International Journal of Community Medicine and Public Health
Karthikeyan S et al. Int J Community Med Public Health. 2024 Oct;11(10):4127-4133
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20242903

Review Article

Trend analysis of Japanese B encephalitis in the states of India during the years 2018 to 2021: an ecological study

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Received: 06 July 2024
Revised: 23 August 2024
Accepted: 04 September 2024

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ABSTRACT

Japanese encephalitis (JE) is the main form of viral encephalitis in Asia. Around 50,000 cases are seen worldwide; and 10,000 deaths per year are seen in children below 15 years of age. JE has been reported from 23 states (viz: national vector borne disease control programme (NVBDCP), geospatial analysis, India). The study is an ecological study that looks in to the pattern of occurrence (time trend-explorative study) of Japanese B encephalitis in the states of India during the years 2018-2021. The objective of this study is to determine the geospatial mortality pattern of JE in the states of India during the years 2018-2021 and also to state wise forecasting using seasonal, environmental and geospatial analysis (mapping) of Japanese B encephalitis case fatality rates (CFR). The secondary data analysis of the JE and AES from the table provided by the NVBDCP was used. The mortality pattern and the distribution of the JE cases were more pronounced in the year 2019. The JE cases and deaths in 2019 were the highest with a mean of 110.6; Standard deviation of 148.8 and case fatality rate was 25.07. With the help of better understanding of the time trend (ecological study), recommendations could be given to strengthen the interventions under the NVBDCP program.

Keywords: Japanese B encephalitis, Acute encephalitis syndrome, National vector borne disease control programme, Geospatial analysis, Case fatality rates

INTRODUCTION

Japanese encephalitis (JE) is the main cause for viral encephalitis in Asia. Around 50,000 cases and 10,000 deaths per year in children below the age of 15 years.[1] Over the past 60 years, it has been estimated that JE has infected 10 million children worldwide. Mortality is 3 million and causing long-term disability in 4 million.[2] JE has been reported from 26 out of 29 states and 7 union territories occasionally since 1978. There were repeated outbreaks reported from 12 states of India during the last 10 years.[1,2] 24 countries in the WHO South-East Asia and Western Pacific regions have endemic JEV transmission, exposing more than 3 billion people to risks of infection. JEV is the main cause of viral encephalitis in many countries of Asia- 68,000 clinical cases every year. Although symptomatic JE is seen in minority, CFR among those with encephalitis can be as high as 30%. The permanent neurologic or psychiatric sequelae can occur in 30-50% of those with encephalitis.[3]

The main epidemiological factors that, aids and favors the JE transmission are coastal land areas, water logging during monsoon rainfalls, excessive irrigation, paddy cultivation, vector bionomics, certain serotypes and the monsoon weather (north east monsoon) itself; especially during October to December every year. This disease is usually maintained in the enzootic and epizootic phase; however, due to the above-mentioned factors could establish itself in to a zoonotic outbreak.[4,5] The well-

known methods for forecasting JE to distinguish between the predicted and observed cases were seasonal average (SA), seasonal adjustment (SAT) using the last three observations (SAT), modified method adjusting long-term cyclic trend (MSAT), and autoregressive integrated moving average (ARIMA). The last two methods were preferred in this study for data inaccuracies over a long-term period. The Geospatial techniques with remote sensing (RS) by applying the geographical information system (GIS) software could be the most effective tool for JE surveillance until recently.[6] The use of environmental (factors) and soci-economic covariates using regression modeling to predict the suitability of Culex vector sustenance had also been done earlier.[7]

The Japanese B encephalitis (Von Economo's disease) as originally described has got peculiar clinical stages that could last for few weeks and recover completely with no residual effects. Acute encephalitis syndrome (AES) is characterized by an acute onset of fever and clinical neurological manifestation that includes mental confusion, disorientation, delirium, or coma due to encephalopathy with poor GCS (Glasgow coma scale) scale with or without seizures.[8]

The incubation period of JE is 5 to 15 days. The stages of JE are the prodromal stage with fever, headache, gastrointestinal disturbances, lethargy and malaise up to 6 days. Acute encephalitic stage (1 week): Fever is usually high around 38 to 40.7 degrees centigrade with nuchal rigidity and focal neurological signs. During this stage convulsion can occur due to signs of raised intra-cranial pressure, difficulty of speech, dystonia, ocular palsies and hemiplegic defect (hemi-paresis). Quadriplegia and extra-pyramidal signs like coarse tremors and altered sensorium progressing in many cases leading to coma. The late stage and sequelae: This stage begins when active inflammation is at an end the temperature and ESR touches normal. Neurological signs either become stationary or tend to improve. Convalescence stage may be prolonged and could result in residual neurological deficits (permanent damage) with emotional instability. The CFR varies between 20-40 per cent and the average period between the onset of illness and death is about nine days.[9,10] The usual tests for JE are IgM antibody capture ELISA-CSF and serum samples by JE virus ELISA kit supplied by the national institute of virology, Pune for example revealed nearly 22.76% and 5% of the AES cases were positive for JE IgM in one study during the years 2011 and 2012 in the West Bengal.[11]

The surveillance mechanisms for JE are in place with investigations that are done as per the IDSP (Integrated disease surveillance project) mechanisms using special surveillance forms. Despite this Japanese B encephalitis is quite notorious for its outbreaks in India with higher CFR.[12] Hence, this study was done by ascertaining the trend analysis pattern of Japanese B encephalitis in various states of India during the year 2018-2021 an ecological time trend study.

Aim and objectives were to determine the pattern of occurrence (time trend) of JE in the states of India for the years 2018-2021 and to determine the geospatial mortality pattern-reference of JE in the states of India for the years 2018-2021.

METHOD

Type of the study was ecological study. Sample size was all the 23 JE reporting states under the NVBDCP during the years 2018-2021 were included. Study population: All the population in the 23 JE reporting states under the NVBDCP during the years 2018-2021. Estimation of the present study was done through secondary data analysis after data clearance in MS Excel office 2008.

The IEC was obtained from the SRM medical college hospital and research centre, Trichy, Tamil Nadu, India.

The following statistical methods were employed by utilizing the mean, standard deviation, Friedman rank test and Chi square test (For significance in trend). CFR (Mortality pattern) tables along with time trend analysis and mapping. The following software including SPSS v 26.0 and mapping software-map builder© was used in this study.

RESULTS

The distribution of the data amongst the 23 different states in India between the years 2018 to 2021 with cases and deaths respectively for the JE and AES is shown in Table 1.

The p=0.000 that is significant, since it was less than 0.05 @ 95% C.I. for the cases and deaths amongst the AES and JE cases respectively between the years 2018 to 2021 (Table 2 and 3). The mean Friedman rank test for deaths was the maximum at 3.17 and 3.3 for the AES and Japanese B encephalitis respectively, during the year 2019 (Table 2 and 3). The Standard deviation was 148.836 and 33.315 the highest correspondingly for JE cases and death during the year 2019 (Table 3). The CFR are shown in the shaded column for the year 2019; as that year was the highest during the overall outbreak period (Table 4). For this reason, the CFR for the year 2019 were depicted in the map across the various states in India and had favored most of the epidemiological and ecological factors for the distribution of JE CFR (Figure 1).

The moving aggregates of the CFR across the top five JE prevalent states during the years 2018-2021 fits the best model for this type of ecological study design and its quite obvious that the year 2019; shows the highest joint distribution data for the CFR that prevailed among the top 5 JE prevalent states correspondingly (Table 5).

Table 1: NVBDCP data entry after data clearance between the years 2018-2021 (till September 2021).

Name of the states	AES* 2018		JE 2018		AES 2019		JE# 2019		AES 2020		JE 2020		AES 2021		JE 2021	
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
Andhra Pradesh	16	0	0	0	2	0	0	0	43	0	0	0	11	0	0	0
Arunachal Pradesh	0	0	0	0	68	2	68	2	1	0	0	0	0	0	0	0
Assam	1492	183	509	94	2652	353	642	161	595	96	320	51	435	80	212	39
Bihar	124	33	74	11	292	82	135	27	172	23	29	2	132	8	14	2
Chhattisgarh	0	0	0	0	273	5	53	5	58	4	13	4	11	0	1	0
Goa	18	0	3	0	71	0	1	0	4	0	0	0	2	0	0	0
Haryana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jharkhand	544	0	66	0	912	3	112	3	485	0	44	0	458	2	32	2
Karnataka	380	5	35	5	397	4	33	4	310	0	17	0	220	0	14	0
Kerala	26	14	5	2	66	7	11	2	13	1	0	0	0	0	0	0
Madhya Pradesh	0	0	0	0	865	1	42	1	0	0	0	0	0	0	0	0
Maharashtra	48	1	6	1	167	11	35	10	46	1	2	1	0	0	0	0
Manipur	283	3	57	3	1177	6	343	6	29	4	29	4	102	2	10	2
Meghalaya	243	6	90	6	711	9	191	9	230	1	38	1	38	1	2	1
Nagaland	27	0	1	0	97	0	10	0	5	0	0	0	8	0	0	0
Odisha	1720	10	143	0	1962	8	195	1	373	3	14	0	163	0	8	0
Punjab	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Tamil Nadu	1287	5	147	0	1007	2	231	1	331	3	47	1	225	3	32	2
Telangana	27	0	20	0	129	0	55	0	5	0	2	0	0	0	0	0
Tripura	311	0	59	0	325	2	61	2	239	0	19	0	109	0	21	0
Uttar Pradesh	3080	230	323	25	2185	126	235	21	1646	83	100	9	1043	21	86	2
Uttarakhand	0	0	0	0	18	0	9	0	28	2	4	2	1	0	1	0
West Bengal	1762	146	140	35	1618	89	82	11	867	26	41	4	637	16	14	1
Total	11388	636	1678	182	14995	710	2545	266	5480	247	719	79	3595	133	447	51

*AES-acute encephalitis syndrome; #Japanese B encephalitis. Source: NVBDCP.

Table 2: Distribution of the mean, standard deviation, mean rank and chi-square test values amongst the AES cases and death between the years 2018-2021.

Year of reporting	Mean		Standard deviation		Mean rank (Friedman rank)		Chi square test	
AES	**Cases**	**Death**	**Cases**	**Death**	**Cases**	**Death**	**Cases**	**Death**
2018	495.13	27.75	811.562	64.526	2.70	2.76	$\chi2$=37.891, @3 df, p=0.000*	$\chi2$=23.25, @ 3 df, p=0.000*
2019	651.96	30.87	782.618	77.935	3.63	3.17		
2020	238.26	10.74	383.653	25.862	2.24	2.28		
2021	156.30	5.78	260.921	17.069	1.43	1.78		

*Denotes p value is significant<0.05.

Table 3: Distribution of the mean, standard deviation, mean rank and chi-square test values amongst the JE cases and death between the years 2018-2021.

Year of reporting	Mean		Standard deviation		Mean rank (Friedman rank)		Chi square test	
JE	Cases	Death	Cases	Death	Cases	Death	Cases	Death
2018	72.96	7.91	122.29	20.717	2.83	2.52	$\chi2=46.446$, @ 3 df, $p=0.000^*$	$\chi2=23.30$, @ 3 df, $p=0.000^*$
2019	110.65	11.57	148.83	33.315	3.7	3.3		
2020	31.26	3.43	67.391	10.595	2.02	2.24		
2021	19.43	2.22	46.171	8.062	1.46	1.93		

*Denotes p value is significant<0.05.

Table 4: Distribution of the CFR of the 23 states during the years 2018-2021 in India.

Name of the state	2018	2019	2020	2021
Andhra Pradesh	0	0	0	0
Arunachal Pradesh	0	2.94	0	0
Assam	18.46*	25.07	15.93	18.39
Bihar	14.86	20	6.9	14.28
Chhattisgarh	0	9.43	30.77	0
Goa	0	0	0	0
Haryana	0	0	0	0
Jharkhand	0	2.67	0	6.25
Karnataka	14.28	12.12	0	0
Kerala	40	18.18	0	0
Madhya Pradesh	0	2.38	0	0
Maharashtra	16.66	28.57	50	0
Manipur	5.26	1.57	13.79	20
Meghalaya	6.66	4.71	2.63	50
Nagaland	0	0	0	0
Odisha	0	0.51	0	0
Punjab	0	0	0	0
Tamil Nadu	0	0.43	2.12	6.25
Telangana	0	0	0	0
Tripura	0	3.27	0	0
Uttar Pradesh	7.74	8.93	9	2.32
Uttarakhand	0	0	50	0
West Bengal	25	13.41	9.75	7.14

*Denotes figures in percentages.

Table 5: Distribution of the CFR JE of first five states roll over in India during the years 2018-2021 in India (Moving aggregates with joint distribution).

Name of the state	2018	Name of the state 2019	2019	Name of the State 2020	2020	Name of the State 2021	2021
Kerala	40*	Maharashtra	28.57	Maharashtra	50	Meghalaya	50
West Bengal	25	Assam	25.07	Uttarakhand	50	Manipur	20
Assam	18.46	Bihar	20	Chhattisgarh	30.77	Assam	18.39
Maharashtra	16.66	Kerala	18.18	Assam	15.93	Bihar	14.28
Bihar	14.86	West Bengal	13.41	Manipur	13.79	West Bengal	7.14

*Denotes number in percentage.

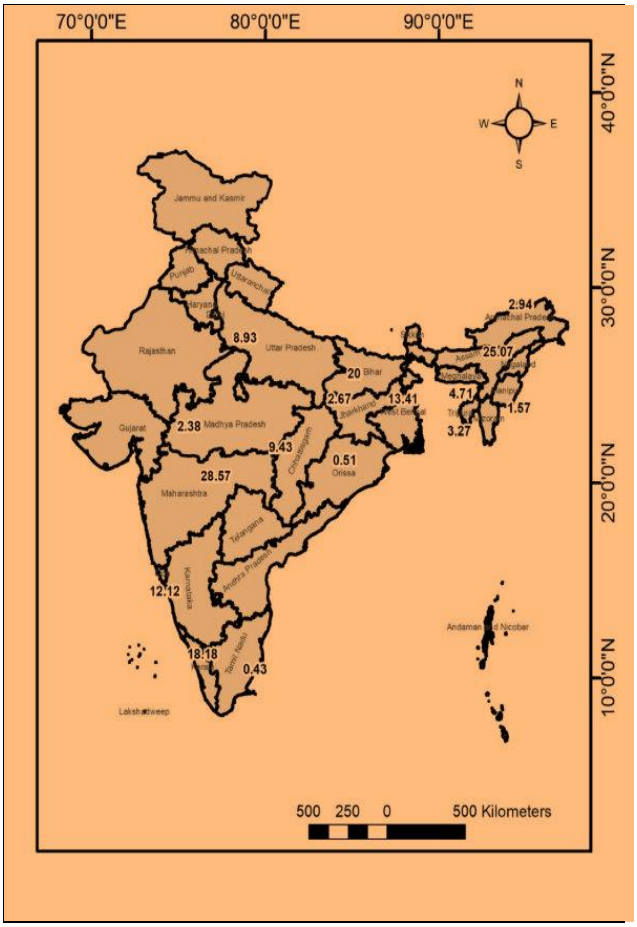

Figure 1: CFR of JE amongst the different states across India during 2019.

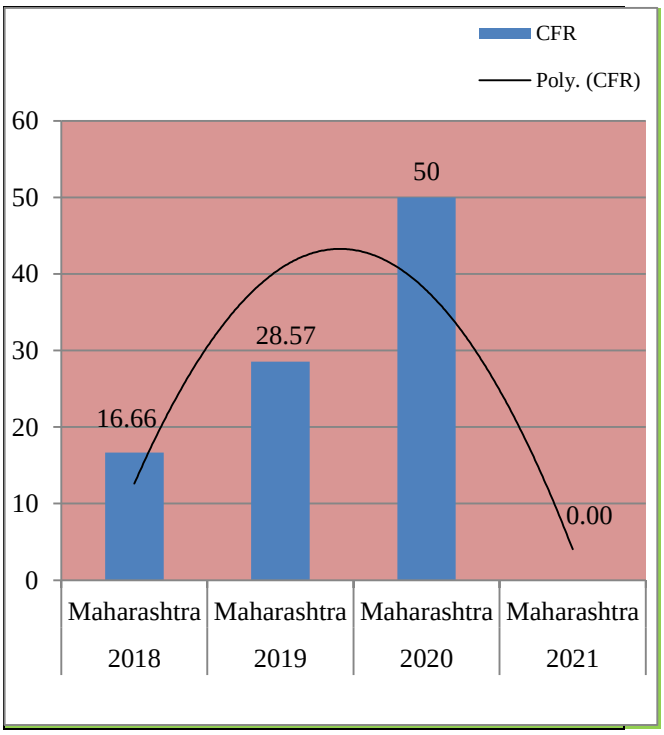

Figure 2: Case fatality rate in Maharashtra.

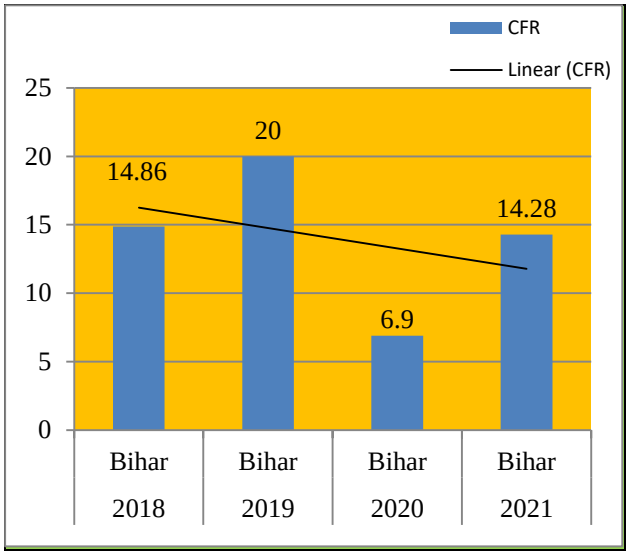

Figure 3: Case fatality rate in Bihar.

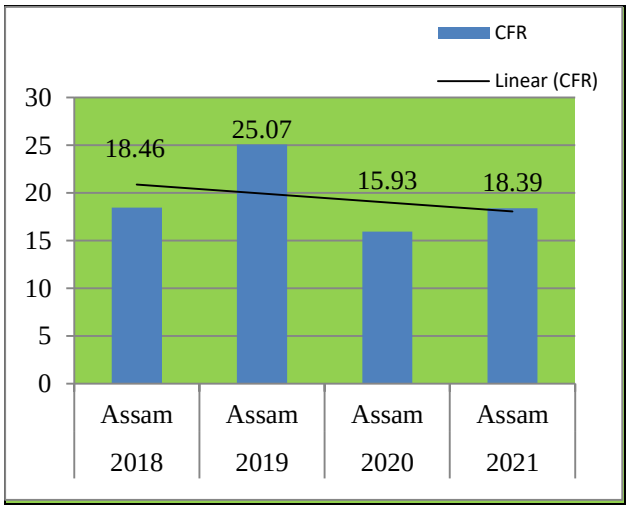

Figure 4: Case fatality rate in Assam.

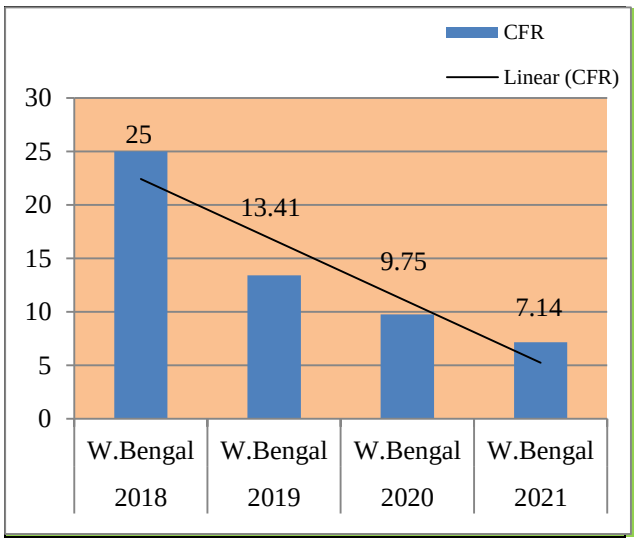

Figure 5: Case fatality rate in West Bengal.

Figure 2-5 emphasized that the CFR in Maharashtra, Assam, Bihar and West Bengal showed a declining trend during the years 2018-2021.

DISCUSSION

In the present study the JE cases and deaths in 2019 were the highest with a mean of 110.6, standard deviation of 148.8 and case fatality rate was 25.07.

In a study by Tiwari et al case fatality averaged nearly 30% and the majority of the survivors were left with permanent neuropsychiatric sequelae and extension of the outbreak in to other adjacent geographical regions.[13]

In our study the chi square test p value was found to be 0.000 and that is significant, since it was less than 0.05 @ 95% CI. for the cases and deaths amongst the AES and JE cases respectively between the years 2018 to 2021. The mean Friedman rank test for deaths was the maximum at 3.17 and 3.3 for the AES and Japanese B encephalitis respectively, during the year 2019.

According to one study in Cachar district of Assam the CFR in AES and JE cases was found to be 12.34% and 12.24% respectively with $p<0.05$ for cases and deaths for AES/JE. The monthly JE cases show seasonal peaks during June to October, during both the rainy and post-rainy seasons.[14]

In one study done in the Northern India especially; the eastern part of Uttar Pradesh and western part of Bihar reported 25% infectious etiology in nearly one third of the AES out of which the most important agent was *O. tsutsugamushi* infection (scrub typhus) an important causative agent of AES in India as a part of fever surveillance.[15]

A study in Bihar total of 396 cases of JE, were reported with approximately 14% CFR. The disease peaks were during the start and end of the Indian summer and monsoon months for AES and JE, respectively.[16]

The current study revealed that the CFR for the Japanese encephalitis in Maharashtra, Assam, Bihar and West Bengal demonstrated a declining trend during the years 2018-2021.

A study involving the trend analysis during 2011 to 2013 revealed that the proportion of JE positives in AES cases is on the decreasing trend in UP; though the total number of AES cases has not substantially decreased, by using case definitions and lab investigations.[17]

Limitations

These kinds of studies could pronounce the effect on ecological fallacies and could influence the ecological bias with subtle influence on the inferential statistics derived from the secondary data analysis.

CONCLUSION

The Japanese encephalitis cases were prominent during the year 2019 as shown by its mean, standard deviation and mean rank (Friedman rank test). The CFR were highest in the states of Maharashtra, Assam, Bihar, W. Bengal and Meghalaya between the years 2018-2021. The trendline; however, showed a decline pattern in all these states during those years.

Recommendations

Based on these study findings the recommendations could be given to strengthen the existing interventions under the NVBDCP program. Strengthen the Serological surveillance techniques (IDSP forms including lab investigations) especially in case of JE positive cases amongst children. During outbreaks could prepare a geospatial analysis with seasonal forecasting methods; SA-reference to predict the mortalities and by addressing the CFR more rigorously. To observe carefully during the clinical stages of JE and by further preventing the post-encephalitic sequelae and its detrimental events by appropriate referral mechanism and clinical judgments. The current JE immunizations mainly in the endemic areas (districts) to go with full swing for example in states like Tamil Nadu compulsorily.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Samuel P, Thenmozhi V, Muniaraj M, Ramesh D, Jerald Leo S, Balaji T, et al. Changing paradigm in the epidemiology of Japanese encephalitis in a non-endemic region. J Vector Borne Dis. 2018;55(3):203-7.
2. Japanese encephalitis. Available at: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/japanese-encephalitis#:~:text=Japanese%20encephalitis%20(JE)%20is%20a,in%20practically%20all%20Asian%20countries. Accessed 23 August 2024.
3. Japanese encephalitis. Available at: https://www.who.int/news-room/fact-sheets/detail/japanese-encephalitis#:~:text=Key%20facts,cases%20every%20year%20(1). Accessed on 21 August 2024.
4. Japanese encephalitis. Available at: https://ncvbdc.mohfw.gov.in/index1.php?lang=1&level=1&sublinkid=5773&lid=3693. Accessed on 20 August 2024.
5. Růžek D. Flavivirus Encephalitis Booklet, in Chapter 15 An emerging and Spreading Arbovirosis, InTech, Janeza Trdine, Rijeka, Croatia. 2011; 295-309.
6. Handique BK, Khan SA, Mahanta J, Sudhakar S. Forecasting Japanese encephalitis incidence from

historical morbidity patterns: Statistical analysis with 27 years of observation in Assam, India. J Vector Borne Dis. 2014;51(3):172-8.
7. Longbottom J, Browne AJ, Pigott DM, Sinka ME, Golding N, Hay SI, et al. Mapping the spatial distribution of the Japanese encephalitis vector, Culex tritaeniorhynchus Giles, 1901 (Diptera: Culicidae) within areas of Japanese encephalitis risk. Parasites Vectors. 2017;10(1):148.
8. Japanese encephalitis. Available at: https://ncvbdc.mohfw.gov.in/WriteReadData/l892s/Revised_guidelines_on_AES_JE.pdf. Accessed on 23 August 2024.
9. Park K. Epidemiology of communicable diseases. Park's Textbook of Preventive and Social Medicine. Chapter 5, 22nd edition, M/s Banarsidas Bhanot Publishers, Jabalpur. 2013;317.
10. Japanese encephalitis. Available at: https://www.indianpediatrics.net/nov2001/nov-1252-1264.htm. Accessed on 23 August 2024.
11. Bandyopadhyay B, Bhattacharyya I, Adhikary S, Mondal S, Konar J, Dawar N, et al. Incidence of Japanese encephalitis among acute encephalitis syndrome cases in West Bengal, India. BioMed Res Int. 2013;2013:896749.
12. Chakraborty D, Banerjee S, Maji D, Kanti Dey T, Mondal P, Basu M. A Descriptive Study of Japanese Encephalitis in West Bengal, India, Based on Surveillance Data: Changing Pattern Observed in Recent Years. Scholars J Applied Med Sci. 2015;3(1E):320-8.
13. Tiwari S, Singh RK, Tiwari R, Dhole TN. Japanese encephalitis: A review of the Indian perspective. In Braz J Infect Dis. 2012;16(6):564-73.
14. Dey AK, Chakravarty A. Epidemiological study on trends of Japanese encephalitis and acute encephalitis syndrome in cachar district of Assam. J Evolution Med Dental Sci. 2019;8(21):1719-25.
15. Singh AK, Kumar A, Dhole TN. Recent Trends and Changing Aetiology of Acute Encephalitis Syndrome in India. Asian J Res Infect Dis. 2020;3(1):33-47.
16. Kumar P, Pisudde PM, Sarthi PP, Sharma MP, Keshri VR. Status and trend of acute encephalitis syndrome and Japanese encephalitis in Bihar, India. National Medical J India. 2017;30(6):317-20.
17. Singh A, Kharya P, Agarwal V, Singh S, Singh N, Jain P, et al Japanese encephalitis in Uttar Pradesh, India: A situational analysis. J Family Med Primary Care. 2020;9(7):3716-21.

Cite this article as: Karthikeyan S, Suguna A, Pandi S. Trend analysis of Japanese B encephalitis in the states of India during the years 2018 to 2021: an ecological study. Int J Community Med Public Health 2024;11:4127-33.