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Correspondence

Epidemiological trends of *Aedes*-borne diseases in European countries during 2015–2020

Dear Editor;

Vector-borne and zoonotic infections (VBZI) are serious bio-threats, with approximately 2.5 billion infected cases as well as 2.7 million deaths worldwide [1]. In addition, vector-borne diseases are cause irreparable economic losses ranging from 2.1 to 57.3 billion dollars [2]. *Aedes*-borne arboviruses including yellow fever virus (YFV), dengue virus (DENV), zika virus (ZIKV), as well as chikungunya virus (CHIKV) are the most global vector-borne diseases that threaten public health, particularly in Asia, Latin American, and the Caribbean [3]. The available evidence shows that rapid urbanization, living in high population density, global warming, as well as international travel have contributed to globalization of such these arboviruses to non-endemic regions [4]. World Health Organization (WHO) identified YFV as one of the ten serious threats for global health; approximately 4 billion people live in high-risk areas for dengue virus transmission [5]. Clearly, careful vector control programs will reduce arbovirus trends. Nevertheless, epidemics and outbreaks of arbovirus diseases have been continuously disseminated throughout the world [6]. Unfortunately, most *Aedes*-borne viruses are co-circulating in residents of the same geographical regions, and all cause febrile illnesses that may lead to obscure clinical suspicion [7].

Despite the fact that the European continent has recently experienced several diseases transmitted through *Aedes*, especially dengue fever, the current situation in the European Union is frangible [8]. In this paper, we used data from the ministry of health departments of different European countries to investigate the current trend of *Aedes*-borne diseases under surveillance during 2015–2020. Trends in reported incidences for each year were compared using the chi-square test. In addition, the presence of correlation between *Aedes*-borne diseases was studied through simple linear regression.

The number of emerging *Aedes*-borne diseases was discrepant during 2015–2020 (Fig. 1). Interestingly, there was a significant increase in the number of *Aedes*-borne diseases in 2016 and 2019. Compared to the average, countries such as Germany, the Czech Republic, Sweden, as well as Switzerland have shown a significant increase of these arboviruses compared to other European regions. In contrast, Poland and Lithuania had the lowest prevalence rates. With few exceptions, the current trend of *Aedes*-borne viral diseases tends to decrease continuously, as shown in Fig. 1. Our findings indicated an alarming increase in ZIKV disease in Germany, Italy as well as Sweden in 2016–2017.

In a likely scenario, Jenkins et al. recently evaluated trends in infectious diseases in Europe (2017–2020); the authors found an increase in tick-borne encephalitis in recent years [9]. Moreover, consistent with our findings, they revealed a high prevalence of tick-borne encephalitis in Austria, Germany, Switzerland, Finland, Norway, and the Czech Republic, with the lowest prevalence in Poland and Lithuania [9].

The declining trend of *Aedes*-transmitted diseases in European territories, clarifies the effectiveness of surveillance and vector-borne diseases control in this continent; however, the current situation is unstable. Factors such as the highly anthropophilic behaviors of *Aedes* species, resistance to insecticides, international trade, climate changes, and travels, all play a critical role on the upsurge of new outbreaks of arbovirus diseases in European residents [10].

Our results suggested a significant correlation between DENV and CHIKV in Europe. We speculate that both of these viruses are carried by the same *Aedes* species in these areas. There is ample evidence for co-circulation as well as co-infection with chikungunya and dengue viruses in the *Aedes aegypti* (*Ae. Aegypti*) mosquito (https://tel.archives-ouvertes.fr/tel-01767226/document, file:///C:/Users/MK/Downloads/Co-distribution_and_co-infection_of_chikungunya_an.pdf). Iwamura et al. measured spatio-temporal changes in vector-borne diseases under climate change; they found that world became ~1.5% more suitable per decade for the development of *Ae. Aegypti* during 1950–2000 [11]. Kraemer et al. highlighted the invasion of *Ae. aegypti* and *Ae. albopictus* into European countries following long-distance importation as well as climate change in these areas [12]. Several severe windstorm seasons have been reported from European regions in 2019 (https://www.eumetsat.int/severe-summer-storms-italy-and-greece). As we expected, these climate changes make European territories more vulnerable to *Aedes* mosquito invasions as well as dramatic increase in *Aedes*-borne viruses. According to the literature, the optimal temperature range for each *Aedes* species is different (21.3–34.0 °C for *Ae. aegypti*; 19.9–29.4 °C for *Ae. albopictus*) [13]. We concluded that global warming could influence changes in the distribution of *Aedes*-transmitted virus. *Ae. aegypti* has a higher ecological flexibility that leads to its global distribution, while *Ae. albopictus* invades the European regions more than Asia and the African continent. The clinical relevance of *Ae. albopictus* depends on its general distribution and the compatibility of the virus with the vector [14,15]. Based on studies, *Ae. albopictus* typically feeds on a single individual than *Ae. Aegypti*, hence, outbreaks associated with *Ae. albopictus* may clarify the self-limiting nature of its outbreaks even at similar vector densities [16,17]. Furthermore, the fitness of DENV, ZIKV and CHIKV for *Ae. albopictus* should not be overlooked.

Overall, in this study we found a downward trend in *Aedes*-borne diseases in Europe, but the current situation is unstable, especially under

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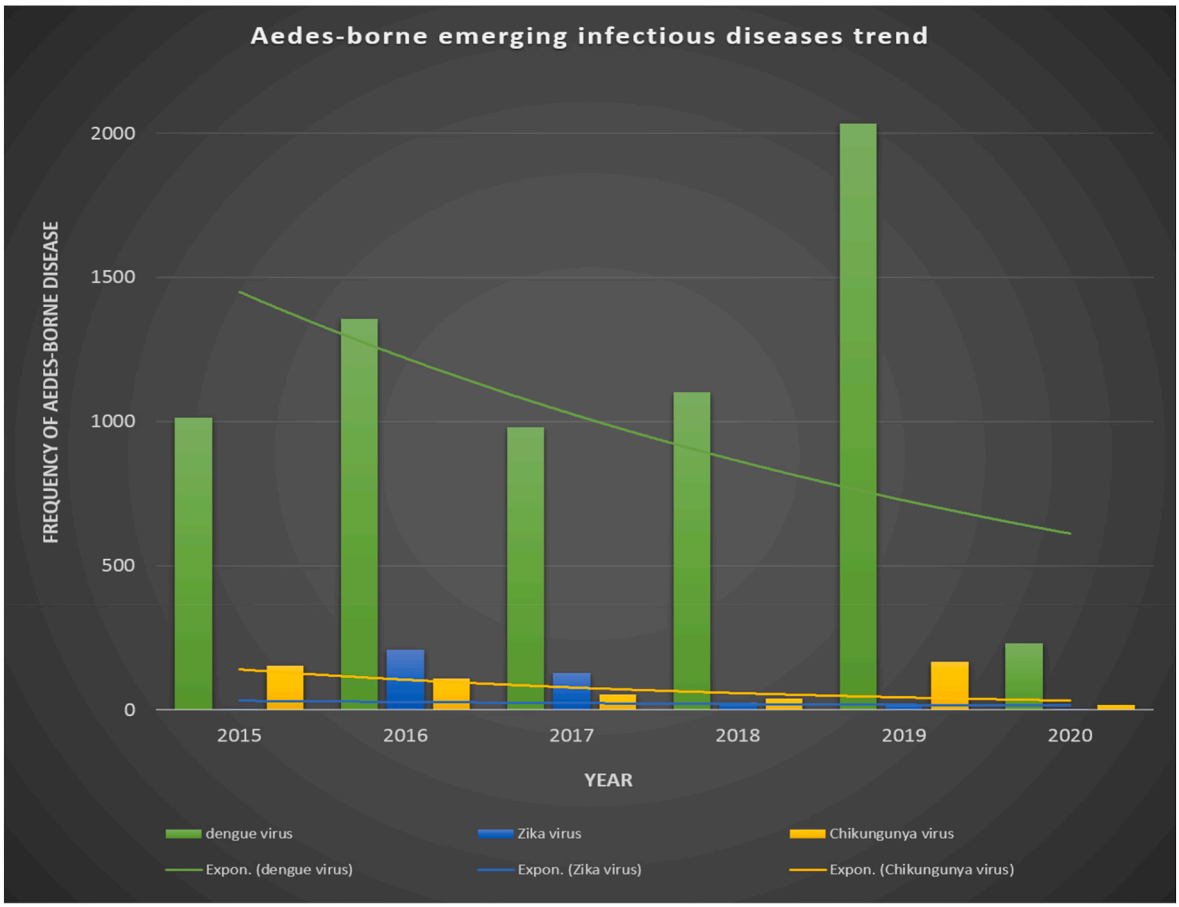

Fig. 1. Trend in *Aedes*-borne viruses in European countries (2015–2020).

the COVID-19 pandemic. Our mission was not accomplished; measures such as nationwide vector surveillance and new strategies for vector control should be implemented. Further decisions regarding the implementation of alternative plans are related to the eco-epidemiological parameters to control the rapid increase of such arbovirus transmissions.

Ethical approval

There is no need for ethical approval.

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Author contributions

Mohsen Karbalaei: Writing and Editing the draft.
Masoud Keikha: Study design, data collection, Writing and Editing the draft.
All authors read and approved the final version of the manuscript.

Declaration of competing interest

None.

Research registration number

1. Name of the registry: Not applicable.
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All the authors of this paper accept full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

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Mohsen Karbalaei
Department of Microbiology and Virology, Faculty of Medicine, Jiroft University of Medical Sciences, Jiroft, Iran

Masoud Keikha*
Antimicrobial Resistance Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
Department of Microbiology and Virology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

* Corresponding author. Department of Microbiology and Virology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
E-mail address: masoud.keykha90@gmail.com (M. Keikha).