

Japanese Encephalitis- the wild perspective

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While it is common to co-exist with jumping langoors or thrilling to spot a hopping Chital in a forest, it is hard to keep track of all the pathogens they carry. Zoonoses today has erased all borders of pathogens limited to a specie and it is not just physical contact but the air we breathe, water we drink or the mosquitoes that bite us, there is a wide array of possibilities how we can contract the pathogens. Japanese encephalitis is a viral disease endemic to the South and Southeast Asia (Mansfield *et al.*, 2017 and Tiwari *et al.*, 2012). Non-human primates and wild herbivores can act as reservoirs or carriers of the virus thus, aiding in its propagation. A carrier is an individual that harbours a pathogen but is not affected by it, and shows no signs while a reservoir is the habitat where a pathogen lives, grows and multiplies and may or may not be affected by the pathogen.

ETIOLOGY

The Japanese encephalitis (JE) virus is a single stranded flavivirus of *Togaviridae* family. It is a RNA virus. It is of zoonotic importance as it causes high fatality. It is transmitted by *Culex* mosquitoes- mainly, *Culex tritaeniorhynchus*; although *Aedes* and *Anopheles* mosquitoes have also been reported to act as vectors. Birds also act as carriers to the JE virus. The virus has five genotypes (G-I, G-II, G-III, G-IV and G-V) however, genotype I, II and III are more common in India (Dwivedi *et al.* 2015).

HOST

The virus mainly attacks the age group of 3-6 years of children (Dwivedi *et al.*, 2015). JE begins with gastrointestinal signs- vomiting, nausea followed by nervous signs like acute flaccid paralysis (Lahre *et al.*, 2024). The biggest challenge is the gap in reporting and diagnosis. Nervous signs in children are often misjudged to other factors in rural settings following stereotypes or taboos.

EPIDEMIOLOGY

The virus shows two types of lifecycles- the endemic cycle is observed in tropical areas with

seasonal tendency for wet season and the epidemic pattern observed in temperate areas (Vaugh and Hoke Jr., 1992).

WILDLIFE AS RESERVOIR

Shortridge *et al.* (1974) performed a seroprevalence assay in King cobra and found significant prevalence and conjectured them to be overwintering reservoir to JE virus. Thus, reptiles too may serve as reservoirs of the JE virus.

Nakgoi *et al.* (2014) captured and examined the seroprevalence of Japanese encephalitis in 38 northern pig- tailed macaques in a protected area of Thailand. PRNT (Plaque reduction neutralization test) method known to be the gold standard test for detecting arbovirus was used for diagnosis and it revealed 13% of tested animals infected with JE virus.

Shimoda *et al.* (2014) conducted a serosurvey of JE virus in captive Japanese macaques (*Macaca fuscata*) in Aichi prefecture, Japan and found 44% animals positive for JEV. The antibody titre was found higher in aged primates compared to juvenile animals. Putra *et al.* (2022) found seroprevalence against JE virus in long- tailed macaques (*Macaca fascicularis*) inhabiting the forest area adjoining the paddy fields in Bali, Indonesia.

Lim *et al.* (2022) reported the possibility of wild birds and migratory birds to serve as reservoir or vector for the JE virus in Singapore city. The mosquitoes may be infected by biting them and transmit the virus to susceptible humans living nearby. Thus, it is important to follow precautionary measures to discourage the breeding sites of mosquitoes such as stagnant water sources.

While, Lakhota *et al.* (2023) examined the seroprevalence of JE virus in lion- tailed macaques (*Macaca fascicularis*) and humans who living in proximity in Thailand. They found 14.3% monkeys positive for antibodies against JE virus. Significantly high levels of antibodies were detected and thus, evident of natural infection and sylvatic cycle in the region. Gender or age predisposition could not be confirmed due to indiscriminate sampling of wild primates. Thus, the study highlighted the role of non-

human primates in the sylvatic cycle of JE virus. They may harbour the virus silently and thus need to be monitored regularly.

INDIAN SCENARIO

Walsh *et al.* (2022) suggested that periodic outbreaks of Japanese encephalitis in India is due to the involvement of wild hosts like Wild ardeid- cattle egret, herons; domestic pigs and the convergence of the agricultural wetland habitats and protected areas. The proximity of these landforms lead to the co-existence of species like pigs, wild birds and the contamination of water sources with pathogens. Dwivedi *et al.* (2025) highlighted that *Culex* mosquito breed in the rice fields, stagnant rain water. It is further known that JE cases surge with rise in temperature and high rainfall. Lack of adequate drainage facilities lead to contaminated and stagnant water sources and thus, the rise of *Culex* mosquitoes.

The first case of JE was reported in 1955 in Vellore, Puducherry. JE was included in the National vector borne diseases control program in 2003. Since then, it has now spread throughout the country. Japanese encephalitis was included in the National immunization program in 2006 in 206 districts identified as endemic for JE. The vaccine schedule includes two doses- first at 9-12 months and second at 16-24 months (MoHFW, 2025). Bandopadhyay *et al.* (2013) reported that a live attenuated JE vaccine SA-14-14-2 is administered to people. Tandale *et al.* (2023) emphasised that vaccination programme has helped control the incidence of JE in India.

Kumari *et al.* (2013) reported four cases of JE virus in Delhi and all four had the history of living in crowded slum areas- Jahangirpuri, Bawana and Gole market. Entomological investigation in these slums revealed the presence of *Culex* mosquitoes mainly and JE virus was detected in one pool of mosquitoes. Pigs reared by farmers acted as amplifying host for the virus

leading to rise in the number of infected mosquitoes in the region. Bandopadhyay *et al.* (2013) highlighted that more cases were reported in children and teenagers due to lack of immunity and probable more activity in the open region exposed to mosquitoes. Bhattacharya *et al.* (2021) reported that urban cycle of Japanese encephalitis is maintained by primates, domestic pigs and wild birds.

Dwivedi *et al.* (2015) also reported maximum fatality in the children aged less than 10 years. Dash *et al.* (2001) reported that cattle act as buffer for the JE virus infection and by sustaining the infective bites without development of infection, they aid in controlling the JE virus.

WAY FORWARD

It is important to follow safety protocols like wearing a mask while handling non- human primates. Non- human primates have also been reported to harbour other major pathogens like Rabies virus, tuberculosis bacteria, Kyasanur forest disease virus, to name a few. It is not possible to control the non- human primate population effectively in a settlement, but to prevent the breeding of *Culex* mosquitoes, the stagnant water sources should be drained and cleaned. Urban societies should maintain appropriate drainage systems. Mosquito control can help limit the JE virus propagation. Veterinarians can aid in regular monitoring and sampling of the non- human primates living near human habitats for surveillance of common pathogens. Humans living in the endemic areas must be encouraged for vaccination.

The one health concept highlights the importance of involvement of medical and veterinary faculties as well as ecologists to monitor the vector distribution and habitat. Recent studies propose the use of deltamethrin infused mosquito bed nets and spraying of DDT or other competent insecticides near drainages to control mosquito population (Talukdar *et al.*, 2025).

REFERENCES

- Bandyopadhyay, B., Bhattacharyya, I., Adhikary, S., Mondal, S., Konar, J., Dawar, N., Biswas, A. and Bhattacharya, N. (2013). Incidence of Japanese Encephalitis among Acute Encephalitis Syndrome Cases in West Bengal, India. *BioMed Research International*,**1**(1): 1–5. <https://doi.org/10.1155/2013/896749>
- Dash, A.P., Chhotray, G.P., Mahapatra, N. and Hazra, R.K. (2001). Retrospective analysis of epidemiological investigation of Japanese encephalitis outbreak occurred in Rourkela, Orissa, India. *PubMed*, **32**(1): 137–139. <https://pubmed.ncbi.nlm.nih.gov/11485074>
- Dwivedi, B., Mohapatra, N., Rathore, S. K., Panda, M., Pati, S. S., Sabat, J., Thakur, B., Panda, S. and Kar, S. K. (2015). An outbreak of Japanese encephalitis after two decades in Odisha, India. *The Indian Journal of Medical Research*, **142**(1): S30–S32. DOI <https://doi.org/10.4103/0971-5916.176609>
- Shortridge, K., Ng, M., Oya, A., Kobayashi, M., Munro, R., Wong, F. and Lance, V. (1974). Arbovirus infections in reptiles: Immunological evidence for a high incidence of Japanese encephalitis virus in the cobra *Naja naja*. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **68**(6): 454–460. [https://doi.org/10.1016/0035-9203\(74\)90068-6](https://doi.org/10.1016/0035-9203(74)90068-6)
- Kumari, R., Kumar, K., Rawat, A., Singh, G., Yadav, N. K. and Chauhan, L. S. (2013). First indigenous transmission of Japanese Encephalitis in urban areas of National Capital Territory of Delhi, India. *Tropical Medicine & International Health*, **18**(6): 743–749. DOI <https://doi.org/10.1111/tmi.12104>

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- Lahre, Y., Jha, D. K., Minj, G., Prasad, U. and Bodra, D. (2024). A study of 32 adult patients of Japanese encephalitis in Jharkhand. *Journal of the Association of Physicians of India*, **72**(9): 19–21. <https://doi.org/10.59556/japi.72.0625>
- Lakhotia, D., Tun, Y. M., Mongkol, N., Likhit, O., Suthisawat, S., Mangmee, S., Tongthainan, D., Fungfuang, W., Tulayakul, P. and Boonnak, K. (2023). A serosurvey of Japanese encephalitis virus in monkeys and humans living in proximity in Thailand. *Viruses*, **15**(5): 1125. DOI <https://doi.org/10.3390/v15051125>
- Lim, M. J., Loh, Z. Y., Yeo, H. L., Yenamandra, S. P., Kong, M., Pang, H. Y., Lee, M. H., Humaidi, M., Chua, C., Griffiths, J., Ng, L. C., Hapuarachchi, H. C. and Mailepessov, D. (2022). Isolation and Genetic Characterization of Japanese Encephalitis Virus Two Decades after Its Elimination in Singapore. *Viruses*, **14**(12):2662-264. DOI <https://doi.org/10.3390/v14122662>
- Mansfield, K. L., Hernández-Triana, L. M., Banyard, A. C., Fooks, A. R. and Johnson, N. (2017). Japanese encephalitis virus infection, diagnosis and control in domestic animals. *Veterinary Microbiology*, **201**:85–92. DOI <https://doi.org/10.1016/j.vetmic.2017.01.014>
- MoHFW (2025). Universal immunization programme online <https://www.mohfw.gov.in/sites/default/files/41016395871489662752.pdf>
- Nakgoi, K., Nitatpattana, N., Wajjwalku, W., Pongsopawijit, P., Kaewchot, S., Yoksan, S., Siripolwat, V., Souris, M. and Gonzalez, J. (2013). Dengue, Japanese encephalitis and Chikungunya virus antibody prevalence among captive monkey (*Macaca nemestrina*) colonies of Northern Thailand. *American Journal of Primatology*, **76**(1):97–102. DOI <https://doi.org/10.1002/ajp.22213>
- Putra, I. G. a. A., Adi, A. a. a. M., Astawa, I. N. M., Kardena, I. M., Wandia, I. N., Soma, I. G., Brotcorne, F. and Fuentes, A. (2022). First survey on seroprevalence of Japanese encephalitis in long-tailed macaques (*Macaca fascicularis*) in Bali, Indonesia. *Veterinary World*, **15**(5): 1341–1346. DOI <https://doi.org/10.14202/vetworld.2022.1341-1346>
- Shimoda, H., Saito, A., Noguchi, K., Terada, Y., Kuwata, R., Akari, H., Takasaki, T. and Maeda, K. (2014). Seroprevalence of Japanese encephalitis virus infection in captive Japanese macaques (*Macaca fuscata*). *Primates*, **55**(3):441–445. DOI <https://doi.org/10.1007/s10329-014-0421-7>
- Talukdar, O., Bhattacharya, S. S. and Gogoi, N. (2025). A special insight on the causal agents and mode of occurrence of Japanese encephalitis (JE) infections in rural regions of Assam, India. *Zoonoses and Public Health*, **72**(4):337–348. DOI <https://doi.org/10.1111/zph.13210>
- Tandale, B.V., Deshmukh, P.S., Tomar, S.J. *et al.* (2023). Incidence of Japanese Encephalitis and Acute Encephalitis Syndrome Hospitalizations in the Medium-Endemic Region in Central India. *Journal of Epidemiology and Global Health*, **13**:173–179. <https://doi.org/10.1007/s44197-023-00110-7>
- Tiwari, S., Singh, R. K., Tiwari, R. and Dhole, T. N. (2012). Japanese encephalitis: a review of the Indian perspective. *The Brazilian Journal of Infectious Diseases*, **16**(6):564–573. DOI <https://doi.org/10.1016/j.bjid.2012.10.004>
- Walsh, M. G., Pattanaik, A., Vyas, N., Saxena, D., Webb, C., Sawleshwarkar, S. and Mukhopadhyay, C. (2022). High-risk landscapes of Japanese encephalitis virus outbreaks in India converge on wetlands, rain-fed agriculture, wild Ardeidae, and domestic pigs and chickens. *International Journal of Epidemiology*, **51**(5):1408–1418. DOI <https://doi.org/10.1093/ije/dyac050>
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