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Global Warming Could Change the Spectrum of Viral Infections in Europe

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Abstract

In the last decades, changes in the global temperature have become a major concern and have found to produced serious impacts on the prevalence of infectious diseases among animal and human populations and increasing health risk in the future.

This is described partly due to change in a geographic distribution of and creating new opportunities for invasive vector-borne pathogens such as mosquitoes, ticks, sand-flies, rodents and other animal and birds, to transmit the infections into new areas and new hosts. For example, outbreaks of Dengue fever, West Nile virus, Chikungunya virus and some other viruses worldwide, particularly in Europe. In addition, the warm climate may also alter the pattern of the diseases through decrease in the host resistance (immunity) to infectious disease and this may destroy the existing infrastructure of public health and increase health risks with the emergence of unexpected epidemics in the future.

Keywords: Climate change; Viral infection; Vector-borne disease; Rodent-borne disease; Zoonotic viral diseases

Introduction

The term global warming means an average increase in Earth's atmosphere and it is thought to be mainly caused by human activities and natural events [1]. In recent years, this increase in the global climate have become an attractive problem and is thought to have considerable effects on the health conditions on the Earth, especially on the spectrum of the infectious diseases among human populations via change in the ecological and biological factors such as increasing the risk of air pollution, change in rainfall patterns, flood and drought, water shortage with decrease in cultivation and famine, increase exposure to the ultraviolet light and many other factors [2].

All these changes are found to be helpful and have an important role in the transmission and distribution of infectious diseases and contamination of the environment either directly or indirectly [3] through many motivate factors between the infectious agents and human populations. In relation to the infectious agents, the hot climate can probably induce the emergence of various viral-carriers globally such as mosquitoes, ticks, sand-flies and rodents. This is mainly through the alteration in a geographic distribution of the virus vectors and transmission of the infections into the neighbour countries. For example, the emergence of Dengue, West Nile virus and some other vector-borne and non-vector-borne viral diseases worldwide, especially in Europe. In other words, global warming can change the epidemiology of infectious diseases.

Whereas regarding to the human population, the environmental changes may encourage migration of population causing alteration in the disease patterns as well as they may also cause decrease in the host resistance to infectious disease through the scarcity and through contamination the sources of the drinking water and so on. All these facilitating the transmission of infection among the populations.

However, the adaptability or susceptibility of human population to the changes in global climate is based on the capacity and speed of changes, the consequence of these changes is depend on early recognition of the epidemic infections and the appropriate application of effective control and treatment [2].

Climate Factors and Viral Diseases

Several environmental factors are mostly thought to assist in transmission of viral diseases worldwide especially carrier diseases. These factors are globally including temperature, humidity, precipitation and wind whilst in Europe, the climate temperature is more likely.

The temperatures of Earth climate are thought to rise by some degrees over the next coming decades and next century that probably have strong impact on the incidence of infectious diseases through producing an adaptive environment for the some serious viruses to emerge in Europe primarily through changes in the life cycle of vectors and parasites that serving as a carrier for the viruses. It is also shown that the humidity has a significant impact on vector population and their life cycles particularly on adult survival activity; however, the global humidity is relatively remained constant.

The majority of virus vectors, such as mosquitoes, ticks and flies, are cold-blooded nature and this makes the incidence of infectious diseases to strongly depend on the surrounding temperatures that can cause changes in vector breeding sites, distribution, biting rates and the duration of their life cycle, for example, malaria mosquitoes has been shown that they cannot survive at extreme temperature for a long period of time (above 40°C) particularly at very wet condition. In addition, the temperature can effect on humans through changing in the manner of the movement and increasing vulnerability to the infections via the alteration in the host body immunity. Therefore, In general, the ability of virus vector to distribute and to reproduce is mainly depend on the climate temperature.

The effect of increased temperature of global environment on the dynamics of the diseases is relatively paid less attention till now, although it has been shown to have negative effect on public health through affecting the body immune status and potentially making the host susceptible to infectious diseases. Similarly, the climate humidity also has effect on public health, especially on those who having chronic respiratory diseases such as asthma, by deteriorating body health status.

Precipitation is another environmental component that is thought to have an impact on the incidence of infectious disease directly and indirectly. The probability of viral diseases especially vector borne and rodents borne viral diseases are demonstrated to directly increase after the occurrence of heavy rainfall via changing the vector breeding sites as well as driving rodents from burrows. This is particularly when rainfall has occurred following hot climate conditions. For example, floods and storms can transmit the carrier vectors into the new places and create the new reproduction habitats; however, they might reduce the population of the virus vectors through killing the immature larvae and destroying the breeding sites. That is to say, rainfall can be used as an indication for emergence of vector borne viral diseases. In addition, floods and storms can also indirectly increase the host vulnerability via contamination of clean water systems and then by ingestion of contaminated drinking water and foods the viral infection outbreaks might occur. It is also found that the prolonged drought and desiccation, particularly following hot climate conditions, are likely to affect human health and increase risk of susceptibility to infection through the water shortage and food scarcity [4].

Recent Outbreaks in Europe and the Potential Impact of Global Warming

In recent years, several viral incidents and outbreaks are demonstrated in Europe in both humans and animal which are expected to be strongly activated by changes in European climate temperature including Usutu virus, Chikungunya virus, Hantavirus, West Nile virus and Dengue virus and some other dangerous viruses, and the majority of them are transmitted by carriers such as mosquitoes, ticks and rodents [5].

Vector borne viral diseases

Some arthropod species especially mosquitos and ticks are acting as a vector for transmission of many serious viral diseases and the diseases are known as vector borne diseases, that are thought to be the most sensitive diseases to the climate temperature [4].

Mosquito-borne viral diseases

West Nile fever is a viral infection of birds caused by the mosquito-borne arbovirus which is a member of Flaviviridae family. It can rarely infect humans via the mosquito bites. It is increasingly distributed in Europe (Figure 1) and it is now causing infections almost every summer in Eastern part of Europe and is gradually spreading towards Central Europe. In the last few decades, it has caused outbreaks in some European countries such as an outbreak in 2000 in Southern part of France which was thought to be developed by a type of biting mosquitoes called *Culex* due to the climate change in that country because the outbreak occurred following an extreme temperature condition with a heavy rainfall. Other outbreaks have been reported in south-eastern Romania in 1996-1997 and in Israel in 2000, which were also associated with hot climate in early the summer. This was before caused sporadic cases in African countries till 1990s but then after the disease is transmitted to European and many other countries because of global warming which where it creates a suitable environment for the vectors to reproduce and for the virus to multiply and finally spreading the infection which then is prevented by insecticides [5-7].

Another mosquito-borne arbovirus disease in Europe is Dengue fever which is an important zoonotic viral disease. In the past, this disease was emerged in Europe by the visitors from the endemic countries, but there was no evidence that the disease was enter the Europe through the introduction of the yellow fever mosquito (*Aedes aegypti*), which is a principle vector for the disease. Over the last two decades, the infection was reintroduced again through other vectors called Asian tiger mosquito (*Aedes albopictus*) resulting in further transmission and expansion of the disease spectrum in Europe (Figure 1). For example, in 2010 dengue fever has been reported in south-east France, Croatia and Greece. Studies have found that the dengue fever is transmitted during high temperature months with extreme humidity and in temperate regions warm climate might assist in further increase in the duration of the transmission season [5].

According to the statistics, the distribution of these exotic mosquitoes and some other vectors has been increased in Europe in the last years and they are dangerous because they can carry some other serious viruses such as the Usutu virus which is another vector-borne zoonosis virus from the same family of the Dengue and West Nile virus (Flaviviridae*)* which can infect many animal species and humans. It is first found in Europe in a sample collected from a donor in Germany in 2012, during a massive blood test. This virus was previously limited to the African countries and it was not common in Europe. It is also thought that this virus is introduced into the Europe due to the effects of global warming, which is more suitable for breeding of their carrier mosquitoes [8].

Another dangerous virus that carried by these type of mosquitoes is Chikungunya virus which is belong to the genus Alphavirus from the family Togaviridae. The disease caused is called Chikungunya fever which transmits to human mainly via biting of infected mosquitoes [5]. It has newly caused an outbreak in a northern-eastern part of Italy in 2007 which infected hundreds of people (Figure 1). During the outbreak it was found that there were a large proportion of infected Asian tiger mosquitoes and the climate at that time in Italy was variable, there was mild winter with heavy rainfall and hot summer (above 20°C), in other words, the climate change has played important role in the establishing the vector and introduction of the disease [6].

Tick-borne viral diseases

It is found that a number of ticks act both as vectors as well as reservoirs for many viral diseases under appropriate climate change conditions, the most common infections are including Tick-borne viral encephalitis (TBE) and Crimean-Congo hemorrhagic fever.

Tick-borne encephalitis (TBE) is another example of viral disease that recently emerged in Europe due to environmental change. It is caused by arbovirus which is transmitted by ticks (mainly *Ixodes ricinus*). Like other vectors, it is found that the temperature affects the life cycle, population and geographic distribution of ticks. Over the last few decades, climate temperature has changed the prevalence of carrier ticks populations in Europe and it has transmitted to higher lands in the Czech Republic where the average temperature was about 37-38°C [5].

The expansion of these ticks in Europe has brought virus encephalitis and it is now become endemic in many European countries (Figure 1). For example in Sweden, It is found that the number of incidence had increased from the mid-1980s was due to the mild climate condition in winter seasons, increasing tick activities and their distributions in the country. Similarly, in Germany and Norway, the tick has also changed their geographic distribution because of climate change. However, it is generally thought that climate change is not the only factor for the increased TBE incidence, other factors have also been contributed such as demographic changes and land use [5,6].

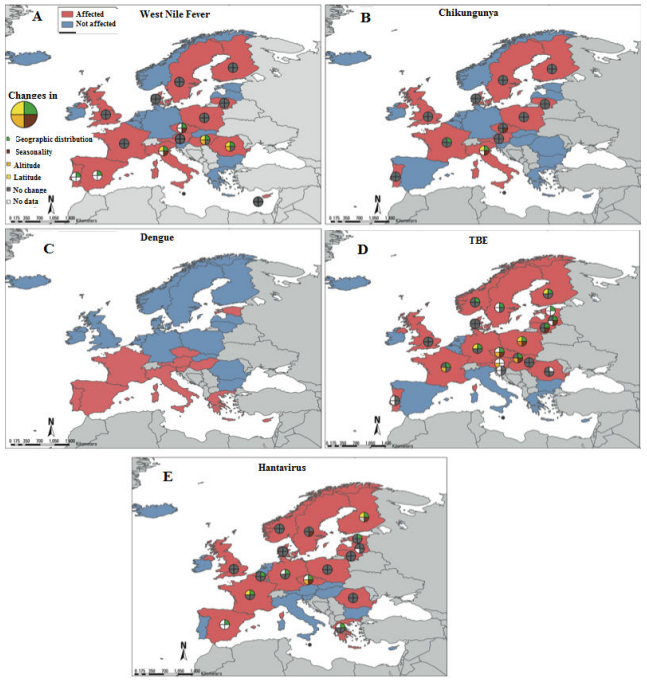

Figure 1: Geographic distribution map of common vector- or rodent-borne viral diseases in Europe over the last decade.

Crimean-Congo hemorrhagic fever (CCHF) is another type of tick-borne viral diseases that is emerged in Europe (Figure 2). It is caused by an RNA virus belong to the genus *Nairovirus* from the family of Bunyaviridae. It is a zoonotic disease of domestic animals and wild animals that can transmit to human beings by animal tick species called (*Hyalomma*). The disease was previously common in African countries but it is newly emerged in many European countries and has caused a number of outbreaks such as in 2001 in Kosovo and in Albania as well as in 2002-2003 in Bulgaria.

It is also believed that the milder weather temperature, which is appropriate for the tick breeding, can change the distribution of the disease. For example, a milder condition in spring in the previous year in Turkey has contributed to the occurrence of an outbreak of Crimean-Congo haemorrhagic fever; however, it was not the lonely reason for the disease emergence [6,7].

Rodent borne viral infections

Several viral infections have introduced into the European population through contact with some climate sensitive animals such as rat, mice and some other wild rodents that are acting as a carrier for some fatal viruses especially Hantaviruses that recently have caused in outbreaks in Europe (Figure 1).

Human Hantavirus infections are deadly zoonotic viral infections caused by Hantaviruses from family Bunyaviridae. The virus is thought to infect humans mainly through rodent excreta and bites [9]. However, human to human transmission is also reported, raising concerns for public health. Hantavirus can cause two types of infection in human including 'haemorrhagic fever with renal syndrome' (HFRS) (also called nephropathia epidemica) and 'hantavirus pulmonary syndrome' (HPS). Today, due to change in the European climate temperature the population of carrier rodents is increased, which are thought to be responsible for raising the incidence of Hantavirus infections [5].

Over the last decades, several outbreaks have occurred in Europe such as in 2005 in Belgium associated with high summer and autumn temperature conditions. It is extended to neighbouring countries such as France, The Netherlands, Luxembourg [10]. Also very recently in 2011-2012, in about 852 cases of human hantavirus infections were notified in Germany [11] as well as in England and Wales in 2013 a few cases have been reported [12].

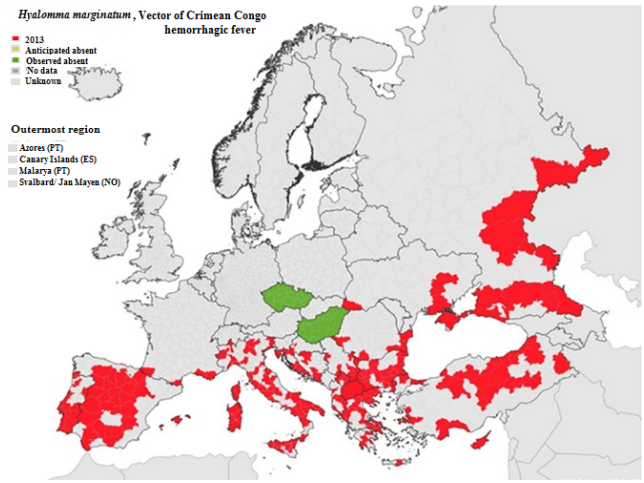

Figure 2: Geographic distribution map of *Hyalomma marginatum* (tick), vector of Crimean Congo hemorrhagic fever, in Europe.

Animal viral diseases

In addition to zoonotic viral diseases, Some other viral infections are also demonstrated in different animal species in Europe that are not reported to infect human beings and they were also related to minimum increases in the climatic temperature conditions such as Bluetongue virus [13,14], Schmallenberg in the UK [15] and many other viruses.

Conclusion

Relatively, all viral diseases and their carriers are reported to be vulnerable to the climate change, especially global warming has found to play an important role in the emergence and distribution of viral diseases. This is commonly significant for vector-borne viral diseases, where hot climate can affect their geographic range [14,16]. This is indicating that the risk of emergence or re-emergence of deadly viral

infections might increase with further warming of the world climate in the future particularly in Europe, through increasing the risk of emergence of infected carrier that are sensitive to climate change and by decreasing the hosts resistance through direct effect of warm environment on human health [17-19].

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Conflict of Interest

No conflict of interest.

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