



# ZOONOTIC DISEASE OUTBREAKS IN KERALA: CAUSES, TRENDS AND MITIGATION STRATEGIES

**Dr. Jinchu K Raju**

*Research Associate, International Centre for Technological Innovations*

## ABSTRACT

*Zoonotic diseases are a significant public health challenge worldwide, with Kerala, a picturesque state in southwest India, experiencing an increase in the incidence of these diseases. This paper analyses the causes of the increase in zoonotic diseases in Kerala between 2018 and 2023 on a multifaceted basis. A number of factors contribute to the emergence and resurgence of these diseases, such as ecological changes, habitat destruction, climate variability, animal trade, and improper food practices. There is a clear emphasis in the study on the importance of wildlife conservation, sustainable land management, animal trade regulation, public awareness campaigns, a One Health approach, research and surveillance, vector control, occupational safety and health measures, community engagement, and government support in mitigating the impact of zoonotic diseases. By implementing these, Kerala can serve as a valuable case study, revealing insights and making recommendations for other states facing similar challenges, emphasizing the importance of collaborative efforts and proactive measures for ensuring the protection of public health and biodiversity.*

## ABBREVIATIONS

AES- Acute encephalitis syndrome,

JE- Japanese encephalitis,

LS- leptospirosis,

S.Typhus- scrub Typhus,

KFD- Kyasanur forest disease,

WN- West Nile,

M.pox- Monkey pox,

C- Case,

D- Death,

DIST-District

TVM-Thiruvananthapuram,

KLM- Kollam,

PTA- Pathanamthitta,

ALPY- Alappuzha,

KTM- Kottayam,

IDK- Idukki,

EKM- Ernakulam,

THR- Thrissur,

PKD- Palakkad,

MLP- Malappuram,

KZD- Kozhikode,

WYD- Wayanad,

KNR- Kannur,

KSD- Kasargod.

## INTRODUCTION

Infectious diseases that originate from animals are considered Zoonotic Diseases, which are acquired by humans from Zoonotic Reservoirs through either natural transmissions or through zoonotic vectors. Emerging zoonotic diseases are either newly evolved diseases most particularly prevalent in developing nations or have occurred in the past but are now rapidly spreading to new regions, hosts, and vectors<sup>1</sup>. Globally, it represents a significant public health issue, with India being a geographical hotspot for these diseases<sup>2</sup>. During the past few years, Kerala, a picturesque state in southwest India, has experienced a significant rise in zoonotic disease incidence. Studies clearly state that more than 75% of contagious diseases in Kerala are due to zoonosis<sup>3</sup>. As these diseases are transmitted from animals to humans, they pose a significant public health challenge, which requires a thorough understanding of the underlying causes. And they often have wide-ranging implications for both human health and the environment, so understanding the causes is crucial not only for the state, but also for the global community. In order to find these, a

multifaceted analysis is required, taking into account numerous factors such as urbanization, agricultural practices, climate change, and human behaviour. Furthermore, as the ecology changes, new spots, hosts, and vectors emerge, for example, cutaneous leishmaniasis, scrub typhus and Japanese encephalitis. The robust and efficient screening programs of the state are responsible for detecting a number of these diseases. Let's dive deeper to understand why Kerala remains vulnerable to more zoonotic pathogens, what the state can further do to curb the outbreaks, and what can other states learn from this small southern state.

## RESEARCH METHODOLOGY

Collected data about predominant zoonotic diseases from Kerala government official websites and newspaper and then arranged them in year wise to understand the increase in its occurrence. Then analysed the probable causes for its emergence and re-emergence. The disease statistics of 2023 is incomplete as the district wise data is not published in the government site. The given data is collected from newspapers.



### TREND OF ZONOTIC DISEASES IN KERALA

Table 1: Trend from 2018 to 2022<sup>4</sup>

Diseases	2018		2019		2020		2021		2022	
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
Leptospirosis	2079	99	1211	57	1039	48	1745	97	2482	121
Prob. leptospirosis	-	-	-	-	-	-	-	-	2833	169
Japanese encephalitis	5	2	11	2	-	-	-	-	2	0
AES(Prob. JE)	28	15	59	5	15	4	36	1	38	8
Scrub typhus	400	6	579	14	423	8	438	6	727	24
KFD	0	0	8	2	29	3	4	0	1	0
H1N1	823	50	853	45	58	2	1	0	94	11
Confirmed rabies	-	-	-	-	5	5	11	11	15	15
Prob. rabies	-	-	-	-	-	-	-	-	12	12
Zika	-	-	-	-	-	-	90	0	15	0
West Nile	1	0	11	2	-	-	1	0	3	1
Monkey pox	-	-	-	-	-	-	-	-	8	1
Nipah	18	16	1	0	-	-	1	1	-	-

### DISTRICT WISE DATA ON ZONOTIC OCCURENCES

Table 2: District Wise Zoonotic Infection Data- 2018<sup>5</sup>

DIST	JE		LS		S.Typhus		H1N1		WN		Nipah	
	C	D	C	D	C	D	C	D	C	D	C	D
TVM	-	-	275	13	262	2	84	11	-	-	-	-
KLM	-	-	134	16	10	2	39	7	-	-	-	-
PTA	-	-	312	11	7	0	15	1	-	-	-	-
ALPY	1	0	254	6	-	-	102	1	-	-	-	-
KTM	-	-	130	2	8	0	61	1	-	-	-	-
IDK	-	-	39	4	5	0	7	0	-	-	-	-
EKM	-	-	77	2	-	-	77	6	-	-	-	-
THR	-	-	83	12	1	0	70	2	-	-	-	-
PKD	-	-	112	7	6	0	43	3	-	-	-	-
MLP	-	-	218	8	6	1	97	9	-	-	4	3
KZD	4	2	261	13	39	0	161	6	1	0	14	13
WYD	-	-	114	1	43	1	22	0	-	-	-	-
KNR	-	-	40	2	9	0	30	3	-	-	-	-
KSD	-	-	2	30	4	0	15	0	-	-	-	-

Table 3: District Wise Data- 2019<sup>6</sup>

DIST	JE		LS		S.Typhus		H1N1		WN		Nipah	
	C	D	C	D	C	D	C	D	C	D	C	D
TVM	-	-	220	10	406	6	41	1	1	0	-	-
KLM	2	2	68	6	16	1	49	5	-	-	-	-
PTA	-	-	78	1	5	0	36	5	-	-	-	-
ALPY	-	-	188	4	6	0	99	5	-	-	-	-
KTM	-	-	80	3	14	0	85	4	-	-	-	-
IDK	-	-	22	1	9	0	18	2	-	-	-	-
EKM	-	-	41	4	1	0	64	2	-	-	1	0



THR	3	0	16	9	3	0	74	2	-	-	-	-
PKD	1	0	55	2	10	0	34	3	-	-	-	-
MLP	-	-	129	3	3	1	67	5	4	2	-	-
KZD	4	0	168	6	32	3	142	7	5	0	-	-
WYD	-	-	83	7	61	3	37	3	-	-	-	-
KNR	-	-	42	1	11	0	83	1	1	0	-	-
KSD	1	-	21	0	2	0	24	0	-	-	-	-

**Table 4: District wise data- 2020<sup>7</sup>**

DIST	JE		LS		S.Typhus		H1N1		KFD		Rabies	
	C	D	C	D	C	D	C	D	C	D	C	D
TVM	1	1	178	6	323	5	1	0	-	-	-	-
KLM	-	-	48	2	3	0	10	0	-	-	-	-
PTA	-	-	91	1	5	0	-	-	-	-	-	-
ALPY	-	-	131	2	2	0	1	0	-	-	-	-
KTM	-	-	112	2	13	0	-	-	-	-	-	-
IDK	-	-	27	3	4	0	-	-	-	-	-	-
EKM	1	0	65	8	4	0	7	0	-	-	1	1
THR	-	-	43	8	3	0	-	-	-	-	-	-
PKD	6	0	36	1	5	1	-	-	-	-	-	-
MLP	5	2	72	3	1	0	8	1	-	-	-	-
KZD	1	1	73	4	16	0	19	1	-	-	-	-
WYD	1	0	158	4	27	2	-	-	29	3	2	2
KNR	-	-	42	2	17	0	11	0	-	-	2	2
KSD	-	-	3	2	-	-	1	0	-	-	-	-

**Table 5: District wise data- 2021<sup>8</sup>**

DIST	LS		S.Typhus		H1N1		Rabies		WN		KFD		Nipah		Zika	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
TVM	251	9	357	3	-	-	1	1	-	-	-	-	-	-	85	0
KLM	63	5	6	1	-	-	2	2	-	-	-	-	-	-	1	0
PTA	87	3	2	0	-	-	1	1	-	-	-	-	-	-	-	-
ALPY	235	10	3	0	1	0	1	1	-	-	-	-	-	-	-	-
KTM	202	7	10	0	-	-	-	-	-	-	-	-	-	-	1	0
IDK	20	8	3	1	-	-	-	-	-	-	-	-	-	-	-	-
EKM	231	16	1	0	-	-	-	-	-	-	-	-	-	-	2	0
THR	53	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PKD	78	5	8	0	-	-	-	-	-	-	-	-	-	-	-	-
MLP	124	9	2	0	-	-	1	1	1	0	-	-	-	-	-	-
KZD	174	10	19	1	-	-	3	3	-	-	-	-	1	1	1	0
WYD	111	4	20	0	-	-	-	-	-	-	4	0	-	-	-	-
KNR	38	4	6	0	-	-	1	1	-	-	-	-	-	-	-	-
KSD	78	0	1	0	-	-	1	1	-	-	-	-	-	-	-	-

**Table 6: District Wise Data – 2022<sup>9</sup>**

DIST	JE		LS		S.Typhus		H1N1		Rabies		KF D		WN		Zika		M.pox	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
TVM	5	2	324	9	535	14	11	1	8	8	-	-	-	-	14	0	-	-
KLM	5	1	155	4	7	0	3	1	1	1	-	-	-	-	1	0	1	0
PTA	0	0	160	4	9	0	3	1	1	1	-	-	-	-	-	-	-	-
ALPY	3	0	293	9	13	0	7	0	2	2	-	-	-	-	-	-	-	-
KTM	3	1	118	5	15	0	-	-	1	1	-	-	-	-	-	-	-	-
IDK	0	0	32	2	6	1	-	-	1	1	-	-	-	-	-	-	-	-
EKM	10	1	258	11	10	0	4	0	0	0	-	-	-	-	-	-	-	-
THR	0	0	174	20	10	2	7	2	5	5	-	-	2	1	-	-	1	1



PKD	9	1	123	16	9	1	18	1	4	4	-	-	-	-	-	-	-
MLP	2	1	185	17	37	4	10	2	1	1	-	-	-	-	-	4	0
KZD	2	0	129	14	27	2	18	2	2	2	-	-	-	-	-	-	-
WYD	1	1	424	4	27	0	4	0	-	-	1	0	-	-	-	-	-
KNR	-	-	50	6	18	0	0	0	1	1	-	-	-	-	-	1	0
KSD	-	-	57	0	4	0	9	1	-	-	-	-	-	-	-	1	0

**Table 7: District wise data -2023(Jan – November)**

Disease	Incidents
JE	1 case in Kozhikode district <sup>10</sup>
LS	till July 36 confirmed deaths and 53 suspected deaths in Kerala. June- 395 cases& 23 deaths, July – 149 cases and 10 deaths <sup>11</sup> , August- 274 cases and 11 deaths, September – 210 cases and 6 deaths, October – 338 cases and 14 deaths, November(till 4) – 40 cases and 2 deaths <sup>12</sup>
H1N1	January – 15 cases and 2 deaths, February – 27 cases and 1 death, March 1 to 21 – 68 cases and 1 death, June – 373 cases and 12 deaths, July – 100 cases and 3 deaths <sup>13</sup> . In August 2023, an African swine flu was identified among pigs in a private farm located in Kanicher village of Kannur <sup>14</sup>
WN	Kozhikode – 6 cases and 2 deaths, Ernakulam – 2 cases and 1 death <sup>15</sup> Alappuzha – 2 cases <sup>16</sup>
ST	Reported in Alappuzha <sup>17</sup>
Rabies	In first five months of 2023 itself, Kerala reported around 1 lakh dog bite cases. Cases reported in each district are <sup>18</sup> , Thiruvananthapuram – 19854, Kollam – 14755, Pathanamthitta – 6212, Alappuzha – 10072, Kottayam – 14159, Idukki – 3831, Ernakulam – 12128, Thrissur – 14164, Palakkad – 12451, Malappuram – 6501, Kozhikode – 8893, Wayanad – 2612, Kannur – 7586, Kasargod – 3919. The number of deaths due to rabies stood at 7 during these months. Deaths occurring even after the anti-rabies vaccination increases the public concern.

## DISCUSSION

Leptospirosis which is a bacterial zoonotic disease spread through the urine of infected animals especially rats<sup>19</sup>. Humans can get the infection through direct contact with urine from infected animals or through water, soil or food contaminated with their urine. The statistical data says leptospirosis is the major zoonotic disease in Kerala which killed 290 people in the year of 2022. From 2018 to 2021 even though there was a reduction in the cases, the death rate is almost similar. But in 2022 the cases and death were multiplied which is a threat to the health system.

Japanese encephalitis is also a re-emerging disease in Kerala which took life of 2 affected people out of 5. Acute encephalitis syndrome (AES) which showed same symptoms of JE even though not clinically proved also caused death of 15 people in 2018. In the next year the number of infected individuals were doubled but the death rate remained as two. For the following two years case of clinically proven JE was nil, at the same time there were cases of probable JE which resulted in death of 4 and 1 people in 2020 and 2021 respectively. In 2022 also the cases of confirmed JE were present, but could treat successfully. In contrast the cases of AES raised to 38 and 8 of the affected were dead.

Scrub typhus is an emerging zoonotic disease in Kerala caused by a rickettsial organism in human. People get infection when they visit infected ecological areas like poorly maintained kitchen garden, abandoned plantations, overgrown forest clearings, shrubby fringes of fields and forest, grassy fields, river banks and mites are also present on the body of animals such as mice and rats<sup>20</sup>. we can see a gradual rise in the reported

cases of scrub typhus from 2018 to 2022. If the cases of scrub were 400 in 2018, then the number reached to 727 in 2022 and 24 of them died. even though the disease is not that much fatal, the mortality rate is increasing year by year from odd numbers to even number which actually a trend to consider seriously.

Kyasanur forest disease (KFD) is another zoonotic infection endemic to Karnataka state and it transmitted to Kerala. It first appeared in Wayanad district in Kerala and then reappeared in other districts during 2014 – 2015 years. This is a viral haemorrhagic disease caused in human by tick bites which mainly live in bodies of monkeys, that gives a second name to the disease 'monkey fever'. Direct contact with an infected animal, most importantly a sick or dead monkey increases the chances of infection. Forest dwellers, forest workers, wood collectors and livestock rearers are come under risk group<sup>21</sup>. After the 2014-15 incidence, the disease again appeared in 2019 and 2 out of 8 infected persons were died. The data shows that the fatality of KFD is less but the number of infected individuals is increasing each year. In 2021 and 2022 it does not caused death, but it is not a point the state can relax. Because it is not a disease which spread from human to human and from 2019 itself there is continuous reported cases of KFD which is a warning to the state pointing to the weak current precautionary methods.

H1N1 or swine flu or pig influenza is a human respiratory infection caused by an influenza strain that started in pigs. Human being gets the infection from close contact with the pigs and then it spread to human to human<sup>22</sup>. There is a considerable decrease in the cases and death rate of the flu from 2018 to 2022



but every year there is an outbreak of the disease which exists as an alarming sign to the state.

Among the prevalent zoonotic diseases rabies is the most fatal one. Since many years a lot of people especially kids lost their lives due to this deadly virus. From the data it is clear that since 2020 it has an outbreak every year which took the life of all patients infected with the virus. That is its fatality rate is 100%. People get the virus from the saliva of an infected animal. It usually transmitted through animal bite especially stray dog bite<sup>23</sup>. The alarming rise in rabies cases point to the tremendous increase of stray dogs in the state and practice and implementation of rules to manage stray dogs is not that much fruitful.

Zika virus is a newly emerging disease in Kerala. It was first reported in 2021 from Thiruvananthapuram district of Kerala state. The number of cases reported from various districts were 90 and were survived. In the next year also, there was a re-emergence of the disease, however the number of confirmed cases were 15, which showed a considerable reduction in the occurrence rate. It was first discovered from a rhesus monkey and isolated from the Aedes mosquito in Zika forest, which is the zoonotic origin of the infection<sup>24</sup>. In 2023, there is no reported cases of Zika till the date. West Nile fever is another emerging zoonosis Kerala and it first detected in the state in 2011. After 7 years it reappeared in 2018 but the mortality rate was zero. In coming years, there was continuous outbreaks except 2020. In 2019, two were dead and in 2022 one lost the life. Birds serve as the reservoir for West Nile virus and the transmission occurs mainly through mosquitoes<sup>25</sup>.

Monkey pox is also a newly emerged zoonotic disease in Kerala in 2022. The confirmed cases were 8 and out of that one person died. Since the government is trying to curtail the re-appearance of zoonotic diseases, these newly forming diseases stand as a question mark to the community health status of the state.

Last but not least is the outbreaks of Nipah. The first emergence of Nipah was in 2018 which resulted in death of 16 people out of 18 affected with the virus. Even though there were occurrences of other zoonotic diseases in Kerala, the government and people became more vigilant about the zoonotic diseases after the attack of Nipah virus. Like rabies, its fatality rate is almost 100% which makes it as one of the prevalent zoonosis in Kerala. Later in 2019 and 2021 two more outbreaks were happened in the state. In both years, only one case was reported. In 2021 the affected individual died. The state's effective coordination of health department was the cause behind the reduced mortality of Nipah outbreaks. They could find the reservoir of virus as fruit bats even after one or two reported cases which helped to implement effective isolation and thereby to reduce further spread of the infection<sup>26</sup>. In Kerala, it appeared continuously in 2018 and 2019 in Kozhikode district, but in 2021 its origin was in Malappuram district. The latest outbreak is in the current year of 2023. 6 cases were reported again in Kozhikode and two of the diseased were died.

## CAUSES OF EMERGENCE AND REEMERGENCE

1. Ecological changes – due to the increase in human population, they are forced to invade the unexploited territories of natural resources by construction of roads, artificial lake, dams etc which finally result in deforestation. Large scale expansion of agricultural resources and unsustainable land-use patterns lead to alteration in the feeding habits of the blood sucking vectors and changes in the population of reservoir animals. Pathogens of zoonotic diseases naturally exist in the ecosystem. The unnatural stress on the ecosystem created by deforestation or people entering wild habitats for agro - forestry purposes could trigger or even bring diseases to human habitations<sup>2</sup>. A recent example is Nipah Virus, caused by fruit bats taking over agricultural products and causing food-borne zoonosis in Kerala<sup>27</sup>.

2. Natural geographical specifications of Kerala - Kerala is enriched with rich wetlands and uncountable waterbodies that keep the state's greenery looks alive. Such places are the main habitats for flocks of migratory birds which cause transmission of zoonotic diseases such as avian flu from wild to domestic bird populations.<sup>27</sup>

3. Destruction of natural habitat – urbanization and industrialisation have largely affected the existence of natural habitats of wild animals such as monkeys, bats, and civet cats which have forced them to move to domestic habitations and establish new interfaces with human beings. And these new interfaces lead to the spread of zoonotic diseases. The recent incidents of appearance of wild animals in Kerala's domestic areas which naturally live in inner forest is an example of this. It may be resulted in the transmission of disease pathogens to domestic animals.<sup>28</sup>

4. Global warming & Climate change - It plays an important role in the spread of zoonotic diseases. There is an individual ideal temperature for breeding and growth of each vector and host vertebrates. If the atmospheric temperature of a place, which was earlier unsuitable for these hosts, turns favourable due to global warming and associated weather changes, the pathogen and the vector will grow there. This will lead to the spread of such diseases in new areas. When coming to Kerala, since some years the weather conditions are becoming unpredictable and the seasonal changes are unnatural. The flood occurred in 2018 is an example of this change. These all may become favourable environment for the growth of pathogens.<sup>29</sup>

5. Handling animal by-products and wastes (occupational hazards) – The disease rate in workers, who are closely contact with animals during the course of their occupation, is higher than the rest of the population, e.g., anthrax in carpet weavers, livestock raisers and workers with animal hair in the textile industry, tick borne diseases in wood cutters, salmonellosis in food processors, bovine tuberculosis in farmers etc.<sup>30</sup>

6. Increased animal population & trading - Countries which import animals, wool, bone meal, meat, etc. from an area where some of the zoonoses are endemic, are likely to introduce the disease into their territories, e.g., salmonellosis, anthrax, etc. In Kerala there are about 18 animal check posts through which



animals are imported from nearby states for many purposes. It is a major cause for emergence of new infections in Kerala.<sup>30</sup> In addition, Rabies was the result of stray dogs and other rabid animals ravaging freely and attacking people, leading to outbreaks of the disease. Over the past 5 years, the number of dogs infected with rabies has doubled in Kerala<sup>31</sup>. Mismanagement of street dogs, including disruption of vaccination and birth control activities, has also played a role in the development of this problem.

7. Improper food practice - it is a fact that the Kerala people largely depends on animal protein as a part of their diet. Experts' opinion that this has increased the prevalence and re-emergence of viral pathogens.<sup>32</sup>

### CONCLUSION AND RECOMMENDATIONS

In conclusion, the rising incidence of zoonotic diseases in Kerala underscores the urgency of developing comprehensive strategies to mitigate their impact on public health. According to the multifaceted analysis presented in this paper, ecological changes, climate variability, habitat destruction, and human behaviour all play a significant role in promoting the emergence and re-emergence of these diseases. There is a need for proactive measures to curtail the spread of zoonotic pathogens as Kerala struggles to address this significant public health issue.

In order to mitigate the risk of disease transmission, wildlife conservation efforts should be strengthened, sustainable land management practices should be implemented, and animal trade should be regulated. It is possible to prevent the entry of diseases into the state by strengthening check-posts by posting veterinary doctors and implementing point-of-care testing methods. To reduce the number of infected stray dogs and thereby to prevent Rabies, local municipalities need to be strengthened in terms of resources and funding for the development of effective control measures. The number of ABC centres should be increased and their activities should be monitored thoroughly.

Foodborne zoonoses should be reduced through public awareness campaigns that emphasize the importance of proper food handling and preparation. It is also essential to invest in research that will enable us to understand the evolving nature of zoonotic diseases and their transmission patterns in order to guide evidence-based interventions. In order to address this pressing issue successfully, more impactful collaboration between governmental agencies, environmentalists, healthcare professionals, and the community is imperative.

Kerala now itself serve as an example for other regions by effective management of Nipah outbreak and can be a complete model for other states by implementing these recommendations in order to safeguard public health, protect the unique biodiversity of the region, and promote the health of its citizens.

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