania species. It is transmitted by sandflies (phlebotomus). The vector and Leishmaniasis infection association due to climatic change is shown in table 1.

<table>
<thead>
<tr>
<th>Area of climatic change</th>
<th>Type of climatic change</th>
<th>Effect on parasitic infections due to climatic changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latin America</td>
<td>Deforestation led to increase in fox population (reservoir host)</td>
<td>Increase in visceral leishmaniasis.</td>
</tr>
<tr>
<td>In Brazil</td>
<td>Cropping of pines and gmelina after clearing of land led to increase in spiny rat (reservoir host)</td>
<td>Increase in cutaneous leishmaniasis.</td>
</tr>
<tr>
<td>Latin America</td>
<td>Sugar of ripe coffee helps in development of parasites in vector (phelbotomine sandflies) in coffee growing regions</td>
<td>Increase in leishmaniasis cases.</td>
</tr>
<tr>
<td>In Southern Sudan</td>
<td>Globalisation (migrants from endemic regions)</td>
<td>Increase in leishmaniasis cases.</td>
</tr>
</tbody>
</table>

**4. SHISTOSOMIASIS**

It is caused by *S.japonicum, S.haematobium, S. mansoni, S. mekongi*. The larvae enter inside the snail (intermediate host) before releasing into water. Snails laying egg condition depend on different climatic condition such as rainfall, water temperature, flow of water and duration of rainy and dry seasons. The most common climatic parameter, construction of dams led to increase in cases of shistosomiasis , discussed in literature. In Egypt and Iran, due to construction of dams and new canal system led to increase in snail populations, which subsequently led to increase in shistosomiasis cases in these areas (21, 22).

**5. TISSUE NEMATODES**

Filariasis is transmitted by *Culex, Aedes* and *Anopheles* mosquitoes, and caused by *Wuchereria bancrofti*. Environmental condition such as flooding and cropping of rice in Orient and stagnant water in India, provide favourable breeding place to mosquitoes resulted in increased in filariais cases in those regions (21, 23).

Loiiasis is transmitted by bite of Chrysops fly. They mostly breed in dense and swamp forest in Africa, however, deforestation decreases their prevalene. (24)

Onchocerciasis is transmitted by bite of simuliiidae (black fly), most common in African regions. Climatic factor such as rainfall provide favourable breeding condition to blackfly (25).

**6. WATER BORNE PARASITIC DISEASES**

The transmission of water borne parasitic diseases such as Giardiasis and Cryptosporidium are affected by climatic factors such as rainfall, temperature, livestock intensification e.t.c.(Table 2).
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Several outbreaks of Cryptosporidiosis and Giardiasis due to change in climatic factors are shown in number of studies (26 -30).

Table 2. Effect of climatic change on water borne parasitic infections (26 -30)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Climatic factors</th>
<th>Impact on pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Increase rainfall</td>
<td>Increase flooding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase contamination of drinking water with septic tanks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase run off increases oocyst contamination of drinking water.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase contamination of vegetable crops with sewage effluent.</td>
</tr>
<tr>
<td>2.</td>
<td>Decrease rainfall</td>
<td>Increase storage of water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease run off</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase contamination of ground water source</td>
</tr>
<tr>
<td>3.</td>
<td>Increase temperature</td>
<td>Increase dessication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease survival of oocyst</td>
</tr>
</tbody>
</table>
| 4.    | Intensification of domestic livestock | Increase contamination of water sources  
|       |                           | Increase contamination of food sources  
|       |                           | Increase pathogen reservoirs                                                                          |

7. Future Perspective

Climatic variability due to natural condition (Floods, Earth quke, Tsunami) or human interventions such as deforestation, urbanisation, water control projects, bodies of water in disrupted area, globilisation can singly or in combination can lead to ecological disturbances, survival of parasites, their spread and in turn incidence of parasitic infections. Therefore, improved surveillance and monitoring is needed so that one should make better use of early warning information to make early action towards epidemic preparedness due to ecological disturbances. The leaders of health sector must stand hand in hand with climate negotiators to confront climate change. Further, leaders from government, private sectors and civil society are encouraged to take action towards climate change.

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