BURDEN OF VECTOR BORNE DISEASE IN INDIA: A COMPRESSIVE ANALYSIS OF MALARIA, DENGUE, CHIKUNGUNYA, JAPANESE ENCEPHALITIS(JE), KALAAZAR

Dissertation Submitted to

The IIHMR University, Jaipur

for the partial fulfillment for the award of the degree of

Master of Business Administration (MBA)

in

Hospital and Health Management

by

Abhishek Panwar

Under the Supervision and Guidance of

Dr. Dhirendra Kumar

2025

CERTIFICATE

This is to certify that Abhishek Panwar in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur has successfully completed his internship at IIHMR University, Jaipur during Mar 10 - May 31, 2025.

Place: JAIPUR
Date: 18/06/2025

Dr. Dhirendra Kumar
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CERTIFICATE

This is to certify that dissertation titled "**BURDEN OF VECTOR BORNE DISEASE IN INDIA: A COMPREHENSIVE ANALYSIS OF MALARIA, DENGUE, CHIKUNGUNYA, JAPANESE ENCEPHALITIS (JE), KALA AZAR**" is a record of the research work undertaken by Abhishek Panwar in partial fulfillment of the requirements for the award of the degree of MBA Hospital and Health Management from the IIHMR University, Jaipur under my guidance and supervision and his approach to the research study has been sincere, scientific, and analytical.

Dr. Dhirendra Kumar
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Date

Dr. Sanjay Gupta
School Dean
IIHMR University, Jaipur
Date

DECLARATION BY STUDENT

I hereby declare that this dissertation titled **"Burden of vector borne disease in India: a comprehensive analysis of malaria, dengue, chikungunya, Japanese encephalitis (JE), kala azar"** is the bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

Abhishek Panwar

Abhishek Panwar

Date:

Abstract

Title: Burden of Vector-Borne Diseases in India: A Comprehensive Analysis of Malaria, Dengue, Chikungunya, Japanese Encephalitis (JE), and Kala Azar

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Advisor Name: Dr. Dhirendra Kumar

Keywords:

Vector-borne diseases, Malaria, Dengue, Chikungunya, Japanese Encephalitis, Kala Azar, India, Disease burden, Surveillance, Public health, NVBDCP

Background:

Vector-borne diseases (VBDs) remain a major public health concern in India due to the country's diverse geography, climate, and socioeconomic disparities. Diseases such as malaria, dengue, chikungunya, Japanese encephalitis (JE), and kala azar are endemic in various regions and collectively pose substantial health and economic burdens. Despite the existence of multiple national disease control programs, the recurrence and geographical spread of these diseases indicate persistent challenges in vector control, surveillance, and public health infrastructure.

Objective:

To conduct a comprehensive analysis of the burden, distribution patterns, and control strategies related to major vector-borne diseases in India—specifically malaria, dengue, chikungunya, JE, and kala azar—over the period from 2018 to 2022.

Methodology:

The study employed a secondary data analysis approach using government databases and state health department records. Data from 2018 to 2022 were analyzed using descriptive statistics and min-max normalization to assess trends and identify high-burden states. The analysis focused on relative disease burden across regions and over time, highlighting persistent vulnerabilities.

Results/Findings:

The analysis identified states such as Uttar Pradesh, Bihar, West Bengal, Karnataka, and Odisha as consistently high-burden regions for vector-borne diseases across five years. Factors such as climatic conditions, high population density, poor sanitation, and weak public health infrastructure contributed to the disease burden. The study also highlighted disruptions caused by the COVID-19 pandemic, leading to reduced surveillance and control efforts in 2020–2021. The findings reveal patterns of persistent vulnerability rather than random fluctuations in disease incidence.

Conclusions:

This study underscores the multifactorial nature of vector-borne disease persistence in India. Effective disease control requires integrated strategies addressing vector ecology, climate change, urban planning, diagnostic capacity, and community engagement. The study provides actionable insights for policymakers to prioritize surveillance, tailor intervention strategies, and strengthen health systems, especially in consistently affected regions. Continued focus and investment are essential to mitigate the burden and protect vulnerable populations.

Acknowledgement

I express my deepest gratitude to **Dr. Dhirendra Kumar**, my esteemed university guide, for his invaluable support, constant encouragement, and expert guidance throughout the course of this dissertation. His insightful suggestions, patience, and dedication were instrumental in shaping this work. I am truly grateful for the time and effort he invested in mentoring me and for providing constructive feedback at every stage of the research.

I would also like to extend my sincere thanks to **IIHMR University** for providing me with the opportunity and resources to pursue this study. The academic environment, access to scholarly materials, and encouragement from the faculty have played a significant role in the successful completion of my dissertation.

This dissertation would not have been possible without the academic and institutional support provided, and I am truly thankful for the enriching experience I have gained during this journey.

Sincerely

Abhishek Panwar

Place - Jaipur

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Abbreviations Used

S.N.	Abbreviation	Full Form
1.	NVBDCP	National vector born disease control program
2.	VBDTS	Vector born disease technical supervisors
3.	NHM	National health mission
4.	PKDL	Post kala-azar dermal lesihmaniasis
5.	NMEP	National malaria elimination program
6.	EDPT	Early detection and prompt treatment
7.	HBHI	High burden and high impact
8.	SPR	Slide positivity rate
9.	ABER	Annual blood examination rate
10.	API	Annual parasite incidence
11.	SFR	Slide falciparum rate
12.	NCVBDC	National center for vector borne disease control

Chapter 1: Introduction

Vector-Borne Diseases:

Infectious diseases known as vector-borne diseases are spread by vectors, primarily arthropods (mosquitoes, sandflies, ticks, and fleas), which transfer infectious pathogens such as bacteria, viruses, and protozoa from one host to another. This contributes to the worldwide burden of these diseases. The World Health Organization (WHO) estimates That annually worldwide around 700,000 deaths are caused by VBD and they also contribute in all the infectious diseases and even that is also more than 17 percent. Particularly in subtropical regions & tropical regions of world, where ideal climatic and environmental conditions allow them to survive, these diseases not only endanger human life but also have an impact on social and economic facets of human existence.

VBDs are broadly classified based on the type of pathogen they transmit:

- Protozoan Diseases: Malaria, Leishmaniasis
- Viral Diseases: Dengue, Japanese Encephalitis
- Bacterial Diseases: Plague, Lyme disease

Vector-Borne Diseases in India:

Vector-borne diseases in India not only affect health outcomes but also hinder economic development by causing loss of productivity and imposing a high financial burden on households and the healthcare system. Despite the implementation of various national control programs, the persistence of these diseases indicates the need for continuous monitoring, innovative control strategies, and community-based interventions to effectively combat the burden.

Rational:

The selection of Dengue, Chikungunya, Malaria, Japanese Encephalitis (JE), and Kala-Azar for this dissertation is based on their shared characteristics, public health significance, and the need for a comprehensive analysis to enhance control strategies. All these diseases are vector-borne, transmitted by insects such as mosquitoes and sandflies. Additionally, they exhibit seasonal outbreaks and regional patterns, with increased transmission typically observed during and after the monsoon season. Malaria and dengue are widespread across India, while JE is concentrated in Uttar Pradesh, Bihar, Assam, and West Bengal & kala azar is an endemic disease in Bihar, Jharkhand, and West-Bengal. Chikungunya, although less geographically restricted, has shown sporadic outbreaks across various regions in India.

While these diseases fall under different national programs, they share common intervention strategies. Malaria is addressed under (NMEP) National Malaria Elimination Program, dengue, chikungunya & JE under the NVBDCP, and Kala-azar through the Kala-Azar Elimination Program.

Furthermore, reliable secondary data on these diseases is available from national databases, enabling an in-depth analysis and assessment of the effectiveness of existing control programs, and the identification of gaps in vector control measures. Studying these five diseases together provides a holistic understanding of the burden and control strategies, facilitating better policy recommendations for improved disease management in India.

Introduction to the Diseases:

1.1 Malaria:

Malaria, a major public health issue in India, was historically linked to swampy areas by the Romans and Greeks. They believed the intermittent fevers, which peaked during the rainy season and coincided with agricultural activities, were caused by foul air from marshes. Although the true cause is now known, this name 'malaria' ('mal' = bad, 'aria' = air) is still used.

Malaria disease is caused by parasites known as plasmodium (P. ovale and P. malariae, P. vivax, P. falciparum) among these P. vivax & P. falciparum, are usually reported from India. P. Falciparum is deadliest among malaria.

Transmission is by Anopheles mosquito’s bite which is infected.

10 to 14 days after getting bitten by the infected mosquito, the illness manifests. Throughout its intricate life cycle, which occurs in liver and red blood cells, the parasite undergoes a number of different alterations.

Symptoms:
Malaria causes headache, vomiting, fever, and flu-type of symptoms. The parasite basically destroys RBC, leading to anemia, fatigue, convulsions, and unconsciousness. It can spread to brain (cerebral malaria) & the other organs. During pregnancy, malaria could be responsible for serious risks to both mother and the fetus, making it harder for pregnant women to fight the infection.

Severe Symptoms:
Severe cases present with the history of fever and any of following at least:

- Difficulty in respiration
- Fits & Convulsions
- Prostration, difficulty sitting, or altered consciousness in a coma
- Anemia (Severe)
- Vomiting or not being able to drink
- Dark and reduced output of urine
- In high-transmission areas: migrating labor tourists and youngsters under five.
- Pregnancy: Pregnant women's inability to manage and treat malaria infections has a negative impact on the developing fetus.

Signs for Severe & Complicated Malaria:
Severe malaria may cause cerebral malaria (coma), convulsions, anemia, kidney failure, hypoglycemia, fluid imbalance, pulmonary edema, shock, bleeding, high fever, hyperparasitemia, and malarial hemoglobinuria.

1.1.1 Global scenario:

Malaria affects approximately 249 million people around the world each year and it causes over 608,000 deaths, with most fatalities occurring in children under five. In 2023,WHO Region of South-East Asia, which includes the eight endemic countries for malaria, recorded around 4 million cases which are contributing to 1.5% of malaria burden globally. The region accounted for 12.7% malaria cases & 3.3% of the deaths averted that year. India, which made valuable strides in reducing the malaria cases and deaths, accounted for half of the region’s estimated cases. India formally left the group of HBHI in 2024 as a result of these advancements. From 2017 (6.4 million cases) (before HBHI project) to 2023 (2 million cases) the nation's malaria cases decreased by 69%.

1.1.2 Programs:

National Malaria elimination program

With population around 95% still residing in the endemic areas, malaria still continues to be the predominant public health concern in many parts of the nation. About 20% of people who live in hilly, tribal, and difficult-to-reach areas report having malaria, accounting for about 80% of all cases. The NVBDCP Directorate establishes rules, regulations, and program resources.

Standard indicators such as SPR, ABER, API, and SFR are used to monitor progress. Monthly malaria information system (MMIS) and monthly epidemiological situation (MES) is also used for monitoring purposes.Surveillance is conducted through PHCs, CHCs, malaria clinics, and higher-level institutions, while ASHA workers facilitate diagnosis and treatment at the village level using RDTs (Rapid diagnostic test) and (ACT) Artemisinin Combination Therapy used for Plasmodium falciparum cases.

The Urban Malaria Scheme:

When National Malaria Eradication Program was launched in year 1958, the urban malaria was not included, as it was believed to be a minor issue confined to mega towns and manageable by local bodies. By the 1970s, rural malaria cases had significantly decreased to around 0.1 - 0.15 million annually, but the urban areas showed a rise in trend. The Committee of Madhok (1970) investigated and found that urban areas accounted for 10-12% of total malaria cases. To prevent urban malaria from spreading to rural areas and reversing progress, (UMS) the Urban Malaria Scheme was approved in 1971 for complement rural malaria control efforts. Currently, UMS protects 142.9 million people across 131 towns among 19 states and one U.T. from Malaria and other mosquito-borne diseases.

Aims:
a) prevention of deaths due to malaria.
b) Reduce morbidity & transmission.

Maximum cases of malaria are reported from Vadodara, Kolkata, Chennai, Vishakhapatnam, Vijayawada, New Mumbai,

Norms Required:

a. The towns must have at least 50,000 residents.

b. The API needs to be at least 2.

c. To prevent or eradicate domestic and peri-domestic breeding locations, towns must establish and rigorously enforce civic bylaws.

Control strategies:

1. EDPT
2. Vector Control: Using Chemical, biological & Individual or community-based preventative measures
3. Community involvement
4. Techniques for Reducing Sources and Environmental Management
5. Program Monitoring and Evaluation

1.1.3 India situation:

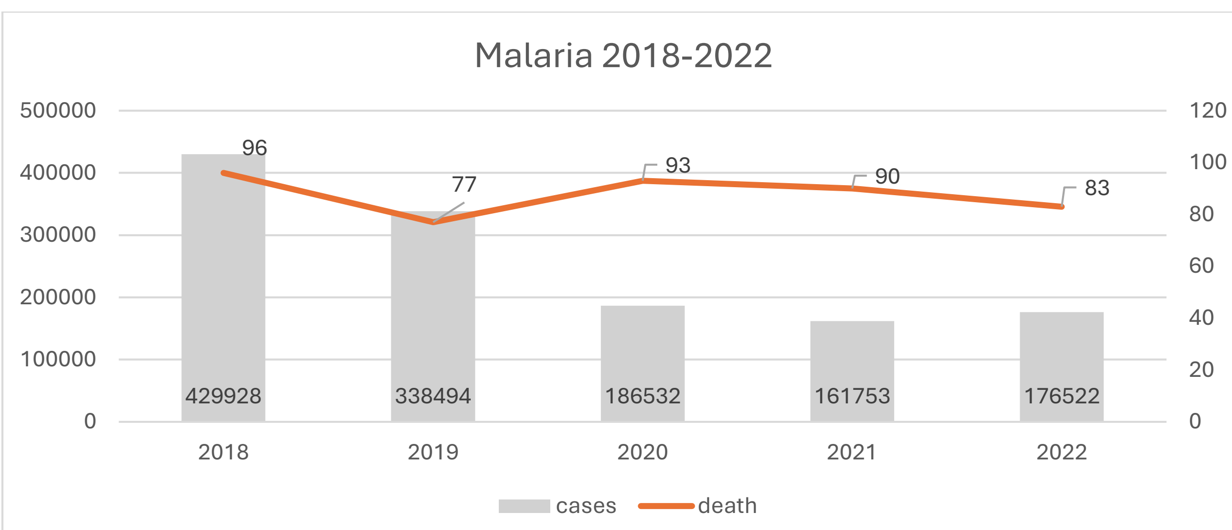

Figure 1.1.1: Annual Malaria's cases and deaths in India from 2018-2022.

Trend in Malaria Cases (2018-2022)

Malaria cases have shown a steady decline from 2018 (429,928 cases) to 2021 (161,753 cases), indicating improved control efforts. However, 2022 there is a slight increase (176,522 cases) after the continuous drop.

Trend in Malaria Deaths (2018-2022)

Deaths declined overall from 96 in 2018 to 83 in 2022, despite fluctuations in 2020 (93 deaths) and 2021 (90 deaths). The trend suggests partial success in reducing fatalities but with occasional spikes.

1.2 Dengue:

Dengue is rapidly spreading, prone to outbreak, mosquito-borne disease cause by four virus serotypes which are DEN-1, DEN-2, DEN-3 and DEN-4 that's been rising in incidence in the recent years, along with repeated outbreaks reported by various states & new areas. Currently, all States and U.T., except for Ladakh, report dengue cases.

The disease is spread by an infected Aedes aegypti mosquito bite.
After feeding on the victim's blood during the acute febrile (viremia) phase of dengue, the female mosquito contracts the infection. Following the 8–10 day extrinsic incubation period, the virus can spread anytime a mosquito bites another person.

Once bitten, a person develops symptoms after 5 to 6 days, with the incubation period which is ranging from 3 - 14 days. There is also evidence of vertical transmission, where infected female mosquitoes pass the virus to their offspring. Dengue affects people of all ages and genders and presents as a severe, flu-like illness.

Vectors:
The Aedes mosquito, a small, black insect with white stripes that ranges in size from 3 to 5 mm, is the vector of dengue illness. It takes seven to eight days for virus to grow & become able to spread the illness.

Feeding Habits:
It is a day-biting mosquito that primarily feeds on humans in domestic and peri-domestic areas. It bites multiple people during a single blood meal.

Resting Habits:
The mosquito hides under furniture, on hanging items like umbrellas and clothing, and in shadowed areas of homes.

Habits of Breeding:

Aedes mosquitoes breed in the man made containers with stagnant water, where their eggs can survive without water for over a year. Common Breeding Sites:
Desert coolers, drums, jars, pots, tanks, tyres and other places where water collects.

Signs & Symptoms for Dengue Fever:

- Sudden fever and headache and especially in forehead
- Pain back of the eyes, worsened by movement
- Pain in Muscle and joint
- Loss in taste and the appetite
- Rash like Measles on the chest and the upper limbs
- Nausea and vomiting

Dengue Symptoms:

- Vomiting frequently, sometimes blood also comes out
- Bleeding through the nose, gums, mouth, and the skin rashes
- Drowsiness, restlessness, & irritability
- Thirst and dry mouth
- Weak, rapid pulse

- Difficulty breathing

1.2.1 Global situation:

30 April 2024, over 7.6 million cases of dengue were reported globally and among them 3.4 million cases of dengue were confirmed along with 16000 cases which were severe and above 3000 fatalities. Over the past five years, dengue cases have significantly increased, especially in America. By the end of April 2024, the cases of dengue were above 7 million in the region, breaking record of year 2023 which was 4.6 million dengue cases & nearly tripled the amount recorded during 2023 in same period. This underscored the growing severity of the problem.

The dengue risk is widespread across the regions and the countries. Factors driving the increasing in risk include:

- Longer season of transmission of dengue in endemic areas
- Expansion and rise in mosquito vectors (Aedes albopictus & Aedes aegypti)
- Climate change & the weather events causing conditions suitable for the mosquito breeding
- Shifts in serotypes affecting the immunity of population
- Weak health systems due to political instability & humanitarian crises
- Movement of infected individuals & goods that may carries the mosquito vectors.

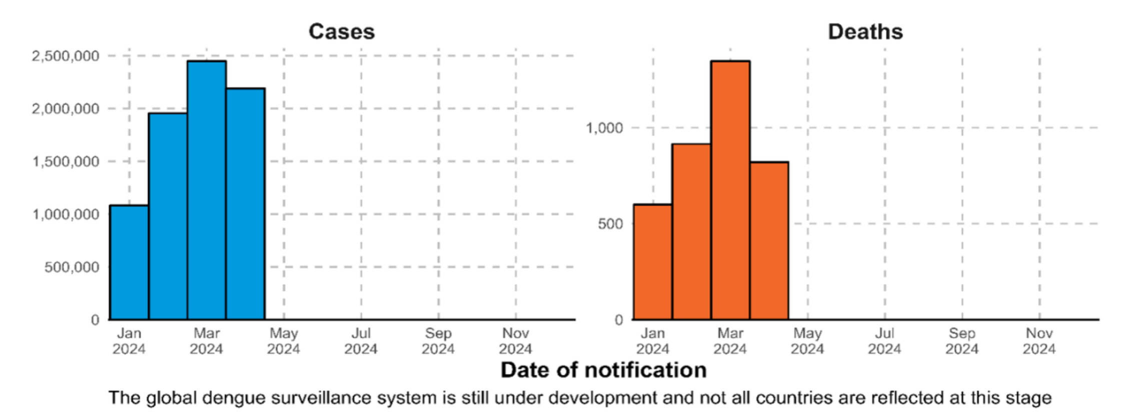

Figure 1.2.1: WHO-reported dengue case and fatality epidemic curve for January–April 2024*

Since Aedes mosquitoes are the vectors of transmission for the dengue, chikungunya, and zika viruses, their geographic distribution and clinical manifestations are similar. This overlap can lead to misdiagnosis and inaccurate reporting without proper lab testing, especially during large outbreaks of suspected dengue. According to WHO, India is dealing with the transmission of all three viruses.

This recent increase in dengue cases is likely and probably due to factors like change in the circulating serotypes and change in climate. The Regions like India, Myanmar, Bangladesh, Thailand and Nepal are presently witnessing beginning of the season of monsoon creating propitious conditions for breeding of Aedes mosquito.

Dengue continues to be the most abundant arboviral disease mediated by Aedes mosquitoes, and an estimated 3.9 billion population (132+) countries having risk of dengue, estimated annual 96 million (cases) of symptomatic and approximately 40,000 (deaths) due to dengue.

1.2.2 Program:

NVBDCP:

1. Guidelines and Manuals: Developed and made available technical guidelines for effective program implementation.
2. Surveillance Network: Established Sentinel Surveillance Hospitals (SSHs) with lab support for dengue diagnosis, increasing from 200 in 2007 to 805 in year 2023, which is linked with 17 Apex Referral Labs for advanced diagnostics.
3. Diagnostic Facility Management: State Program Officers and NVBDCP ensure functional diagnostic facilities and availability of kits, following technical guidelines.
4. Standardized Diagnostics: IgM MAC ELISA kits for testing which are provided by NIV Pune, are supplied to the identified SSHs, with costs covered by the Government of India.
5. Test Kit Allocation: Annual kit allocation is planned based on past dengue and chikungunya data, with buffer stocks maintained for emergencies.

6. Training and Capacity Building: Regular training is conducted to equip program managers for prevention, control, and outbreak management.
7. Disease Monitoring: Continuous monitoring to detect outbreaks early and implement timely preventive measures.
8. State Preparedness: Advisories issued to ensure states are prepared for potential outbreaks.
9. Financial Support: Budgetary assistance is also provided to the States/U.T. under NHM of dengue and Chikungunya control.

Control strategies:

1. EDPT
2. Vector Control: Using Chemical, biological, & Individual or community-based preventative measures
3. Community involvement
4. Techniques for Reducing Sources and Environmental Management
5. Program Monitoring and Evaluation

1.2.3 India situation:

Dengue cases in India have been rising, with the highest numbers reported in Karnataka, Kerala, Tamil Nadu, and Maharashtra. Despite this increase, Case Fatality Rate (CFR) has been dropped from 3.3% in year 1996 to 0.17% in year 2023 due to timely and coordinated efforts. The Health Secretary emphasized the need to identify hotspots, enhance vector surveillance, and geotag cases to take preventive measures. He also stressed ensuring the availability of platelets and hospital resources to reduce fatalities and encouraged states to seek support from the Ministry.

Urban areas, contributing 55-58% of cases in recent years, with a rise to 68% in 2023. To strengthen prevention and control, the Health Secretary called for collaboration between the Health Ministry and Ministry of Housing and Urban Affairs to develop a Joint Action Plan.

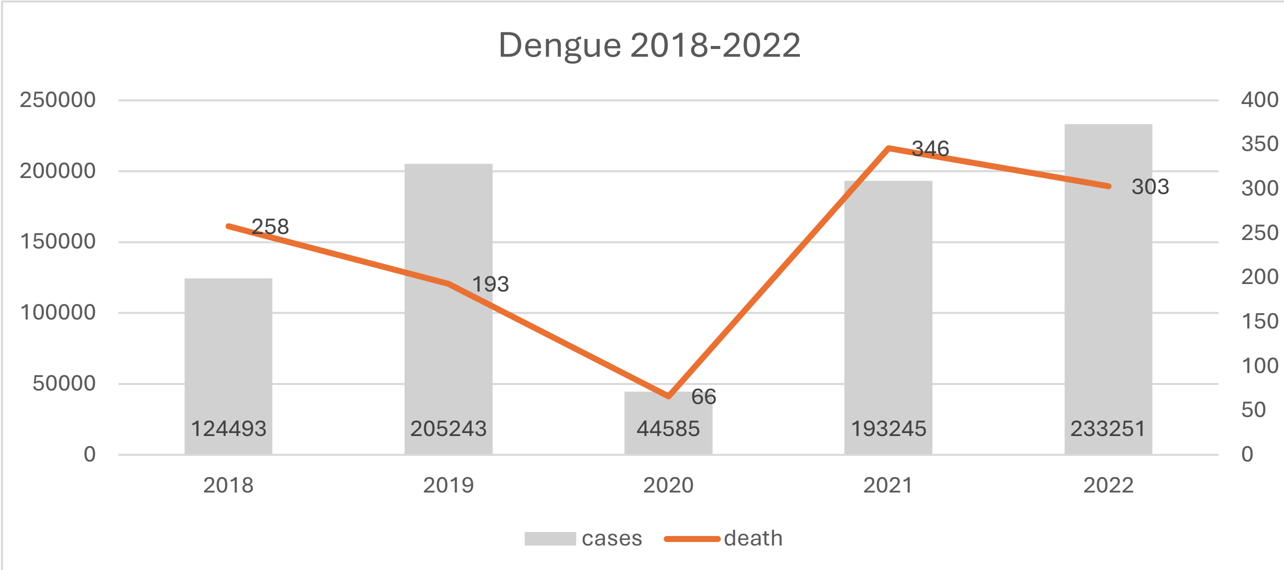

Figure 1.2.2: Annual Dengue cases and deaths in India from 2018-2022.

Trend in Cases:

Dengue cases fluctuated over the years. They increased from 124,493 (2018) to 205,243 (2019) but dropped significantly in 2020 (44,585 cases). However, there was a sharp rise again in 2021 (193,245 cases) and 2022 (233,251 cases), showing a resurgence in recent years.

Trend in Deaths:

Deaths varied over the years, with the lowest in 2020 (66 deaths), corresponding to the drop in cases. However, fatalities peaked in 2021 (346 deaths) and remained high in 2022 (303 deaths), indicating increased severity despite case fluctuations.

1.3 Chikungunya:

The bite of an infected mosquito transmits chikungunya, sometimes referred to as chikungunya fever or chikungunya virus sickness. Like dengue, it causes fever, rash, and excruciating joint pain (arthritis), but it is rarely fatal. The disease primarily affects peri-urban and urban settings and is highly widespread in Africa, India, and Southeast Asia. As of yet, no particular treatment is available. Chikungunya is a mosquito-borne arboviral illness that is becoming a global public health concern. Therefore, it is critical to comprehend its global impact in order to create effective preventative and control strategies.

Chikungunya caused through chikungunya virus and that is grouped in family Togaviridae, genus Alphavirus. mosquito species that breeds in the clean water collected in tanks, containers, discarded materials, and other domestic and peri-domestic settings, as well as natural habitats like the tree holes and plantation, is the same one responsible for spreading chikungunya. Similar to dengue the transmission of Chikungunya is influenced by the rainfall & temperature.

Chikungunya is transmitted through Aedes mosquito's bite who is infected, mostly it's Aedes aegypti. People are main reservoir for the virus, with mosquitoes spreading disease through biting infected person & then after biting another individual. The Aedes aegypti mosquitoes are most active and bite during the daytime. Since Chikungunya is not contagious, it cannot be transmitted directly from one person to another. Chikungunya's incubation period, or the time between infection and symptom manifestation, can last anywhere from two to twelve days with mostly cases occurring within 3 to 7 days. The acute phase of fever of chikungunya usually present for a few days or a few weeks, although some individuals may experience prolonged fatigue for several weeks.

Fever cases of Chikungunya are sometimes misdiagnosed clinically as dengue infections; therefore, the Chikungunya fever incidences could be much higher than what has been reported.

Anyone can have chikungunya who is bitten by infected mosquito and the period between being bitten by the mosquito which is carrying chikungunya virus and onset of symptoms is usually 4 - 7 days. Usually, the sickness starts abruptly with rash, joint pain, nausea, vomiting, fever, chills, and headache & The term "chikungunya" comes from Swahili which means "that which contorts or bends up," describing stooped posture caused by severe joint pain (arthritis), which is a hallmark symptom. In many cases, especially in children, infection may occur without causing any noticeable symptoms.

Chikungunya is diagnosed through blood tests, primarily using ELISA (Enzyme-Linked Immunosorbent Assay). Since its symptoms are similar to dengue, laboratory confirmation is essential, especially in dengue-prone areas. Testing is conducted at 783 identified (SSHs)

Sentinel Surveillance Hospitals and 17 Apex Referral Labs (ARLs) using IgM kits provided by the National Institute of Virology (NIV).

1.3.1 Global situation:

- Chikungunya virus is usually present in tropical and subtropical regions and has been reported in over 100 of countries across the Africa, Asia, Europe, Americas, and Indian and Pacific Oceans. Zika & Dengue disease can easily be misdiagnosed with chikungunya as they have similar symptoms.
- India is among the countries experiencing current outbreaks and has had an evidence of transmission of chikungunya in last five years.
- Outbreaks have occurred globally, including in Americas, Asia, Africa, Europe, and island regions in Indian and Pacific Oceans.
- One hundred and ten countries reported 18.7 million chikungunya cases, accounting for 1.95 million DALYs from 2011 to 2020. Caribbean region & Latin American had greatest burden of chikungunya.
- The direct costs were estimated at an overall economic impact of 2.8 billion dollars and 47.1 billion dollars in indirect costs globally over the period. However, the number of people affected by chikungunya is underestimated due to complications in the reporting and diagnosis.

1.3.2 Program:

NVBDCP:

There is no vaccine or specific medication to cure chikungunya. Prevention focuses on avoiding bites of mosquito and also eliminating the breeding sites risk of infection is reduced.

(a) Source Reduction Method:

1. Eliminate all potential breeding sites of mosquito in and also around domestic and peri-domestic areas.
2. Avoid storing water for more than one week by emptying & drying containers weekly.

3. To get rid of mosquito larvae, strain stored water once a week using a fresh cloth. Water can be reused, but the fabric needs to be sun-dried to kill the immature mosquitoes.

(b) Using Larvicides:

1. Apply Temephos at a rate of 1 ppm per week to water that cannot be drained but is utilized for cattle and other purposes.
2. A ready-to-use emulsion containing 0.1% pyrethrum extract can be sprayed indoors to eradicate adult mosquitoes.

(c) Biological Control:

1. Introduce larvivorous fish, such as Gambusia fish and Guppy fish , into water tanks & in other water sources to control mosquito larvae.

Public Health Measures

- Educate households on infection prevention.
- Reduce vector population and limit contact between vectors and patients.
- Engage community groups in chikungunya prevention and control.
- Implement vector control and source reduction in hospital settings.

1.3.3 India situation:

In late 2005, an outbreak of suspected fever cases was reported in parts of Andhra Pradesh and Karnataka, initially believed to be dengue. However, the presence of severe joint pain raised concerns, and by January 2006, laboratory tests confirmed it as chikungunya. The World Health Organization later confirmed the re-emergence of chikungunya in India. The outbreak had an attack rate ranging from 4% to 45%. In year 2006 Chikungunya re-emerged in India and almost all the States were affected by the Chikungunya.

Now the current situation is as follows:

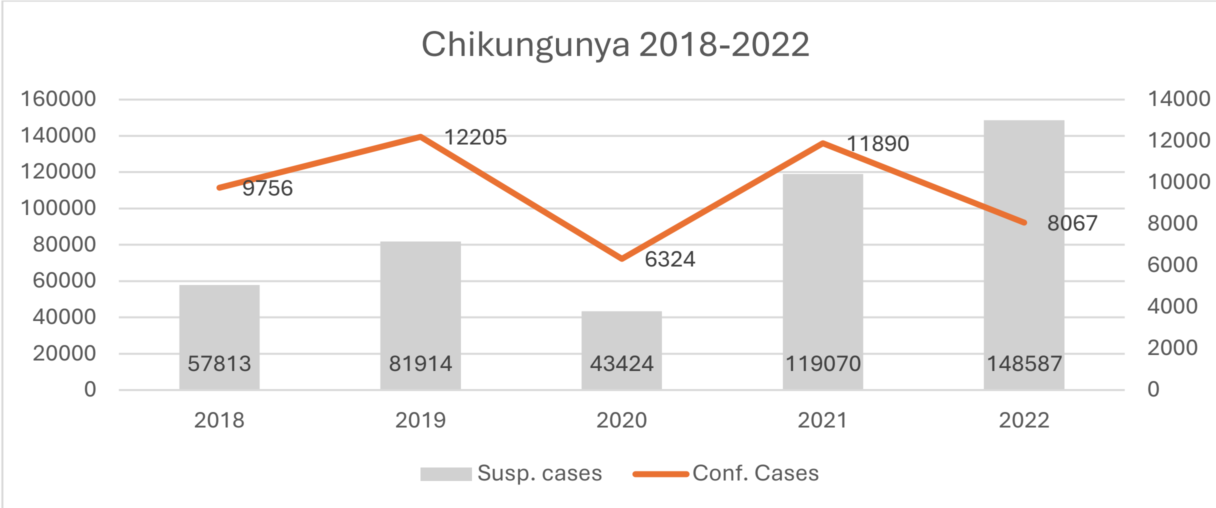

Figure 1.3.1: Annual Chikungunya Susp. cases and Conf. cases in India from 2018-2022.

Trend in Suspected Cases:

Suspected cases showed an overall increasing trend, except for a drop in 2020. The cases peaked in 2022 at 148,587, indicating a rising incidence of disease.

Trend in Confirmed Cases:

Confirmed cases fluctuated, peaking in 2019 (12,205) and 2021 (11,890), but declining in 2020 and 2022. There is no clear correlation with suspected cases. Could be due to poor diagnosis.

1.4 Kala-Azar:

Visceral leishmaniasis, commonly known as kala-azar (KA), originated in India in the late 19th century. The term means "black disease," derived from the Hindi word kala (black) and the Persian word azar (disease), referring to the skin's dark discoloration during infection. Kala-azar is a slow-progressing disease caused by the protozoan parasite *Leishmania*, with Leishmania donovani being the only species responsible for the disease in India.

The parasite primarily targets the reticuloendothelial system and is commonly found in the bone marrow, spleen, and liver.

Post Kala-azar Dermal Leishmaniasis (PKDL) occurs when Leishmania donovani invades skin cells, causing dermal lesions. Some kala-azar cases develop PKDL years after treatment, though recent findings suggest PKDL may occur without progressing through the visceral stage. However, more data is needed to fully understand the course of PKDL.

In India, Phlebotomus argentipes is only sandfly vector responsible for transmitting kala-azar. Sandflies who are basically small insects and are about $1/4^{th}$ of size of mosquito, with a body length 1.5 to 3.5 mm. They have delicate bodies covered in long hairs and large, erect wings. The life cycle include egg, four stages of larva with pupa and adult, taking over a month, depending on temperature and ecological conditions. Sandflies thrive in warm, humid environments with high subsoil water and vegetation, breeding in areas rich in organic matter. These insects are fragile and sensitive to desiccation.

Transmission of this vector-borne disease is by Phlebotomus argentipes, is only vector in India known to us. It is anthroponotic, with humans being the sole reservoir for disease & Female sandflies acquire parasite when they are biting an human who is infected. The parasite transforms into the flagellate form (promastigote) in the sandfly's gut, multiplies, and moves to its mouthparts. Infection spreads to healthy humans via bite of the infected sandfly.

Signs and symptoms icnludes recurring fever, often with a double peak, along with loss of the appetite, weight loss, pallor, and gradual weakness. The spleen also enlarges swiftly, becoming big but normally soft & non-tender. Enlargement of liver occurs but is less pronounced, with a smooth surface and sharp edges. Lymph node swelling is uncommon in the India. The skin becomes scaly, thin and dried, with hair loss. In lighter-skinned individuals, a grayish discoloration of feet, hands, abdomen and face has given rise to term "kala-azar" or "black fever." In addition to developing rapidly, anemia gives patients a distinctive appearance when paired with emaciation and an enlarged spleen.

PKDL:

This happens when Leishmania donovani parasites infect the skin, typically appearing 1-2 years after recovering from kala-azar, though it may sometimes develop without prior illness.

Various Lesions:

- Diffuse nodular lesions may develop on these macules after months or years.
- Hypopigmented macules, which resemble lepromatous leprosy and are typically less than 1 cm in size, can occur anywhere but are most frequently found on the face.
- Erythematous butterfly rash, worsened by sunlight, is an early sign.
- Papules and nodules, mainly on the face but especially on chin.
- Lesions progress over the years and rarely heal on their own.

Manifestations which are rare:

- Larger plaque lesions from merged smaller ones.
- On the hands & feet Verrucous lesions are seen
- Papillomatous type lesions appear on the face.
- Pityriasis rosea-like lesions.
- Xanthematous rash (orange plaques in folds and creases)
- hypertrophic lesions on the nose, lips, and eyelids.

1.4.1 Global situation:

Kala-azar which is marked by weight loss & irregular fever an liver & enlarged spleen, and anemia. Most of the cases occur in East Africa, Brazil, & in India, with estimate of 50,000 to 90,000 newly coming cases globally each year, though only 25% - 45% are reported to the WHO. It remains one of the deadliest diseases caused by parasites with potential to high outbreak. In year 2019, over 90% reported cases came from 10 countries: Kenya, Nepal, Somalia, South Sudan, Brazil, Eritrea, Ethiopia, India, Sudan & Iraq. Poverty, poor housing, and inadequate sanitation, such as not proper waste management or open sewage, add-on in the risk of infection.

1.4.2 Program:

NVBDCP:

Since 1992, India has achieved a 97% reduction in kala-azar cases through accelerated program implementation, with fatalities dropping from 1,419 in 1992 to 58 in 2018 and 37 deaths reported in 2020. The National Health Mission was launched in 2013 so kala-azar is eliminated from public health issue, with the coordination of the NVBDCP.

Key Measures Supporting Kala-Azar Elimination:

- Financial investment and trained workforce.
- Microstratification and case-based surveillance in high-risk areas.
- Electronic health records for monitoring and timely response.
- Presenting liposomal amphotericin B, a single-dose medication.
- Building homes out of concrete in endemic areas.
- Regular programs are reviewed by technical advisory committees.
- Collaborating in a strong network of valuable partners.

Even after significant progress the challenges remain, including difficult geographical region, marginalized populations and poor health-seeking behavior, low socio-economic situations, improper housing, and implementation problems.

With declining cases, maintaining strong surveillance is crucial and is now getting incorporated with other health programs. Continued focus of government and continous political commitment have helped in keeping kala-azar elimination a priority on the agenda of public health.

National Kala-Azar Elimination Program:

Indian government launched a Kala-azar Control Program, centrally sponsored in 1990-91, which significantly reduced cases from 77,102 in 1992 to 22,625 and deaths from 1,419 to 277 by 1995. Since December 2003, the central government has provided 100% operational costs for spray wages, transportation, anti-kala-azar medicines, and insecticides.

In 2000, the program was reviewed, and kala-azar elimination was deemed feasible. The National Health Policy (2002) set the elimination target for 2010, revised to 2015, and later extended to 2023, although the WHO NTD Road Map aims for 2030.

HR and Implementation Support:

- NCVBDC provides human resource support at state and district levels and has deployed Vector Borne Disease Technical Supervisors (VBDTS) at the block level 4 districts in Jharkhand, 33 in Bihar, and 11 in the West Bengal for monitoring and supervision.
- All activities are performed under the NVBDCP, integrated into the NHM.

Goal and Objective:

• Goal: To eradicate Kala-Azar as a problem of public health in order to enhance the health of the vulnerable population in endemic areas of Kala Azar.

• Objective: Eradication of Kala-azar By 2023, the annual incidence of kala-azar at the block level will be less than one case per 10,000 people.

Elimination Strategy:

Preventive diagnosis and holistic management of cases.

Control: Incorporated vector management and surveillance

Observation, scrutiny & assessment.

Developing human resources capacity.

Advocacy, communications and social mobilization

Good management of the programme.

Disease management involves vector control, monitoring and evaluation, and surveillance/treatment, carried out at the national, state, district, and block levels.

Kala-azar Elimination Initiative:

- ASHA Incentive: ₹500 for identifying, ensuring treatment along with follow-up of kala-azar & cases of PKDL.
- Wage Loss Compensation: 4,000 Rs/- for new patients of PKDL and 500 Rs/- for patients of kala-azar.
- Free Diagnosis & Treatment: Available at all CHCs/PHCs in endemic blocks.

- Performance Incentives: Monetary Rewards for states, districts, and blocks achieving elimination targets.

Additionally on state level Bihar and Jharkhand states provides Rs. 6,600/- to a VL patient towards wage loss and West Bengal State provides nutritional support for 6 months worth of Rs 6000.

Kala-azar Management Information System (KAMIS):

It enables real-time reporting and tracking of kala-azar data. The system is now transitioning to the Integrated Health Information Platform (IHIP), which provides more comprehensive & incorporative approach to disease surveillance & management.

1.4.3 India situation:

Kala-azar is prevalent in eastern Indian states—Bihar, Jharkhand, Uttar Pradesh, and West Bengal. An estimated 165.4 million people are at risk across these 4 states. 54 districts are endemic, with sporadic cases reported from a few other districts. The disease primarily affects poor socio-economic populations, mainly in rural areas.

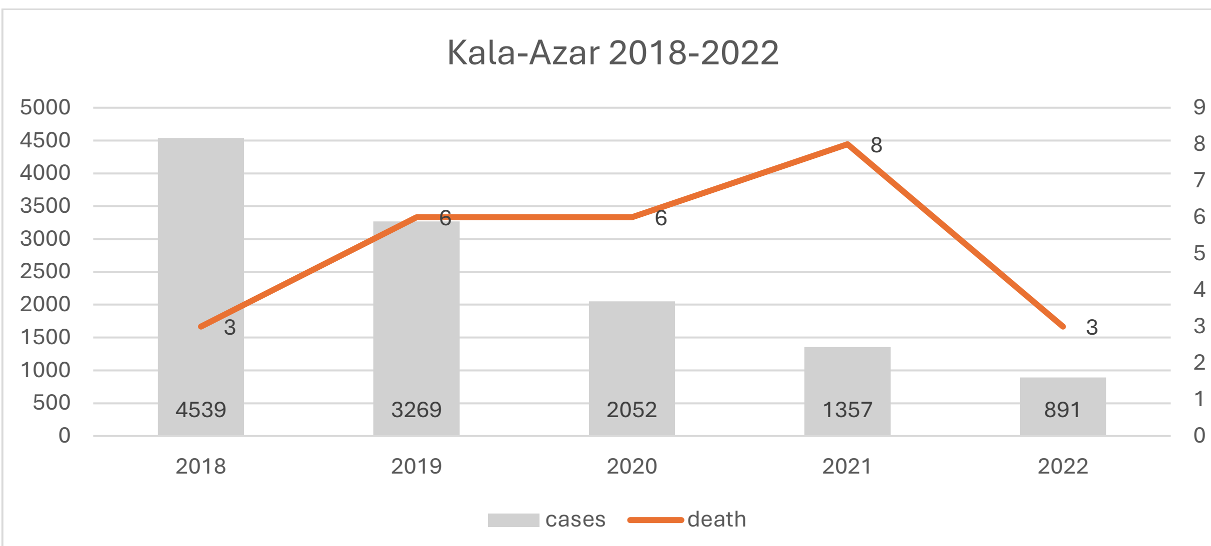

Figure 1.4.1: Annual Kala-Azar cases and deaths in India from 2018-2022.

Trend in Cases:

Kala-Azar cases have been steadily declining from 4,539 in 2018 to 891 in 2022, indicating effective control measures or reduced transmission over the years.

Trend in Deaths:

Deaths fluctuated, peaking at 8 in 2021 despite fewer cases. The numbers were lower in 2018 and 2022 (3 deaths each), suggesting that while cases dropped, mortality rates varied, could be due to different factors like disease severity or healthcare access.

1.5 Japanese encephalitis:

The JE virus, which causes Japanese encephalitis, is an zoonotic viral disease that spread from animals, pigs, and birds (particularly those in the Ardeidae family, such as pond herons and cattle egrets) & to humans via Culex mosquitoes (Vishnui group). It can cause febrile illness and could be of varying severity, often affecting central nervous system, leading to , seizures, severe complications and death. This disease has high case fatality rate (CFR), & survivors may experience long-term neurological complications.

It primarily affects animals, with pigs and birds, especially from the Ardeidae family (like cattle egrets and pond herons), serving as natural hosts. The virus is maintained in an enzootic cycle and occasionally causes focal outbreaks under specific ecological conditions. Human infection occurs when the virus spills over from this zoonotic cycle. During the monsoon, increased mosquito breeding in areas like rice fields and irrigation canals boosts vector populations, allowing the virus to spread from wild birds to peridomestic birds, mammals (like cattle and pigs), and eventually to humans.

The virus of JE had been seperated from various mosquitoes species in India, with the Culex mosquitoes of Vishnui group (Culex pseudovishnui, Culex tritaeniorhynchus, & Culex vishnui,) being primary vectors. These mosquitoes, especially the Culex vishnui subgroup, are spreaded widely and breed in water along with dense vegetation which is mainly of rice fields. Their sufficiency is linked to rice cultivation, pools & shallow ditches. They typically rest outdoors in the vegetation & shaded areas but can also be found indoor during summer.

There are 15 Mosquito Species of culex that is associated with JE Virus in the India (tritaeniorhynchus, vishnui, pseudovishnui, bitaeniorhynchus, epidesmus, fuscocephala, gelidus, quinquefasciatus, whitmorei, barbirostris, paeditaeniatus, subpictus, annulifera, Indiana, uniformis).

The Japanese Encephalitis (JE) virus is transmitted to humans by Vishnui group Culex mosquitoes, primarily from animals, birds (especially from the Ardeidae family, like cattle egrets and pond herons), and pigs. Pigs play a crucial role as amplifier hosts by allowing the virus to multiply rapidly without showing symptoms, maintaining prolonged high viraemia, which increases the chances of mosquitoes getting infected. Humans, however, are dead-end hosts as they develop low and short-lived viraemia, preventing further transmission. JE cannot spread from human to human, and mosquitoes do not acquire the infection from infected humans.

Japanese Encephalitis virus infection have similar symptoms to other viruses causing the encephalitis so distinguishing JE from other forms of viral encephalitis is challenging.

Diagnosis:

Suspected JE Case:

Acute fever lasting ≤7 days, accompanied by:

- A new onset of seizures (apart from febrile seizures), or
- An abnormal mental state, or
- Early signs like irritability, drowsiness, or abnormal behavior beyond typical febrile illness.

Lab Confirmed JE Case:

The suspected case confirmed by any of the following:

- JE virus nucleic acid in blood, CSF, or tissue (RT-PCR or NAAT)
- A four-fold increase in the paired sera's IgG antibody (14 days apart)
- JE virus isolation from brain tissue, CSF, serum, blood, or plasma
- JE-specific IgM antibody present in the CSF or serum (IgM Capture ELISA)
- JE antigen detection through immunofluorescence

Treatment:

At present specific treatment for JE is not available. Managing JE ususally focuses on supportive care to alleviate symptoms and complications. Like hospitalization of severe cases, supportive care, medication for fever and pain relief and fluid management.

1.5.1 Global situation:

In Japan, the first JE case was documented in 1871. In many Asian nations, JE is main cause of viral encephalitis, along with around 100,000 of the clinical cases reported annually, often higher during outbreaks. Although symptomatic cases are rare, the case-fatality rate can reach 30%, and 30-50% of survivors may experience permanent neurological, cognitive, or behavioral issues. Most cases occur in children under 15. Over 3 billion people are at risk since JE is endemic in 24 countries in the WHO's Western Pacific and South-East Asia areas.

1.5.2 Program:

National vector born disease control program:

JE Vaccination: Routine immunization covers 334 districts, with adult vaccination conducted in 42 districts of Assam, West Bengal, and Uttar Pradesh.

Training: Regular re-orientation training on AES/JE case management in endemic states.

Advisories: Issued to endemic states before the transmission season.

Diagnostics: Strengthened with 171 (SSHs) Sentinel Surveillance Hospitals & 15 (ARLs) Apex Referral Laboratories, provided along with free kits fir diagnosis from NIV, Pune.

Review and Guidelines: Program activities and epidemiological trends are reviewed before transmission season, and clinical management guidelines for JE have been developed.

Adult JE vaccination was introduced in the 42 districts and across 3 states with increased JE incidence in adults — Uttar Pradesh (7 districts), West Bengal (26 districts), & Assam (9 districts). The JENVAC vaccine is used for individuals aged 15 and above.

1.5.3 India situation:

Japanese Encephalitis (JE) remains the major concern of public health in India and The Virus Research Centre (VRC-NIV) first detected JE viral activity in 1952, with first human case which was reported in Vellore, Tamil Nadu, in 1955. Major outbreaks occurred in West Bengal's Burdwan district in 1973 and 1976, followed by cases in Assam in 1978. In 2003, JE was integrated into (NVBDCP) National Vector Borne Disease Control Program. Since then, JE have been reported in 355 districts across 24 States/UTs.

Endemic Regions: JE is the endemic disease in 355 districts across 24 States and UTs, with Assam, Meghalaya, Manipur, and other states like Bihar, Odisha, and Uttar Pradesh reporting high cases. Assam accounts for 30-50% of recent cases.

Seasonal Pattern: JE outbreaks peak between July and October, coinciding with the monsoon and post-monsoon seasons when mosquito populations increase.

High Case Burden: India contributes significantly to Asia’s JE cases, with thousands of cases reported annually, though actual numbers may be higher.

Vulnerable Populations: Children under 15 and rural populations, particularly those involved in agriculture, are most affected. Severe cases can lead to long-term neurological issues or death.

Vaccination Efforts: India has expanded JE vaccination in endemic areas, with adult vaccination introduced in Assam, West Bengal, and Uttar Pradesh.

Vector Control: Mosquito control through larval source reduction, insecticide-treated nets, and community awareness campaigns are key prevention strategies.

Public health efforts focus on improving surveillance, expanding vaccination, and enhancing vector control to reduce JE’s impact.

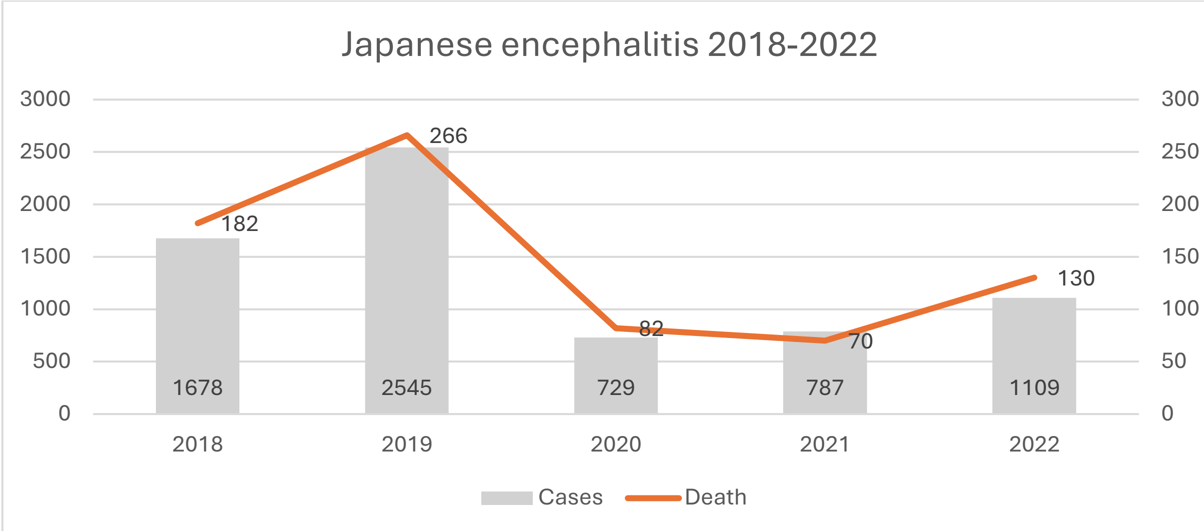

Figure 1.5.1: Annual Japanese encephalitis cases and deaths in India from 2018-2022.

Trend in Cases:

Japanese encephalitis cases peaked in 2019 (2,545 cases) before significantly dropping in 2020 (729 cases). A slight increase was observed in 2021 (787 cases) and 2022 (1,109 cases), indicating fluctuating but generally lower case numbers compared to 2018-2019.

Trend in Deaths:

Deaths followed a similar pattern, peaking in 2019 (266 deaths) and then dropping in 2020 (82 deaths) and 2021 (70 deaths). However, 2022 saw a rise (130 deaths), could be due to some resurgence in severity or case fatality.

Chapter 2: Review of literature

S.N.	Title	Date	Author	Summary
1	Malaria control initiatives that have the potential to be gamechangers in India's quest for malaria elimination	28 May 2022	Manju Rahi and Amit Sharma	The paper highlights India's progress in reducing malaria but identifies challenges in surveillance,

				treatment of *P. vivax* malaria, drug resistance, diagnostics and vector control, proposing solutions like digital tools, tafenoquine, improved diagnostics, alternative antimalarials, and novel vector control methods.
2	Time series analysis of malaria cases to assess the impact of various interventions over the last three decades and forecasting malaria in India towards the 2030 elimination goals	15 February 2024	Mrigendra P. Singh, Harsh Rajvanshi, Praveen K. Bharti, Anup R. Anvikar & Altaf A. Lal	The study analyzes malaria trends in India from 1990 to 2022, forecasts case burdens for 2023 and 2030, assesses the impact of national interventions, and examines external factors influencing malaria incidence from 2011 to 2021.

3	Assessment of public perspectives and barriers towards dengue preventive practices using the Health Belief Model in Puducherry, India: A cross–sectional study	August 2024	Govindasamy, Dharani, Vijalakashmi, Gnanasekaran, Vijayakumar, Balakrishnan, Rahul, Arya	The study highlights gaps in dengue prevention, such as low risk perception with limited awareness of breeding sites, and reliance on government efforts. Addressing these gaps with community-specific interventions can enhance prevention efforts.
4	The resurgence of dengue epidemic and climate change in India	March 4, 2023	Nitish Mondal	The paper explores factors driving the rise in dengue cases, including limited awareness climate change, and their impact on transmission and healthcare. It highlights the need for early

				treatment and addressing socioeconomic factors to reduce disease burden.
5	Chikungunya seroprevalence, force of infection, and prevalence of chronic disability after infection in endemic and epidemic settings: a systematic review, meta-analysis, and modelling study	February 8, 2024	Hyolim Kang, Megan Auzenbergs, Hannah Clapham, Clara Maure, Jong-Hoon Kim, Prof Henrik Salje, Christopher G Taylor, Ahyoung Lim, Andrew Clark, Prof W John Edmunds, Sushant Sahastrabuddhe, Oliver J Brady, Kaja Abbas	By calculating seroprevalence, force of infection (FOI), and the frequency of chronic impairment and hospitalization, the study seeks to evaluate the worldwide burden of Chikungunya. Additionally, it aims to give a thorough grasp of the long-term impacts and transmission intensities in various places.
6	Seropositivity of chikungunya in hospital setting, India: A systematic review and meta-analysis	October 17, 2024	Ramya Nagarajan, Lavanya Ayyasamy, Parasuraman Ganeshkumar, Saravanakumar	This study aims at highlighting the significant burden of confirmed Chikungunya

			Velusamy, Manoj Murhekar	cases, particularly in southern India, and emphasizes the need for improved reporting and community-based surveillance to enhance disease management.
7	Nationwide cross-sectional surveillance of *Leishmania donovani* in phlebotomine sand flies and its impact on national kala-azar elimination in India	18 November 2024	Harish Kumar Shah, P. A. Fathima, P. M. Ajithlal, Ashish Kumar, Anjali Rawani, Mahender Singh Thakur, Suman Sundar Mohanty, Devojit Kumar Sarma, Krishna Pandey, Ashwani Kumar, Manju Rahi & Prasanta Saini	This research surveyed sand flies across India, identifying Leishmania donovani in more species than previously known, underscoring the need for enhanced vector control and surveillance to support kala-azar elimination efforts.

8	Kala-azar elimination in India: reflections on success and sustainability	03 March 2025	Dhruv K Pandey, Jorge Alvar, Margriet den Boer, Saurabh Jain, Naresh Gill, Daniel Argaw, Subhash Salunke, Mobassir Hussain, Nupur Roy	The paper presents findings from KAEP assessments in 2019, 2021, and 2023, highlighting factors behind its success, identifying implementation bottlenecks, and recommending strategies to sustain elimination and achieve long-term validation.
9	Impact of vaccination against Japanese encephalitis in endemic countries	September 3, 2024	G. William Letson , Anthony A. Marfin, Jessica Mooney, Huong Vu Minh, Susan L. Hills,	The study evaluates the effects of Japanese encephalitis (JE) immunization campaigns in 23 nations on public health and Chinese Taipei, showing a significant decline in JE incidence,

				especially in countries that introduced vaccination before 2006. It emphasizes the need for sustained efforts and improved delivery systems to maximize vaccination effectiveness.
10	Japanese Encephalitis in India: A Comprehensive Review from Past to Present	December 2024	Surekha Kishore1, Venkatesh U, Shival Kishore Verma, Shikhar Kishore Verma, Sanjeev Kishore and Gowri Priya K	The paper explores the clinical, epidemiological, and molecular aspects of Japanese encephalitis (JE) in India, covering prevention, treatment, and surveillance efforts while highlighting future strategies for disease control and eradication.

Chapter 3: Methodology

STUDY DESIGN:

▪ Secondary data analysis

STUDY SETTING:

▪ IIHMR University, Jaipur

STUDY POPULATION:

▪ Inclusion Criteria: Published data from government databases and state health departments.

▪ Exclusion Criteria: Non relevant sources.

SAMPLE SIZE:

▪ Data from national and state surveillance systems over 5 years.

SAMPLING TECHNIQUE:

▪ Purposive sampling of relevant data sources.

DATA COLLECTION PROCEDURE:

▪ Data will be collected from secondary sources.

DATA ANALYSIS PLAN:

▪ Quantitative Data: Descriptive statistics, Normalization, trend analysis using MS Excel.

ETHICAL CONSIDERATIONS:

▪ The study will use publicly available secondary data from reliable sources so proper permissions and acknowledgments will be ensured wherever required.

▪ Unbiased analysis will be ensured.

▪ Patient data privacy will be ensured.

Chapter 4: Results

The analysis of disease trends in India between 2018 and 2022 reveals a complex interplay of successes and persistent challenges in controlling and managing Malaria, Dengue, Chikungunya, Kala-Azar, and Japanese Encephalitis.

1. For year 2022 -

To assess the relative vulnerability of Indian states and union territories to vector-borne diseases, average normalized scores were calculated for the year 2022 using min-max normalization across five selected diseases. The normalization was based on the percentage distribution of reported disease cases per state. Since the indicator reflects disease burden, it is interpreted negatively, means that lower normalized scores indicate higher relative prevalence of vector-borne diseases in a given state.

After applying the Pareto Principle (80/20 rule), the eight states with the lowest average normalized scores were identified, assuming that a small proportion of regions are responsible for a significant share of the overall disease burden. These states are considered to be the most affected and may require focused public health attention.

	2022	
S.N.	**State/UT**	Average
1	West Bengal	0.5534
2	Bihar	0.7449
3	Karnataka	0.7547
4	Assam	0.7932
5	Jharkhand	0.7972
6	Chattisgarh	0.8350
7	Uttar Pradesh	0.8439
8	Odisha	0.8483

Table 4.1.1: Eight lowest performing states of India for year 2022.

Observations –

West Bengal recorded the lowest average normalized score (0.5534), indicating a relatively high disease burden across the five vector-borne diseases considered in 2022.

Followed by Bihar and Karnataka, with scores of 0.7449 and 0.7547 respectively, also appear among the more heavily impacted states and Other states like Assam, Jharkhand, Chhattisgarh, Uttar Pradesh, and Odisha — also demonstrate lower scores, pointing to a notable share of disease prevalence within the national context.

2. Longitudinal Analysis of Vector-Borne Disease Burden (2018–2022):

	2018	
S.N.	State/UT	Average
1	Uttar Pradesh	0.6335
2	West Bengal	0.6780
3	Karnataka	0.7351
4	Odisha	0.7459
5	Bihar	0.7475
6	Jharkhand	0.7622
7	Gujarat	0.7800
8	Maharashtra	0.7814

Table 4.1.2: Eight lowest performing states of India for year 2018.

	2019	
S.N.	State/UT	Average
1	Uttar Pradesh	0.6748
2	Karnataka	0.7113
3	West Bengal	0.7117
4	Bihar	0.7238
5	Assam	0.7961
6	Jharkhand	0.8310
7	Odisha	0.8372
8	Chattisgarh	0.8501

Table 4.1.3: Eight lowest performing states of India for year 2019.

	2020	
S.N.	State/UT	Average
1	Karnataka	0.6906
2	Uttar Pradesh	0.7041
3	Bihar	0.7672
4	West Bengal	0.7717
5	Odisha	0.7793
6	Maharashtra	0.7934
7	Assam	0.7969
8	Punjab	0.7992

Table 4.1.4: Eight lowest performing states of India for year 2020.

	2021	
S.N.	State/UT	Average
1	Uttar Pradesh	0.6486
2	Jharkhand	0.6749
3	West Bengal	0.6933
4	Karnataka	0.7258
5	Gujarat	0.7317
6	Bihar	0.7563
7	Odisha	0.7612
8	Chattisgarh	0.7881

Table 4.1.5: Eight lowest performing states of India for year 2021.

State-level vulnerability to vector-borne diseases over time (2018-2022) was assessed using the same method used above and using these yearly scores, the eight lowest-performing states per year were identified. This analysis was focused on recurring patterns, consistent poor performers, and possible explanations for these findings.

Observations –

Uttar Pradesh, West Bengal, Bihar, Karnataka, Odisha appeared in all five years suggesting long standing vulnerabilities in these regions followed by Jharkhand that appeared in 4 out of five years where Chhattisgarh and Assam appeared in 3 out of 5 years.

Punjab appears only in 2020, likely due to a localized outbreak or reporting changes.

Gujarat and Maharashtra were present in earlier years but dropped off in recent ones, suggesting potential improvements or changes in disease dynamics.

Possible factors -

Geographic and Climatic Conditions:

- States like Odisha, West Bengal, Bihar, and Assam are in humid, flood-prone, and monsoon-heavy regions, which create favorable conditions for vector breeding.
- Uttar Pradesh and Jharkhand include vast rural areas with challenges in sanitation, waste management, and stagnant water, exacerbating disease spread.

Impact of COVID-19 (2020–2021): The pandemic may have influenced:

- Disease surveillance: Reallocation of healthcare resources might have affected vector control programs.
- Migration: Mass movement of people during lockdowns may have impacted disease dynamics, particularly in Uttar Pradesh and Bihar.
- Healthcare access disruption, especially for preventive care.

High population in Bihar, Uttar Pradesh & West Bengal adds additional stress to health system and facilitate the disease spread.

Poor performing states often face constraints in public health infrastructure, access to clean water, maintaining sanitation and effectiveness of vector control initiatives.

3. Implications:

Uttar Pradesh, West Bengal, Bihar, Karnataka, Odisha represents priority regions for vector control strategies, surveillance systems, and public health campaigns as they consistently appear in bottom tier.

Identifying these long-term trends will help in designing region specific intervention models.

Considering the climate data and urbanization patterns of these regions will be helpful for proactive disease control.

This study also demonstrates the utility of normalized data and average scoring as tools to reveal relative disease burden, offering a more comparable and equitable framework for state-wise analysis.

Chapter 5: Discussion

The study explored epidemiological trends of the malaria, chikungunya, dengue, JE and kala azar along with effectiveness and gaps in the national programs and their intervention strategies. The analysis was conducted using min-max normalization to account for the proportional disease burden across states. Given the negative nature of the indicator, states with lower normalized scores are interpreted as having higher disease prevalence. The findings offer insight into geographical patterns, persistent vulnerabilities, and potential factors influencing disease trends over time. The results contributed to the better understanding of Burden of the Vector-Borne Diseases.

Key findings:

Uttar Pradesh, Bihar, West Bengal, Karnataka, and Odisha consistently ranked among the lowest, indicating a persistent high burden of vector-borne diseases.

Jharkhand, Chhattisgarh, and Assam also showed recurring appearances, particularly in recent years.

States such as Punjab, Maharashtra, and Gujarat appeared sporadically, suggesting temporary fluctuations rather than persistent trends.

Vector resistance and inconsistent control measures has led to fluctuating cases and shows the requirement of continues surveillance, monitoring of resistance patterns and improved reporting system.

Socioeconomic Factors such as poverty, poor sanitation, and improper healthcare access contributes significantly to persistence of vector-borne diseases.

Gaps in diagnostic efficiency has led to discrepancies in the disease detection and underreporting of cases.

Effect of climate change, urbanization and deforestation has influenced the dynamics of the vector borne disease cause it led to favorable conditions for the diseases and expanding their geographic range.

Comparison with existing literature:

The observed findings are consistent with broader epidemiological studies and national health reports.

The paper "Vector-Borne Diseases in India" by Dhopte and Hari (2020) provides an overview of several vector-borne diseases prevalent in India. It discusses diseases like the Dengue, Malaria, Japanese Encephalitis (JE), Lymphatic Filariasis, and Chikungunya & it emphasizes the correlation of Stagnant Water, Urbanization and Poverty, Environmental Factors with increased vector breeding and transmission rates — all of which are common conditions in the consistently low-performing states identified in this study.

The spike or deviation in some years, particularly in 2020 and 2021, may also align with observations from recent publications on the **indirect impact of COVID-19**, where reallocation of health resources led to disruptions in routine disease surveillance and vector control measures (WHO, 2021).

Strengths of the study:

Cost effective and time efficient as data is already available.

Reliable and standardized data as the source is government database.

Large sample size as government datasets cover multiple regions and timeframes.

Reduced ethical concerns since data is publicly available so ethical risk related to privacy and consent are minimized.

Limitations of the study:

Low control over data quality as data can be missing or incomplete.

Inability to capture the recent trends as dataset is availability is till 2022.

Selection of dataset of specific time bracket may introduce bias, limiting the generalizability of findings.

While five diseases were considered together for holistic understanding, the specific burden of individual diseases is not separately analyzed here.

Change of data collection methods can also hinder generalizability of findings.

Chapter 6: Conclusion

The collective findings of this research show the multifaceted nature of vector-borne disease challenges. The persistence of these diseases is not only attributable to biological factors like vector resistance, but is significantly compounded by socioeconomic vulnerabilities, diagnostic limitations, and the escalating impacts of environmental changes. Effectively controlling these diseases requires a holistic approach that integrates counter measures for all of these. Failure to address these will again lead us to the cycle of disease burden that will hinder the public health progress.

The analysis revealed that States such as **Uttar Pradesh, Bihar, West Bengal, Karnataka, Odisha, and Jharkhand** were frequently among the lowest performers across multiple years. The longitudinal nature of the study highlighted stable patterns of vulnerability rather than random yearly fluctuations. These trends were found to be associated with known environmental, demographic, and infrastructural risk factors such as high population density, inadequate sanitation, urban slums, and favorable climatic conditions for vector breeding. Additionally, temporary deviations in disease burden were noted during 2020 and 2021, which may be linked to the indirect effects of COVID-19 pandemic over disease surveillance & vector control efforts.

Furthermore, if we look upon the implications of the study, the findings of the research provide insights for strengthening public health policy and particularly for vector borne disease control programs by highlighting the complexity in controlling the disease. The findings will help to enhance surveillance, prevention and management strategies which will lead to more efficient resource allocation and improved public health outcome. The research shows the need for optimizing interventions that can reduce the burden of vector borne disease and protect the vulnerable population.

Recommendations:

Strengthening the vector surveillance to monitor the vector population and resistance patterns and effective application of control measures.

Improving diagnostic capacity, investment in diagnostic infrastructure and training for healthcare professionals to ensure timely and accurate disease detection.

Continue vaccination programs to ensure consistent and widespread access to vaccination for the preventable vector-borne diseases.

Improving drainage system and reducing open water bodies in slum and building resilient health system ensuring vector borne disease programs are isolated from disruptions like pandemics and incorporate contingency planning.

Early case detection and management through community-based surveillance for improved and effective treatment within primary health systems.

Climate responsive strategies and decentralized planning should be developed and implemented that addresses the climate change, urbanization and deforestation on vector borne disease dynamics.

Ultimately, this research contributes to the ongoing efforts to mitigate the burden of the vector-borne diseases and also to sustain & improve public health.

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