

Environmental Health

CLIMATE CHANGE

**“Outbreak of Tick-Borne Encephalitis in Central-East European Countries due to Global Warming”**

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**Introduction**

While the climate of our planet is changing, wide-ranging effects for human health are expected to occur. These consequences include changes in the spread of vector-borne diseases. And this is explained by the fact that the biology and ecology of vectors and reservoirs hosts are potentially affected from the temporal and spatial alterations in temperature, precipitation and humidity. As a result, we observe an extended risk of disease transmission and as many climate change impact models predict, the largest changes will occur on the fringes in terms of both latitude and altitude. In central and east Europe (e.g. Czech Republic, Slovakia, Austria), the increased incidence of Tick borne encephalitis (TBE) has been associated to global warming. The warmer climate in Europe the past decades has obvious impacts on the geographical distribution of *Ixodes ricinus* ticks, which are the predominant vectors of TBE in many European countries[[[1]](#footnote-1)](http://www.ecologyandsociety.org/vol2/iss1/art5/) [[[2]](#footnote-2)](http://wwwnc.cdc.gov/eid/article/16/3/08-1364_article.htm#suggestedcitation) [[[3]](#footnote-3)](http://www.sciencedirect.com.ezp-prod1.hul.harvard.edu/science/article/pii/S1433112804800081).

**Climate**

One aspect of climate change is Global warming. This term refers to the phenomenon of the recent and continuous rise of the average temperature in global basis, near the earth’s surface. The leading cause of Global warming is the greenhouse effect. As the earth’s climate is fueled by the sun, our planet absorbs solar radiation, whereas a part of it is reflected back into space. Due to the presence of a natural layer of atmospheric gases, a portion of the reflected solar radiation is being absorbed. Some of it is released back into space but most of it is forced back to earth. As a result the earth’s surface gets warm and creates the natural greenhouse effect. Without the existence of this effect the average temperature of earth would be much lower causing the appearance of ice. Furthermore, this effect increases by release of certain gases (e.g. carbon dioxide and methane) to the atmosphere leading to the rise of the earth’s temperature [[[4]](#footnote-4)](http://www.epa.gov/airtrends/aqtrnd95/globwarm.html).

 Figure 1 The greenhouse effect

**Virus**

Tick borne encephalitis (TBE) is a zoonotic arbovirus infection endemic to Russia and Eastern and Central Europe. TBE is transmitted to humans usually by the bite of a tick (either *Ixodes persculatus* or *Ixodes ricinus*). TBE occurs after the consumption of infected unpasteurized milk and its transmission takes place in spring and summer, mostly in rural areas favored by the vector. This certain infection is a serious cause of acute central nervous system disease that might be followed by death or long –term neurological effects. More specific, the virus (TBVE) is an arbovirus belonging to the family Flaviviridae and the genus Flavivirus. TBVE is divided in two subtypes, Eastern and Western. The first one is transmitted by and the second one is the Western Central European by *Ixodes persculatus*[*[[5]](#footnote-5)*](http://www.facebook.com/l.php?u=http%3A%2F%2Fcid.oxfordjournals.org%2Fcontent%2F28%2F4%2F882.full.pdf&h=tAQGkSAPt)[*[[6]](#footnote-6)*](http://www.who.int/ith/diseases/tbe/en/).

 Figure 2 Tick-borne encephalitis virus

**Tick**

*Ixodes ricinus* belongs to the family Ixodidae (hard ticks) and has a wide geographical distribution from Portugal to Russia and from North Africa to Scandinavia. Regarding their lifecycle is important to know that the *Ixodes ricinus* is a three-host tick. The larvae, nymphs and adults tend to feet on animals of different sizes. Larvae and nymphs prefer small to medium-sized animals and adults tend to feed on large-sized animals. This tick species feeds on a broad range of mammals, birds and reptiles and frequently bites humans.Their life cycle takes 2 to 4 years to complete. It’s feeding generally peaks in spring and early summer with a second active season in autumn in some areas. When it is not seeking a host it occurs at the base of vegetation, where the relative humidity is higher. A basic characteristic of these ticks is the fact that they are particularly sensitive to environmental conditions since in their pro longed nonparasitic faces they require a micro climatic relative humidity of at least 80% to avoid fatal desiccation. Therefore, are favored to areas with moderate to high rainfall and with lush in order for the soil surface to maintain humidity in the dry seasons. Primarily are observed across Europe in deciduous woodland and mixed forest, but can be found in a range of habitats that support its blood hosts and a moist microclimate[[[7]](#footnote-7)](http://www.cfsph.iastate.edu/Factsheets/pdfs/ixodes_ricinus.pdf) [[[8]](#footnote-8)](http://www.hindawi.com/journals/ipid/2009/593232/).

 Figure 3 Life cycle stages of *Ixodes ricinus*

**The studies**

Several studies have shown that global warming is related with the geographic and temporal distribution of TBE cases. For example in Czech Republic Zeman and Benes showed the certain association between the climate and the virus. They achieved it by analyzing the data according the geographic/temporal pattern of cases of tick-borne encephalitis (TBE) in the Czech Republic that were registered since 1970. In more detail, they used a geographic information system (GIS) and more than 8,700 notified places of infection were defined on a map. Afterwards, to estimate the vertical distribution of the TBE cases a digital elevation model of corresponding spatial resolution was selected and overlaid in GIS. The Series of yearly disease ceilings (assessed alternatively as the highest altitude and also as the respective mean altitudes of the upper 5 or 10 cases in a given year) were tested against the null hypothesis of random elevation course. Consequently, were analysed for correlation with contributing factors such as yearly TBE incidence rate, mean yearly temperature, population density of small rodents and roe deer.

The results from the statistical tests established the fact that the TBE ceiling has an upward expansion the last three decades. The pointed average rate of the gradual rise regarding this period was around 5.4 ± 1.7 m yearly. The numbers are well correlated with simultaneous rise of the mean temperature which is approximately 0.036 ± 0.007°C yearly, and the vertical temperature gradient of 0.0065 ± 0.0004°C m−1. Additionally, the data indicated a significant correlation of TBE-ceiling estimates with TBE-incidence data and the mean yearly temperature recorded the past two years. Even though, the data showed a correlation between TBE incidence and rodent population (principal hosts of ticks) density that was observed 1–2 years earlier, the TBE ceiling is not affected by rodent population dynamics and neither the population dynamics are correlated with mean yearly temperatures. Also, there is an association between the TBE incidence and mean altitudes of the upper 10 cases with official data on harvested roe deer.

From an overall prospective, is verified that the variations of TBE incidence and TBE ceiling are concurrent processes that match with the alterations of the temperature. Despite the fact that TBE is not directly affected from temperature but other factors might also be linked with the expansion of the disease, the effects of global warming on the vertical disease distribution in Central Europe are incontrovertible[[[9]](#footnote-9)](http://www.sciencedirect.com.ezp-prod1.hul.harvard.edu/science/article/pii/S1433112804800081).

Another study that investigated the temporal trends in the altitude at which TBE cases established and TBE response to climate warming was located in Slovakia. All the cases of TBE reported for persons in the period 1960-2004 were analyzed. With the use of an altitudinal model of the country in combination with the ArcGIS 9.2 software, the average altitude of cadastral units corresponding to the reported TBE was estimated. After determining a TBE focus as a location infected from TBE at last one time in a given year, the average altitude for TBE per year was plotted against time. Furthermore, temporal trends were identified by linear regression analysis. Next, the frequency distribution of TBE foci in relation to altitude was plotted and accumulated for the period of five years. The series of annual mean altitudes of TBE foci was tested against the null hypothesis of random elevation and analyzed for correlations with mean yearly temperature and precipitation.

The results during 1961–1979, showed that the mean altitude for TBE was randomly raised and the statistical analysis indicated no temporal trend. A non temporal trend in the average annual air temperature was also reported. On the other hand, between 1980 and 2004, a non random variation of the mean altitudes for TBE was observed. Additionally, a significant correlation was shown between the mean altitude for TBE and the mean annual air temperature for the certain period of year. As it concerns precipitation, there was no significant correlation. The years 2001-2004 were the years with the strongest reported correlation between the mean altitude for TBE and mean annual air temperature. This trend proves the positively response of the mean altitude for TBE to climate warming, with a delay of several years[[[10]](#footnote-10)](http://wwwnc.cdc.gov/eid/article/16/3/08-1364_article.htm).

Additionally to the other studies, a survey focused on the Baltic countries was established in order to identify discontinuities in climate conditions that explain the discontinuities in TBE epidemiology in the certain area.

The certain study covered from north to south, Estonia, Latvia and Lithuania occupy the northeast corner of Europe on the eastern coast of the Baltic Sea. These countries faced a dramatic increased in TBE incidence (annual incidence of TBE raised from 0.5–7 to 11–54 cases per 100,000 population) compared to the rest European countries, in early 1990 (independence from Soviet rule). Although, the above countries have a small size, the way that TBE raises to each country separately was non-uniform but occurred suddenly rising by one or even two times greater within a year in comparison with the previous 10-year mean level. Due to the appearance of those facts among the Baltic countries came up the chance to test whether the climate is involved with the sudden and discontinuous spatial expansion of TBE incidence. They gathered data for the annual TBE number of cases that were registered from the permanent residence of patients during 1970 and 2004. The source was the national Public Health Agencies in Estonia, Latvia and Lithuania. Along with the above data, daily records of the air temperature (minimum and maximum), precipitation (mm) and snow cover (cm) were taken from ground stations in each country. The requirements for the selection of the stations were to be located near to appropriate tick habitat and to be representative with other epidemiological patterns and also those parts of Estonia and Latvia where either I. ricinus ticks occur alone or with I. persulcatus (in eastern counties). The means of the daily records were used as to be able to find a relation between the temporal changes and the biology of the tick.

The results showed a heterogeneity concerning the time that the TBE incidence occurred and the range of changes in the TBE incidence, which was not stable within countries. The records provided a significant increase in spring-time daily maximum temperature. This increase could lead to the excess transmission of TBE virus between larval and nymphal ticks co-feeding on rodents but could not elucidate the temporal heterogeneity of TBE epidemiology because this kind of alteration in the climate are basically consistent in the Baltic. Consequently the increased incidence thought to be a result of national changes in public health practices. Further, the investigation based on archives and discussions with the appropriate persons associated with public health and medicine (held before and after the increase in TBE cases), declared that it is possible to get overestimated results if any changes regarding the public health activities happen. But the degree of overestimation based on these changes is limited and cannot account for the full extent of the up-surge[[[11]](#footnote-11)](http://www.plosone.org/article/info%3Adoi/10.1371/journal.pone.0000500).

Conclusion

From the information that we received from the above studies we conclude that indeed global warming has an impact on the vertical spread of TBE in Central East Europe. The disease is demonstrating an expansion towards to higher altitudes due to the higher temperatures that we have the last decades in our planet. These observations match with the theoretical predictions. Behind the upward expansion of TBE, there are other contributing factors (most of them associated with temperature) to the appearance of this effect. For example the expansion of of *Ixodes ricinus* ticks to higher altitudes due to favorable temperatures and climate conditions (mild winter, warm spring) that makes ticks more active. Also the increased deer density due to climate warming (milder winters) is related to the excess of TBE incidence. Concerning the last study of this paper, we noticed a controversial hypothesis for the cause of the increase of TBE cases, between the authors and professionals from Baltic and Russia. In this manner more studies should establish to get more accurate and informative results.

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