

## **PhD THESIS**

**Title: "Characteristics of imports and assessment of the possibility of malaria recovery in Bulgaria in the face of global climate change"**

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## **ABSTRACT**

Malaria is still one of the most important diseases at present, causing more deaths than all other parasitic diseases combined. Malaria was eradicated in Europe in the 1970s. Since then, malaria cases have been mostly imported to the continent by international travelers and immigrants from endemic regions. Despite the significant number of malaria cases imported and the documented existence of suitable anopheline vectors, autochthonous transmission has not been widely observed in Europe, possibly as a result of early diagnosis and treatment by efficient health systems.

The objective of this PhD thesis is to evaluate the potential for reestablishment of malaria transmission in Bulgaria and possible clinical and epidemiological consequences caused by malaria importation in the context of the global climate change.

For the period of our study, 175 cases of malaria have been imported in Bulgaria to 17 of the 28 districts of the country. Of these, 123 were Bulgarian nationals and 52 – foreigners, which difference was found to be statistically significant (Mann Whitney test:  $P$  value = 0.0004,  $P < 0.05$ ). Among foreign citizens with imported malaria, persons aged between 20-24 and 30-34 years prevailed, and among Bulgarian citizens prevailed the age groups of 30-34 and 50-54 years. Both groups were predominantly male patients: 85.4% among Bulgarian citizens and 96.2% among foreigners. According to the geographical origin of importation, about 80% of the cases were imported from Sub-Saharan Africa, 19% from Asia and about 1% from South America. According to the type of the causative agent, cases caused by *P. falciparum* (70.28%), followed by *P. vivax* (22.28%) predominated. The other species of malaria plasmodia did not have significant epidemiological importance, as causes of imported malaria in the country. Complications developed in 22 of the patients during the course of the disease, mainly from CNS involvement and in seven of the cases the disease was fatal. Majority of cases (110 (62.86%)) were registered in the period of possible transmission under the current weather conditions (April - October). Comparing data on average monthly temperatures by districts in the country during the period 1916 - 1975 and 2000 - 2015, we found a

statistically significant increase in average monthly temperatures in 19, of a total of 28 districts: Blagoevgrad, Veliko Turnovo, Vratsa, Gabrovo, Dobrich, Kardzhali, Montana, Plovdiv, Razgrad, Ruse, Silistra, Smolyan, Targovishte, Haskovo, Shumen and Yambol. The spatial analysis of cases of imported malaria in the country shows that a large number of areas with a significant reduction in the time for sporogony and correspondingly accelerated malaria transmission rates fall into the clusters with the highest number of reported cases of imported malaria, which identifies them as areas at increased risk of reestablishment of malaria transmission.

In conclusion, we must point out that in Bulgaria there is a potential risk of reestablishment of the local malaria transmission. It is conditioned by the presence of both components - receptivity and vulnerability in our territory. The vulnerability for now is moderate and it is determined by the number of malaria cases imported from endemic countries. However, it is directly dependent on a number of factors - migration, economic, social and cultural ties, etc., which may change in the future, and therefore the vulnerability must be monitored on an ongoing basis. In Bulgaria, a high level of receptivity is maintained and our study shows that some of the biological characteristics of the vector have changed in recent years, which may be explained by climate change. This can aggravate the epidemiological situation in the event of an epidemic situation. In order to mitigate the effects of importation and prevent malaria return in Bulgaria, a high level of malaria surveillance system performance must be maintained.