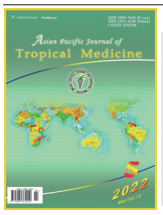

Letter to Editor

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# Decline of Japanese encephalitis in Eastern Uttar Pradesh, India, 2009-2019

Neha Srivastava[1], Hirawati Deval[1], Nikhat Khan[2], Rajni Kant[1], Aparup Das[2]✉

[1]*ICMR-Regional Medical Research Centre, BRD Medical College Campus, Gorakhpur, Uttar Pradesh, 273013, India*

[2]*ICMR-National Institute of Research in Tribal Health, Nagpur Road, Garha, Jabalpur, Madhya Pradesh, 482003, India*

Japanese encephalitis (JE), one of the major viral encephalitides, is caused by *Flavivirus* circulating in rural areas of Asia and Western Pacific regions[1] and is a neglected tropical viral disease due to its endemicity[2]. The culicine mosquitoes, mainly of *Culex tritaeniorhynchus* and *Culex vishnui* group, are the vectors of JE virus (JEV)[1]. Being a neurologic infection, JE manifests with a set of serious symptoms leading to death in many cases and/or change in behaviour of the patients leading to permanent disability[3]. In the eastern part of Uttar Pradesh State of India (mainly Gorakhpur and Basti divisions), JEV, a stern public health concern that commonly distresses children and young adults, was believed to be the principal cause of acute encephalitis syndrome[4]. However, other known causes of acute encephalitis syndrome in the eastern Uttar Pradesh region include scrub typhus, dengue, and enteroviruses[4,5]. Incidentally, in recent years, JE cases have been significantly reduced in this particular region, indicating success in control efforts by the government. In order to have a close look into the JE incidences in the last 10 years and bring forth the control activities that impacted case reduction, we analysed the 10-year (2009-2019) data of JE incidences in the eastern part of Uttar Pradesh and the rest of India.

A JE case is defined as a case with acute onset of fever and change in mental status or new onset of seizures (excluding simple febrile seizures) that has been confirmed by laboratory investigations as JE by IgM-based ELISA test. In this study, data on JE cases used for the analysis were retrieved from (1) the line list of JE cases prepared by ICMR-Regional Medical Research Centre, Gorakhpur of hospitalised cases in paediatric and medicine wards of the Baba Raghav Das Medical College, Gorakhpur from the year 2009 to 2019 and (2) from the online data repository of the National Vector Borne Disease Control Programme, India (http://www.nvbdcp.org). The national data from the National Vector Borne Disease Control Programme data repository were also included in the analysis to understand contribution of JE by the eastern part of Uttar Pradesh with respect to other parts of India. Microsoft Excel was used for data curation and analysis.

A total of 3 870 JE cases was reported from Uttar Pradesh between 2009 and 2019, out of which 2 269 (58.6%) were from the eastern part of Uttar Pradesh. The Gorakhpur (with four districts) and Basti (with three districts) divisions were the major contributors of total JE cases in the eastern part of Uttar Pradesh and contributed to about 86.7% (1 967) of total JE cases from this part of the state when the data were segregated into adult and paediatric cases; surprisingly, the paediatric cases were found to be as high as 75.2% (1 706) of the total cases in the eastern part of Uttar Pradesh. However, males (56.9%; 1 290 cases) contributed more to JE burden than females (43.1%; 979 cases).

In order to understand the overall trends of JE incidences in each year between 2009 and 2019 and the contribution of JE incidence by the eastern part of Uttar Pradesh region to the country-wide incidences (excluding the data of eastern part of Uttar Pradesh) in India, we converted the JE case data to JE incidences and further analysed (Figure 1). To be noted that until 2010, the eastern part of Uttar Pradesh contributed highly to the national incidence of JE. However, from 2011, contribution of JE incidence by the eastern part of Uttar Pradesh region to the national incidence was significantly reduced. Moreover, the declining trend continued until 2019, indicating that the incidence of JE had declined over the years since 2010 in the eastern part of Uttar Pradesh region, which used to be the epicentre of JE outbreaks in India, plausibly due to multipronged control strategies.

Why is the region of eastern Uttar Pradesh highly endemic to JE? This region is geographically situated at the banks of river Rapti, a Ganges tributary that originates in Nepal and runs from rainforest of Indo-Nepal border making this region as one of the most flood-prone areas. The bowl-shaped terrain further adds to the complexity of waterlogging. Also, the southwestern part of Gorakhpur district is surrounded by three other rivers: Rapti, Rohil, and Ami. Additionally, some community-accepted practices, *e.g.*, common agriculture, intensive irrigation in rice farming, water storage for livestock and ponds for fish farming are also commonly practiced[6]. These stagnant water bodies infested with vegetation and unique

✉To whom correspondence may be addressed. E-mail: aparupdas@nirth.res.in



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topographic and eco-climatic conditions provide conducive environment for breeding of the culicine mosquitoes. Furthermore, pigs known as the reservoir/intermediate host of the JEV are being largely farmed in this region, supporting completion of JEV transmission cycle for infecting humans[6]. The eastern part of Uttar Pradesh region shares border with Nepal, which is also a JE endemic country. Therefore, possible introduction and continuous exchange of JEV through the porous international border cannot entirely be negated. Moreover, in the absence of a specific antiviral therapy against JEV and defined supporting treatment by most of the severe patients, disease management becomes much intricate.

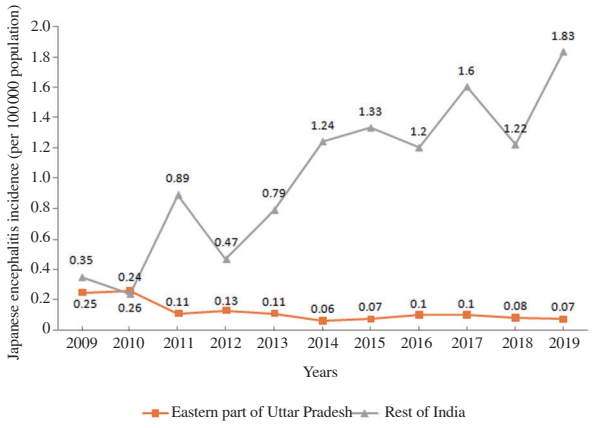


**Figure 1.** Comparative year-wise assessment of Japanese encephalitis incidence (per 100000 population) between contributions from eastern Uttar Pradesh and rest of India during a ten year (2009-2019) period.

What causes the gross reduction of JE incidences in the eastern part of Uttar Pradesh region in recent years? As a part of preventing JE outbreaks in the endemic regions of Uttar Pradesh as a whole, mass immunization of children (age 1 to 15 years) was initiated in 2006[7]. Later, in 2014, as per recommendation from World Health Orgnization, JE immunization was included in universal immunization programme[8]. JE vaccine was administered in two primary doses, the first dose to children aged 9-12 months and the second dose at the age of 16-24 months in the JE endemic regions[8]. Whereas sincere efforts by the Indian and Uttar Pradesh state governments employing (1) vector control, (2) strengthening of JE surveillance programs, (3) immunization in children might have impacted in overall decrease in JE incidences, (4) in the eastern part of Uttar Pradesh, behaviour change and community-based awareness programme, named DASTAK (https://gorakhpur.nic.in/scheme/dastak-campaign/), possibly have largely impacted in controlling outbreaks, transmission and overall incidences of JE to a greater extent[9,10].

The current analysis has two limitations. Firstly, the data analysed here on JE of the eastern Uttar Pradesh were from a single tertiary care centre, *i.e.*, the paediatric and medicine wards of the Baba Raghav Das Medical College, Gorakhpur. Secondly, JE patients handled by the traditional practitioners/quacks and private hospitals are not included in the study, as, such data are not available in public health database. We understand that if all these data would have been included in the current analyses, overall interpretations made in this communication might have been affected.

## Conflict of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Authors' contributions

NS conceptualized, collected and analyzed data and wrote the first and revised draft of the manuscript. HD and NK also have helped in data collection and analysis and preparing the manuscript. RK conceptualized, supervised and helped in editing of the manuscript. AD conceptualized, supervised the work, reviewed and prepared the final version of the manuscript.

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