Climate change poses a threat to prevalence of Visceral Leishmaniasis: An Overview

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ABSTRACT *climate and incidence of diseases is regulated by different biological aspects like host-parasite-vector interaction, probability of transmission and the lifecycle of vector and parasite. VL is transmitted by Phelobotomus argentipusthat lives in warmer places where humidity and temperature both are present at regular intervals in a day (humidity during night and temperature at day time). These conditions are essential/necessary for the survival of vector, parasite development and for their distribution. In the present context global climate changes and temperature rise have significantly affected sand fly growth leading to the increased transmission of the disease. Natural factors like recurrent floods increase the transmission of larvae from one place to another place thus also increase the distribution of disease. This review focuses on the climatic factors that affect the overall incidence of VL.*

Keywords: *Climate change, Visceral Leishmaniasis, Temperature, Humidity*

Introduction

The Intergovernmental Panel on Climate Change (IPCC), reported an average warming of the global mean surface temperature of 0.85°C [0.65–1.06°C] over the period of 1880 to 2012 (IPCC, 2013).The mountains and mid-high latitudes of the northern hemisphere have reported different trend of surface temperature as result of global warming. According to reports, the rate of warming of the Himalayas has been higher than the global average (Shrestha *et al*., 2012). Temperature rise due to climate change can adversely affect human health in several ways of which those mediated by natural systems like air borne, water borne and vector bone diseases are worth mentioning. Human population residing in areas endemic to vector borne disease like visceral leishmaniasis (VL) will be most adversely affected in such altered climatic conditions (IPCC 2014). Furthermore the vulnerability of infection increases due to compromised quality of life, health, hygiene and economic status.

VL, often termed as a "neglected disease of the poor" is caused by a kinetoplastid obligatory endoparasite *Leishmania donovani* affecting the reticulo-endothelial system (viz. spleen, lymph nodes, bone marrow and liver) (Ghoshal *et al*., 2010). The disease also known as kala-azar is fatal if left untreated in over 95% of cases. The parasite exists in the flagellated promastigote (invertebrate form) and non-motile amastigote form (residing with vertebrate host). The causative agent of the disease is transmitted by a female sand fly vector called *Phelobotomus argentipus.* Different factors like ecological attributes, natural disasters, parasite species, previous and present exposure of the subjects to the parasite, human behavior and quality of life and management significantly affect the epidemiology of the disease. The disease has severe manifestations like fever, weight loss, anaemia, hepato-spleenomegaly (Ghoshal *et al*., 2009). The disease was also known as Black fever due to the blackening of skin but in India this manifestation is not witnessed. VL is very commonly misdiagnosed with other co-endemic diseases like malaria and tuberculosis. The immune system of the affected individual is compromised which serves as a gate for other opportunistic infections like AIDS (Martins-Melo*et al*., 2014). VL is becoming a growing public health threat; the spatial distribution and burden of VL is up surging every year (Leta *et al.,* 2014).

Climate and Disease risk

The transmission of VL is dependent on the biological cycle of its vector, the sand-fly. The time of incubation, the factors affecting its breeding, availability of adequate climatic factors for the transmission of the parasite plays a role in the incidence of the disease. Slightest alteration in the climatic factors tends in shifting the vectors into a comfortable zone which promotes greater disease risk. The ecological preference of these flies differs: rainfall, humidity, temperature, soil type and moisture content, and land cover type are significantly associated with the distribution pattern of these sand flies, although no universal pattern has been established so far (Figure 1). Alteration of climatic factors like temperature, humidity, rainfall has been reported to have a positive correlation with the prevalence of the disease (WHO, 2013).

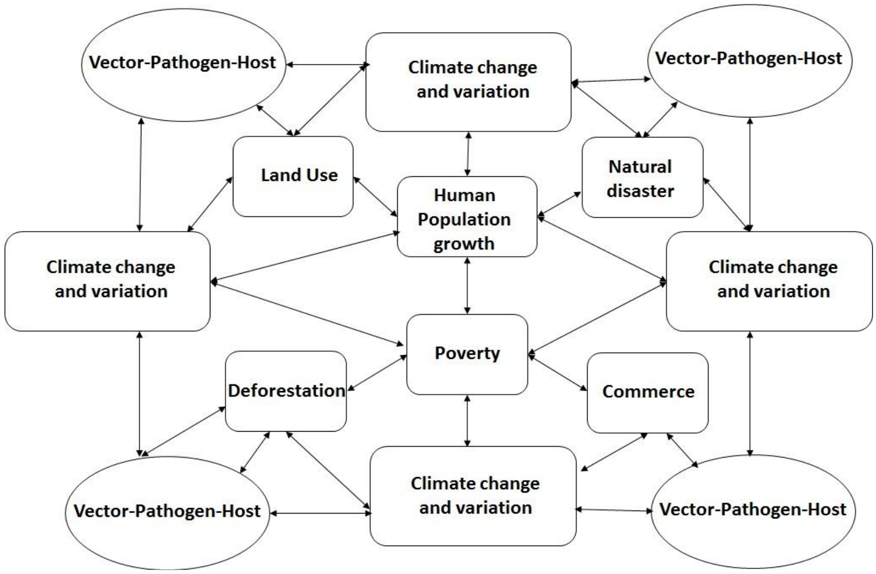

Figure 1: Overview of climate and other associated factors affecting vector borne diseases.

Effect of Temperature and Humidity

The sand fly can withstand cold temperatures during diapause (overwintering) and usually require an average temperature of 20^{0}C for survival. During the day time the flies often take refuge in cracks and crevices of the walls, tree holes and trunks. Sand fly survival reduces if the conditions become too hot or cold or dry. According to reports the survival of sand flies increased when the harbored in Poroton stone buildings which accumulate humidity during the day time (Singh *et al*., 1999). Due to global warming and human exploitation there is a decrease in the temperature differences between the maximum and minimum level. This helps the biological cycle of the sand fly as it can escape the extreme cold temperature (Dawit *et al*., 2013). In currently endemic areas, higher seasonal temperatures would lead to prolonged activity periods and shorter diapause periods. This could result in an increased number of sand fly generations per year. This has a direct correlation to the disease incidence. A study conducted in Ethiopia demonstrated that the annual average temperature has 33 % influence on VL occurrence followed by soil type as the most important contributing factor (Tsegaw *et al*., 2013).A positive association of VL cases with temperature and rainfall has been observed with reports of disease outbreaks 2–3months after heavy rainfall in Nepal. The abundance of the vector *P. argentipes* has also been found to be positively correlated with the maximum temperature of the month of collection and negatively correlated with the precipitation of previous months in both Nepal andIndia. Furthermore the occurrence of VL in the non-endemic new regions due to alteration in temperature and rainfall have made the scenario alarming (Dahal *et al*., 2008; Picado *et al*., 2010).A positive association has been reported between the El Niño cycle and the annual incidence of visceral leishmaniasis in Brazil, but more basic research is needed to substantiate such correlation (Ready 2008). Studies on the environmental factors in the Gangetic plains of North India demonstrated that the presence of water bodies, woodland and urban, built-up areas, soil of the fluvisol type, air temperatures of 25.0-27.5^{0}C, relative humidities of 66 % - 75 %, and an annual rainfall of 100-<160 cm were all positively associated with the incidence of VL (Bhunia et al., 2010). Climatic changes are also influenced by natural calamities like floods, which forcefully modify the environmental conditions of a geographical area. There is always a positive association between the occurrence of flood and the incidence of vector borne diseases. Human exploitation like deforestation to cater the constant needs of urbanization synergistically affects climate change. It also leads to deforestation associated with environmental impacts, which can facilitate the spread of leishmaniasis.

Conclusion

The disease pathology of VL is complex which is furthermore complicated due to improper methods of lifestyle and management and climate change. The distribution patterns and incidence of the disease have altered with outbreaks in non-endemic areas due to adaptability of the sand fly to the new environment. Climatic factors like temperature, rainfall and humidity have influenced the incidence of the disease. High level of precipitation (rain) has also played very important role in the spared of disease, flooding may spread the vector of disease and the larvae of fly to distant and non-infected areas also. The scenario has become alarming due to urbanization and deforestation activities. Such changes have affected the vector-host-reservoir interface of the disease. Therefore, further studies should be conducted to identify the potential reservoir hosts and to understand the transmission dynamics, as well as the habitat preference of Phlebotomines and flies. Therefore climate change indeed plays a significant role in the incidence of VL.

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