



## Mosquito Borne Diseases and Public Health: A Case Study of Malaria and Dengue in Uttar Pradesh

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### Abstract

Mosquito, a creature that causes human deaths more than other creatures in the world, spread lethal diseases called Mosquito-Borne Diseases (MBDs). Mosquito-borne diseases have been the cause of concern for the whole world for centuries. In India, malaria and dengue are the center of focus as confirmed cases of these diseases are more than the other MBDs. According to the National Center for Vector-Borne Diseases (NCVBD), India has witnessed over 18 lakh confirmed cases and over 2500 deaths since 2019 caused by mosquitoes, approximately 11% of confirmed cases and 9% of deaths were from Uttar Pradesh. Since many researches on MBDs have been done but discussions on the impact of MBDs especially malaria and dengue on public health and their socio-economic implications are untouched, and also there is no comprehensive state-level study as such, especially for Uttar Pradesh which has a diverse demographic composition and high population density. The study aims to assess the impact of mosquito-borne diseases, particularly malaria and dengue, on public health in Uttar Pradesh. The study also aims to examine the significance of this impact, provide preventive measures at both individual and government levels, and discuss the socio-economic implications of these diseases. Secondary data on mosquito-borne diseases for India and Uttar Pradesh has been obtained from National Data and Analytics Platform (NDAP), an open data source platform of NITI Aayog, and analyzed to assess the impact of MBDs on public health. Correlation analysis is conducted between death rate to denote public health and MBD death rate, which is calculated as the number of deaths per 1000 MBD infected people. Another tool is a regression model, which takes the MBD death rate as a dependent variable and the Malaria-Dengue

mortality rate as an independent variable which is calculated as the number of deaths per 1000 people infected either with Dengue or Malaria. The results of the analysis indicate a positive relationship between MBD mortality rate and total mortality rate, indicating a negative impact of these diseases on public health. The study confirms that mosquito-borne diseases, particularly malaria and dengue, have a significant negative impact on public health. The impact is twofold, as these diseases directly affect public health by causing severe illness and even death, while the additional expenses incurred in treating and managing these diseases burden daily wage earners and those below the poverty line. This can lead to malnutrition and further detrimental effects on health. To mitigate the impact of mosquito-borne diseases, individuals are encouraged to adopt preventive measures such as avoiding mosquito bites and preventing mosquito reproduction in their surroundings. At the government level, the National Vector Borne Diseases Control Programme (NVBDCP) and Urban Malaria Scheme (UMS) are implemented to control and prevent these diseases through various strategies. But these programmes have not benefited the people of villages and town areas as much, therefore the government must take proactive measures to cover each and every region in the country, it should also conduct awareness programmes about MBDs, distribute insecticide-treated bed nets, use Pyrethrin spray and promote personal protective measures.

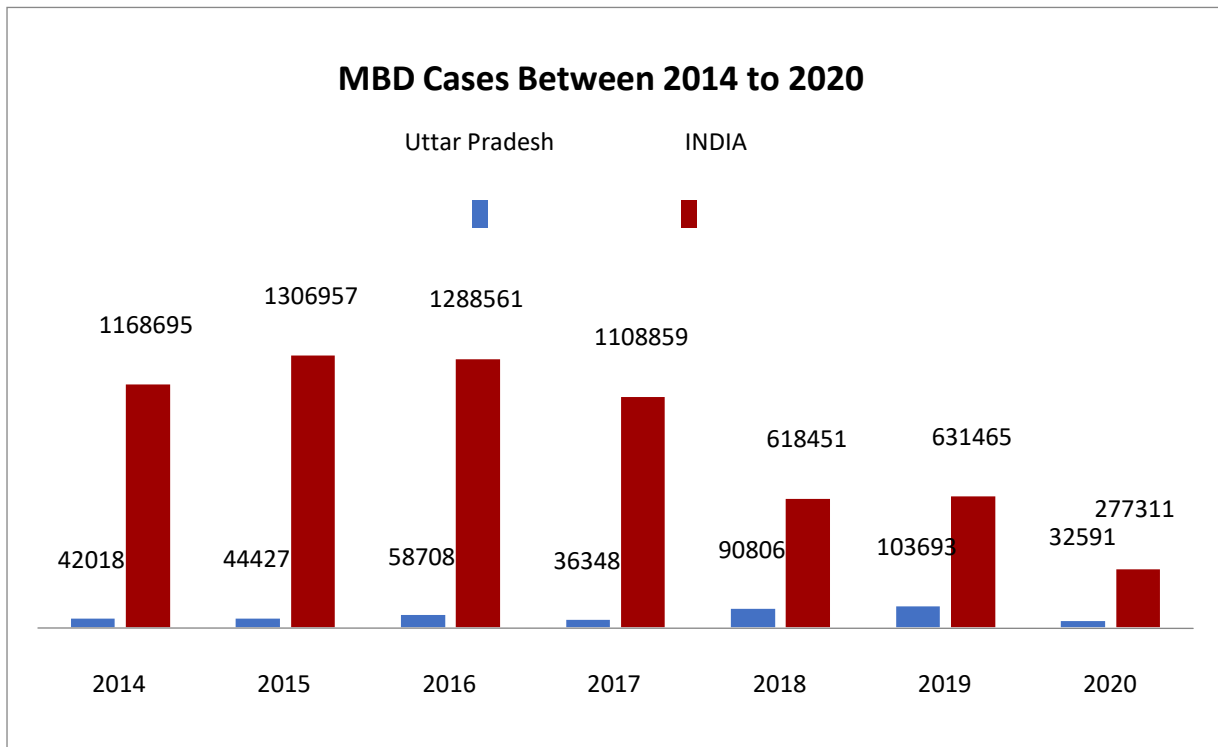
**Keywords:** Public Health, Mosquito-Borne Diseases (MBDs), Dengue, Malaria

## **Introduction**

Mosquitoes are notorious for biting humans to satisfy their protein cravings needed for egg production. They rank among the most prevalent and abundant insects worldwide. These pesky insects thrive in dirty water, damp soil, and humid environments. Their bites can spread various harmful microorganisms, leading to severe diseases. Common illnesses transmitted by mosquitoes include Malaria, Dengue, Chikungunya, Kala azar, Japanese encephalitis, Filariasis, Yellow fever, West Nile virus, and Zika virus, among others, impacting millions globally with significant health challenges. In 2019 alone, Malaria alone led to an estimated 229 million cases and over 400,000 deaths worldwide, as per the World Health Organization (WHO). India bears a substantial burden as well, facing diseases like Dengue, Malaria, Kala Azar, Chikungunya, and Japanese encephalitis, primarily spread by mosquitoes. According to the National Vector Borne Disease Control Programme (NVBDCP), India witnessed over 640,000 cases of mosquito-borne diseases between 2014 and 2020, with Dengue and Malaria accounting for 93% of these cases. The mortality rates from Malaria and Dengue combined are alarmingly high in India, posing a grave public health concern. In essence, the tiny yet mighty mosquito poses a

significant threat to global health by serving as a carrier for deadly diseases that impact millions of lives each year.

Mosquito-borne diseases pose a significant health challenge in India, with Malaria emerging as the most widespread ailment. This disease, caused by the plasmodium parasite and transmitted by female Anopheles mosquitoes, has been a major health concern. According to the data of National Vector Borne Disease Control Programme (NVBDCP), between 2014 and 2020, India recorded over 5 million cases of malaria, 7% of which were reported in Uttar Pradesh. While the mortality rate from Malaria remains relatively low, the economic burden it places on healthcare systems is considerable, surpassing that of other mosquito-borne diseases. Dengue, on the other hand, stands out as the most hazardous disease transmitted by mosquitoes, with the highest fatality rate among all Mosquito Borne Diseases (MBDs). This disease, caused by the dengue virus transmitted by Aedes mosquitoes, has claimed over 1300 lives in India, with Uttar Pradesh contributing 8% of the total cases. The impact of MBDs on public health is profound, leading to a substantial strain on healthcare resources. They result in increased hospitalizations and outpatient visits, particularly affecting regions with inadequate infrastructure and limited resources, predominantly in rural areas.



*Figure-1: the extent of Mosquito-borne diseases in India and Uttar Pradesh between 2014 and 2020*

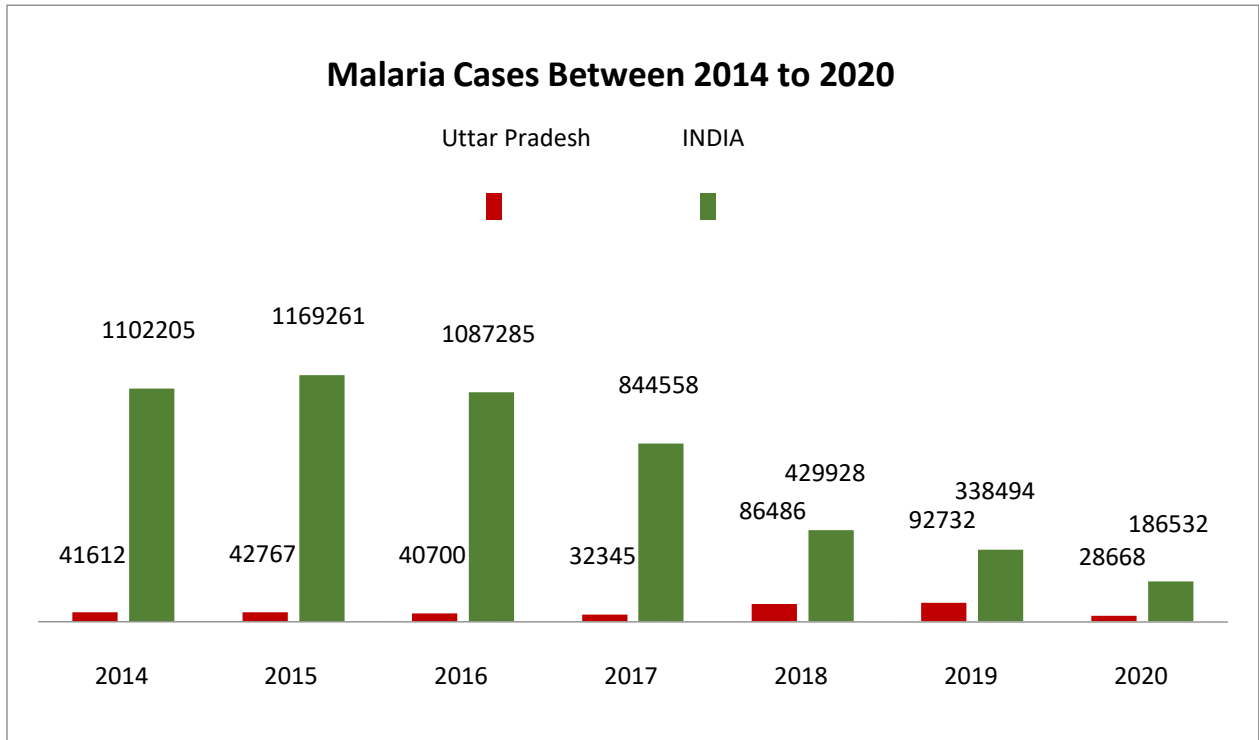


Figure-2: the extent of Malaria in India and Uttar Pradesh between 2014 and 2020

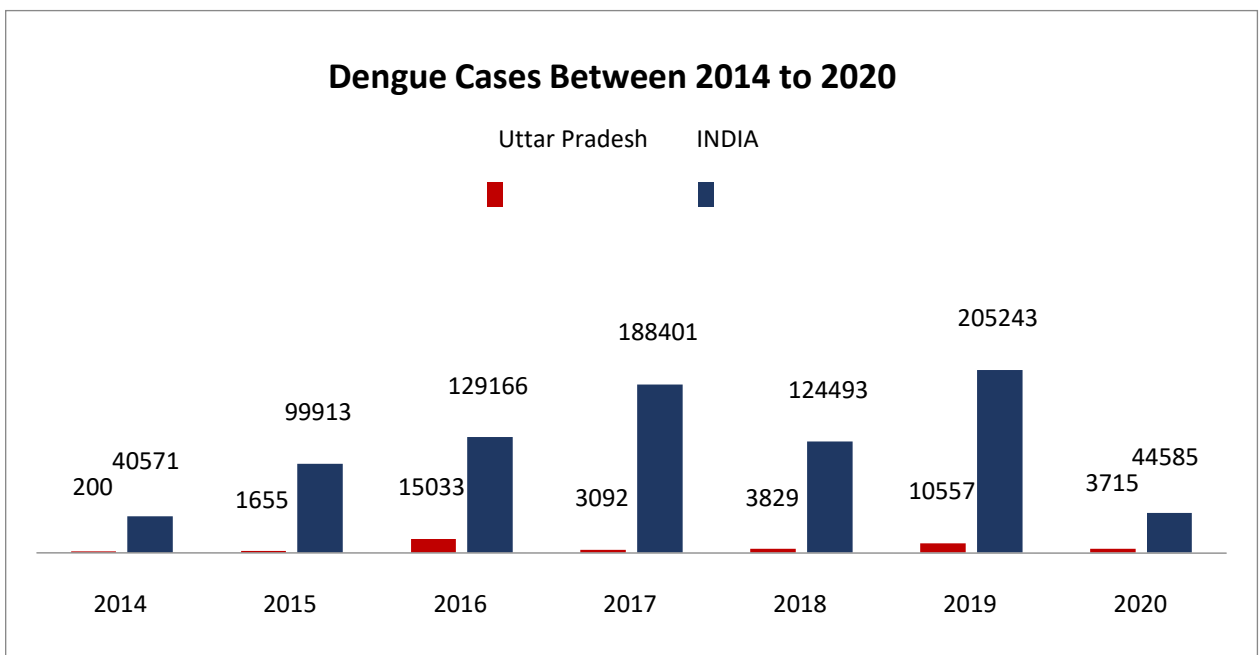


Figure-3: the extent of Dengue in India and Uttar Pradesh between 2014 and 2020

To address the challenges posed by mosquito-borne diseases, India has taken proactive

measures by launching the National Vector Borne Diseases Control Programme (NVBDCP) under the National Centre for Vector Borne Diseases Control (NCVBDC). This flagship program identifies MBDs, for which strategies are mapped out to offer technical and financial support to States and UTs in terms of funds and necessities. Since Uttar Pradesh is the most populous state in India and has the highest population density; the fact that vector borne diseases often spread from one person to another with a lot of ease; calls for concern on the impact these diseases would have on public health in this state.

Thus, the agricultural rate in Uttar Pradesh was about 6 percent between 2014 and 2020 in between the percentage shares of India's agriculture. Approximately accounts for 3% of the total communicable diseases in India; and out of each 100 infected patients, 98 suffer from Malaria and Dengue separately. It is euphemistic to say that the Uttar Pradesh fared any better during this period in terms of mortality arising from mosquito borne diseases. All these diseases bring out social and economic repercussions, making them have negative impacts on human health, rising incidences of diseases hence time off work and, learning difficulties arising from such diseases. As they harm the development of tourism, and various forms of trading operations. its prevalence in affected areas, therefore, calling for intensified and multifaceted strategies to address these diseases effectively.

### **Objectives**

1. To assess the impact of mosquito borne diseases (especially malaria and dengue) on public health in Uttar Pradesh.
2. To provide the preventive measures to mitigate mosquito borne diseases at both individual and government level.
3. To assess the share of dengue and malaria in total mosquito borne diseases.
4. To analyze the socio-economic implications of mosquito borne diseases.
5. To estimate the burden of mosquito borne diseases on healthcare system.

### **Research Methodology**

The secondary data of Mosquito-borne diseases including Malaria, Dengue, Chikungunya, Kala azar and Japanese encephalitis has been taken from National Data and Analytics Platform (NDAP) which is an open data source launched by National Institution for Transforming India (NITI) Aayog, for all states and Union territories. Data of all states and union territories has been merged to acquire the actual situation of Mosquito-borne diseases in India. Data of Malaria, Dengue, Chikungunya, Kala azar and Japanese encephalitis has been merged to see the overall impact of MBDs on public health. Since there is no study till now in Uttar Pradesh, the

study has been done especially on Uttar Pradesh and comprises it with MBDs Situation in India.

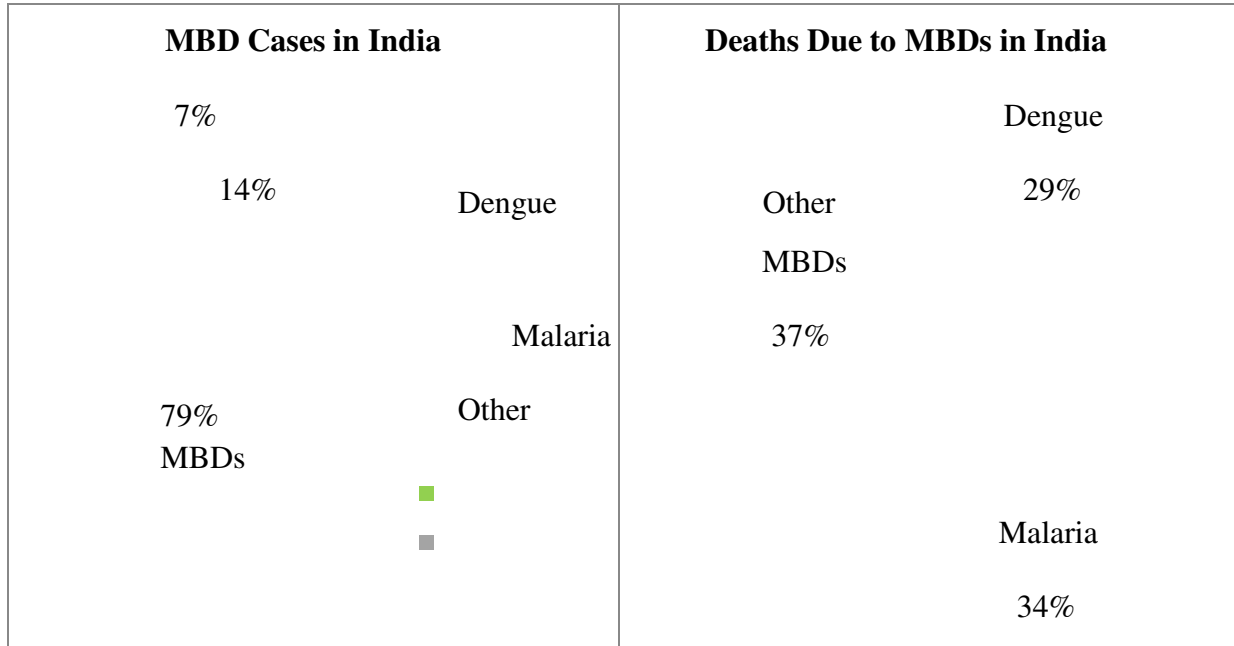


Figure-4: Percentage Share of Mosquito toborne diseases in India India

Figure-5: Percentage Share of Deaths due Mosquito borne diseases in India

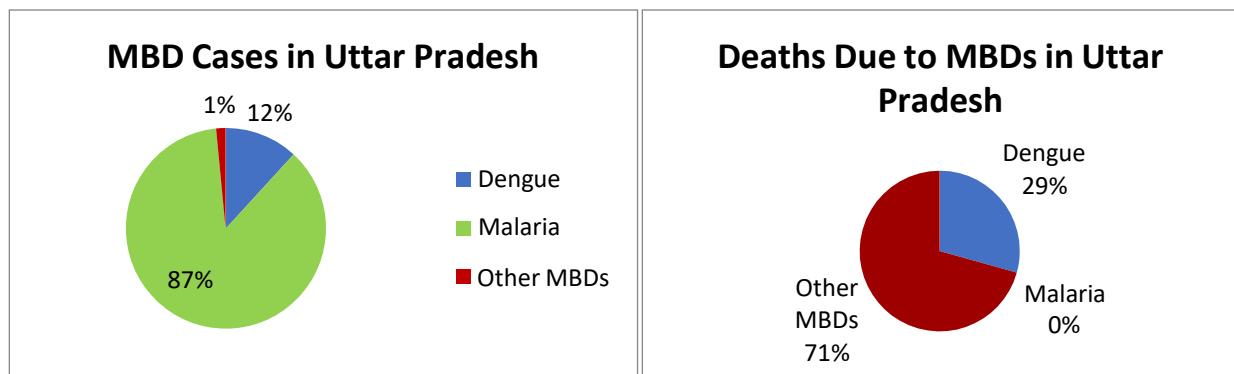


Figure-6: Percentage Share of Mosquito toborne diseases in Uttar Pradesh Pradesh

Figure-7: Percentage Share of Deaths due Mosquito borne diseases in Uttar Pradesh

Figure-4 shows that Malaria is the most prevalent disease among all MBDs as percentage share of malaria is highest (79%) among all MBDs in India. Figure-5 shows that Malaria and

dengue are the deadliest diseases among all mosquito-borne diseases in India. However overall death percentage of Malaria is higher but death percentage among all dengue infected people is highest. Figure-6 shows that Malaria is most prevalent disease in Uttar Pradesh too, as it shares approximately 87% cases among all cases of Mosquito-borne diseases. Figure-7 exhibits that no deaths found because of Malaria in Uttar Pradesh but Dengue is deadliest among all mosquito borne diseases.

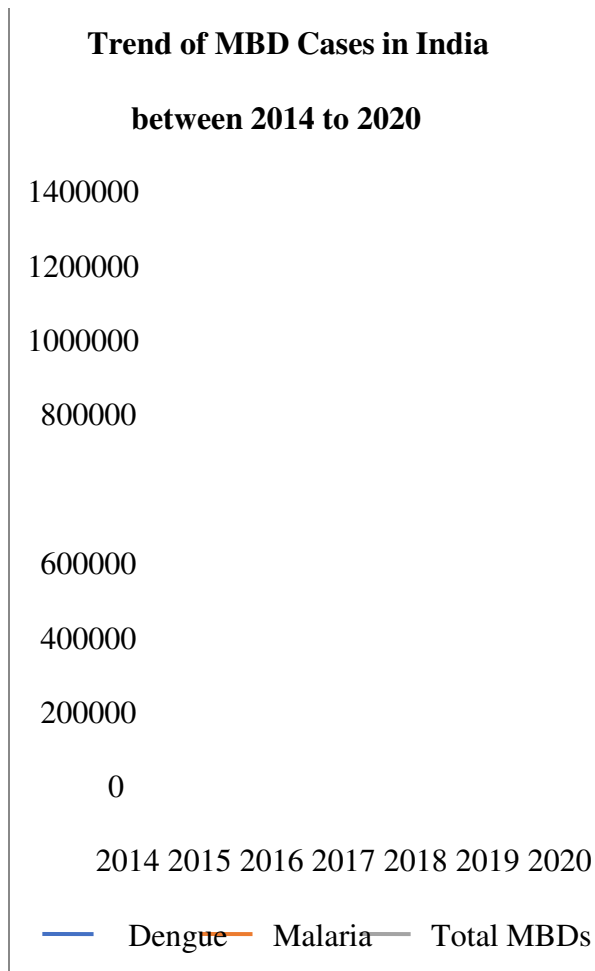


Figure-8: Trend of MBD cases in India

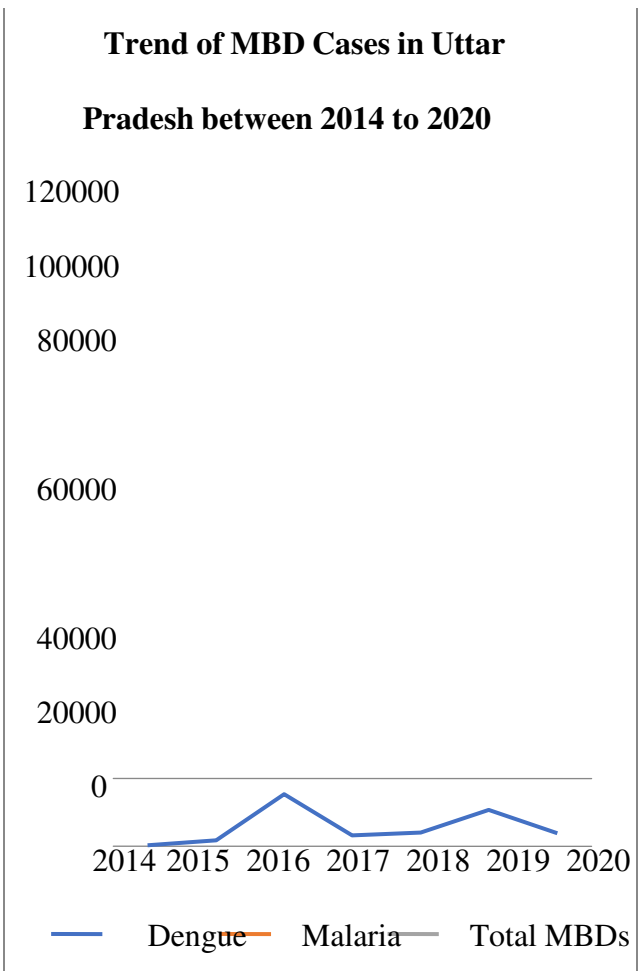


Figure-9: Trend of MBD cases in Uttar Pradesh

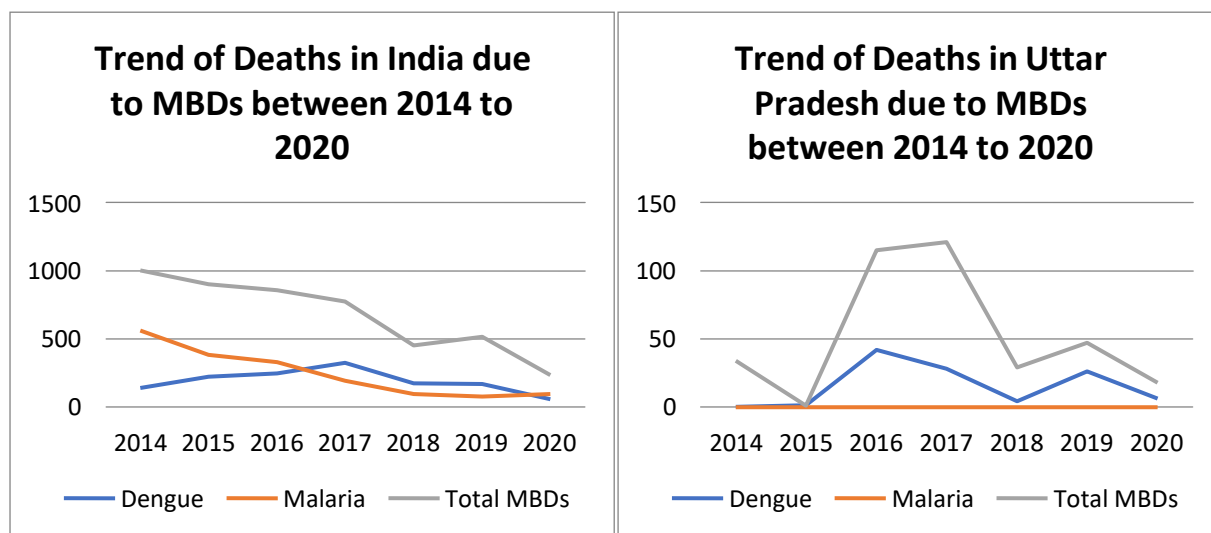


Figure-10: Trend of deaths due to MBDs in India Figure-11 Trend of deaths due to MBDs in Uttar Pradesh

From Figure-8 and Figure-10, it is clearly visible that cases of mosquito borne diseases and deaths due to them follow downward trend in India between 2014 and 2020, which is good sign and indicator of continuous improvement. But when we talk about the same for Uttar Pradesh it is slightly unexpected trend pattern, where we get decline till 2015 and sharp increase till 2017 followed by again falling rate, which is not a good indicator.

Regression model taking the MBD mortality rate as a dependent variable and the Malaria-Dengue mortality rate as an independent variable which is calculated as the total number of deaths per 1000 people infected either with Dengue or Malaria shows interesting results.

$$\text{Model - MBD} = a + b(\text{Dengue}) + c(\text{Malaria})$$

$$\text{Results - MBD} = 88.50 + 1.47(\text{Dengue}) + 1.25(\text{Malaria})$$

Therefore, the results indicate a positive impact of Dengue and Malaria on MBD mortality rate with 97% R-squared value, which shows that change in MBD mortality rate is 97% explained by death rate due to Malaria and dengue. In easy language, we can say that Malaria and Dengue combine contributes 97% change in death rate among total deaths due to MBDs.

Correlation coefficient between total Death rate and MBD death rate is 0.8792, Which shows high correlation between these two variables. R-squared is also very high at 0.773. These results indicate that change in death rate is associated highly with change in MBD death rate.



## **The Burden of Mosquito Borne Diseases on Healthcare**

In India, the prevalence of mosquito-borne diseases (MBDs) like malaria, dengue, chikungunya, Japanese encephalitis, lymphatic filariasis, Zika virus, and West Nile virus presents significant public health challenges. Factors such as poor sanitation, inadequate healthcare infrastructure, and climate change worsen mosquito breeding and disease transmission. The economic burden of MBDs is hard to gauge due to underreporting and inadequate surveillance systems. Mosquito-borne diseases pose a significant burden on healthcare systems globally. These diseases cause a large number of illnesses and deaths each year, particularly in regions where they are endemic. The burden on healthcare systems includes costs associated with diagnosis, treatment, and prevention of these diseases. Healthcare facilities in affected areas often face challenges in managing outbreaks, providing effective treatment, and controlling the spread of these illnesses.

In addition to direct healthcare costs, there are several indirect costs related to mosquito-borne diseases, such as loss of productivity due to illness, impact on tourism and economic development, and expenses for vector control measures. Efforts to combat mosquito-borne diseases require a coordinated response from healthcare providers whether private or public, public health authorities, government and communities. This includes strategies for mosquito control, vaccination programmes where available, surveillance and monitoring of disease outbreaks, and public awareness campaigns to educate the population about prevention methods. Investing in research for new treatment options, vaccines, and innovative mosquito control techniques are essential and necessary to reduce the burden of mosquito-borne diseases on healthcare systems and improve public health outcomes.

The direct annual medical cost of dengue in India is estimated at around US\$548 million, with a substantial portion of cases requiring hospitalization leading to high healthcare costs. The overall economic and disease burden of dengue is likely higher than reported, necessitating more robust control measures. A thorough evaluation of disease burden involves analyzing various factors like prevalence, morbidity, mortality, and disability-adjusted life years, before and after interventions, and using mathematical models to estimate the impact of interventions on disease outcomes. Mosquito-borne diseases cause physical harm and even death.

It also results in significant economic losses due to healthcare expenses, reduced productivity, and diminished quality of life. Mosquitoes are a major vector of disease transmission, affecting not only humans but also animals like dogs and horses, amplifying the impact on overall well-being and economic stability.

The median gross total cost of illness (a single episode of malaria) was 4,000 INR, the median direct medical cost was zero, and the median direct non-medical cost was 100 INR. The majority of individuals (92.2%) took treatment from public healthcare sectors (Affan K, 2021).

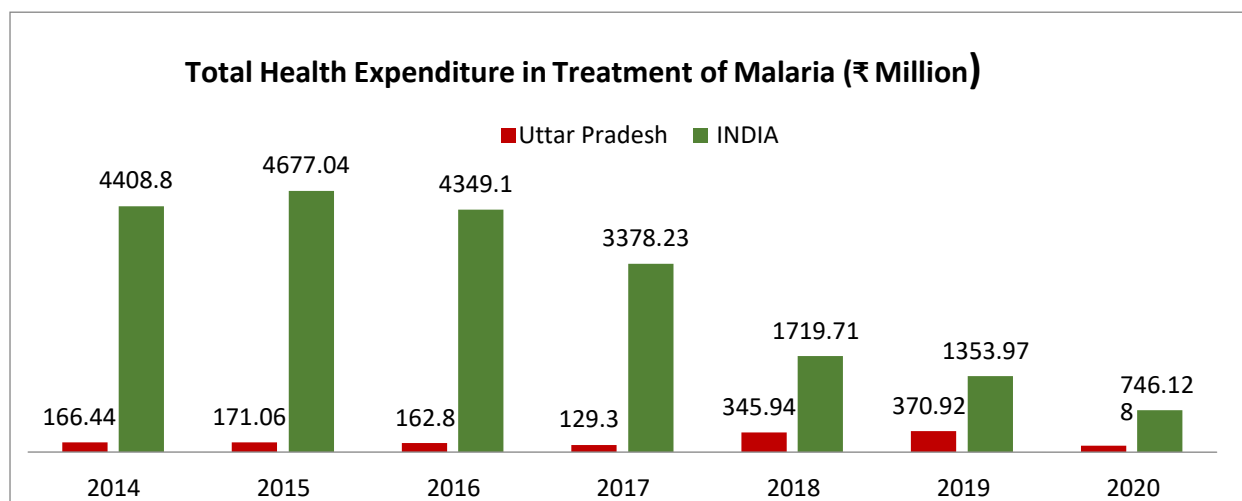


Figure-4: Estimated Total health expenditure in treatment of Malaria in Million Rupees

## Preventive Measures to Mitigate the Impact of Mosquito Borne Diseases

To reduce the impact of mosquito borne diseases on public health, the following measures can be used-

- Implement effective mosquito control measures, such as removing standing water where mosquitoes breed, using insecticides, mosquito nets, and screens on windows.
- Conduct regular mosquito surveillance and control programmes in areas prone to mosquito infestations.
- Educate the public about the importance of personal protection measures, such as using insect repellent, wearing long sleeves and pants, and staying indoors during peak mosquito activity times.
- Raise awareness about symptoms of mosquito-borne diseases and encourage seeking medical attention if symptoms are present.
- Support vaccination programmes where available for specific mosquito-borne diseases like yellow fever, dengue, or Japanese encephalitis.
- Promote environmental management practices to reduce mosquito breeding sites, such as proper waste disposal and maintaining clean surroundings.
- Use biological control methods, like introducing mosquito-eating fish or bacteria that target mosquito larva.
- Invest in research to develop new methods of controlling mosquito populations

and preventing the spread of diseases.

- Enhance surveillance systems to monitor mosquito populations and disease outbreaks for early detection and response.
- Collaborate with neighboring countries and international organizations to address cross-border mosquito-borne disease transmission.
- Strengthen healthcare infrastructure to ensure timely diagnosis, treatment, and management of mosquito-borne diseases.
- Engage local communities in mosquito control efforts through community clean-up drives, workshops, and other awareness programmes.
- Implement policies that support the prevention and control of mosquito-borne diseases, including allocating resources for research, surveillance, and healthcare services.

### **Socio-Economic Implications of Mosquito Borne Diseases**

The implications of MBDs, which carry both social and economic repercussions, are profound and far-reaching. These ailments not only affect individuals on a personal level but also have significant implications for wider societal frameworks and economic systems. From severe health issues that debilitate individuals to the broader impact on communities and economies, the consequences of these diseases manifest in various ways. On a personal level, these diseases can manifest as a myriad of health issues those can significantly impact an individual's quality of life. The physical and mental toll of these illnesses can be debilitating, leading to chronic pain, discomfort, and a decreased ability to perform daily tasks. Individuals grappling with these diseases often face challenges in managing their symptoms, seeking treatment, and coping with the emotional and psychological strain that accompanies chronic illness. From the physical pain of symptoms to the mental anguish of dealing with a long-term condition, the burden on individuals can be immense. Moreover, the economic implications of these diseases are equally substantial.

The loss of productivity due to illness can have a ripple effect on both individual livelihoods and broader economic structures. When individuals are unable to work at their full capacity due to health issues, it not only impacts their income and financial stability but also contributes to a decrease in overall productivity within the workforce. The economic burden of these diseases extends beyond the individual level, affecting businesses, industries, and economies at large. Absenteeism from work due to these illnesses poses a significant challenge for both employees and employers. Individuals who are sick or experiencing health issues may be forced to take leave from work to prioritize their well-being and recover. This absence can

result in lost wages for the individual and productivity losses for the employer. Additionally, the strain of managing a chronic illness while trying to fulfill work obligations can lead to increased stress, burnout, and decreased job satisfaction. Employers also face challenges in managing absenteeism, finding replacement workers, and maintaining productivity levels in the face of employee health issues. Furthermore, these diseases can create hindrances in education, limiting individuals' ability to access learning opportunities and reach their full potential. Students grappling with chronic illnesses may face barriers in attending classes, participating in school activities, and keeping up with academic requirements. The physical and mental toll of these diseases can impede students' ability to focus, concentrate, and engage in learning, impacting their academic performance and overall educational experience.

The challenges presented by these illnesses can lead to academic setbacks, reduced opportunities for personal and intellectual growth, and barriers to future educational and career pursuits. In addition to the individual repercussions, the social and economic impact of these diseases extends to broader societal structures and systems. Communities affected by prevalent illnesses may experience strain on healthcare resources, social services, and support systems. The burden of caring for individuals with chronic illnesses can fall on families, caregivers, and healthcare providers, leading to increased demands on resources and potential limitations in access to care.

The social fabric of communities can be tested as individuals grapple with the challenges of living with chronic illnesses, requiring support, understanding, and resources to navigate their situations. Moreover, the economic impact of these diseases can reverberate through various sectors and industries, affecting employment rates, healthcare costs, and overall economic stability. The healthcare system may experience strain in providing healthcare facilities for individuals with chronic illnesses, leading to increased costs, resource allocation challenges, and potential gaps in service delivery.

Employers may face rising healthcare expenses, productivity losses, and challenges in retaining a healthy and engaged workforce. The broader economy may see fluctuations in consumer spending, workforce participation, and overall economic growth due to the pervasive effects of these diseases on individuals and communities. In conclusion, the implications of these diseases are multifaceted, with far-reaching effects on individuals, communities, and economies. The combination of social and economic repercussions creates a complex web of challenges that individuals, organizations, and societies must navigate. By understanding the profound impact of these diseases and working towards holistic solutions that address the various dimensions of the issue, we can strive to mitigate the adverse effects and support individuals in achieving better health outcomes and improved quality of life.

## **Results and Discussion**

The detrimental consequences of mosquito-borne diseases on public health are multifaceted and extend far beyond mere physical health implications. The findings of studies are conclusive in showing that these diseases do not only negatively impact health but also significantly affect socio-economic, cluster, and general communal support and society's welfare as a whole. The implications of these diseases are immense, not only reflected in physical breakdowns, but also in various aspects of life thus calling for collective efficiency and desperate need for immediate action.

These diseases affect families in form of frequent illnesses disrupting a family's productivity, businesses through labor absenteeism and lowered productivity, and schools, where students are constantly absent from class or make little academic progress. Furthermore, these diseases are catastrophic in that their impact permeates every sphere of society and affects developmental progress, stutters growth, and creates a tangible feeling of insecurity and helplessness among people across the globe.

These diseases not only threaten the stability of the current healthcare systems but also undermine the fabric which underpins societies, making them vulnerable to episodes of ruthless communicable diseases and intensifying existing health inequalities. This dark cloud of mosquito born-fatal diseases is hanging over the head as an imminent threat which cannot be overemphasized and which requires much attention and prompt from the government and other relevant stakeholders to address since the lives and wellbeing of today and tomorrow's generation is at stake.

It is therefore important to recognize the fact that only through an innovative approach of a systems orientation towards implementation of multiple and converging strategies and interventions, can we defend us against these treacherous diseases and build a strong public health foundation that would be able to stand up to such challenges.

The potent preventive measures that may be taken include intensive use of effective and safe intervention and repellents, extensive public awareness campaigns, mass vaccination, proper management practices of the environment, research and development on more efficient ways to control the breeding of mosquitoes, regular surveillance, proper international cooperation, improvement of health-care facilities, increase involvement of communities, climate change adaptation measures, and proper policies that must be taken and implemented in order to reduce the additional harms that result. In turn, it is our responsibility and I think our duty to meet this challenge – that we face these diseases and join forces against this formidable public health issue that has created a worrying discourse thus needing to kick-start for a healthier and more efficient future for all.

## **Conclusion and Findings**

The MBDs such as malaria and dengue are being felt more and more in India with specific respect to the UP. Information about malaria clearly shows that millions of people have been affected throughout the world and the lives of many people and their families, are most affected in the developing world. While today malaria poses no fatal threat, it asserts economic cost that puts pressure on already struggling health facilities.

On the other hand, while comparing other MBDs, Dengue poses a greater danger to human beings in terms of mortality rate. These diseases lead to increase of hospitalization rate, outpatient interaction, and they bring burden to the health care system especially in the undeveloped and inaccessible zone of health care services mostly in rural areas. In Order to contain the diseases that are transmitted by these carriers India has ventured into the National Vector Borne Diseases Control Programme.

Uttar Pradesh is again at a higher risk in terms of transmission of diseases as it falls under one of the highly populated state, high population density state. These diseases have impacted on health, working productivity, loss in working days, learning institutions, tourism, and commercial activity within the affected regions. It would be pertinent to carve out that, the share of Uttar Pradesh in India accounts for majority of the deaths due to mosquito-borne diseases with reference to either Malaria or Dengue.

These diseases remained fatal compounded in Uttar Pradesh in the period from the year 2014 to the year 2020 as well. To control these diseases there is need to implement effective strategies to strengthen the combat forces.

To reduce the effects of those diseases on public health, the following measures are necessary: breast screening, family planning, oral rehydration, water treatment, environmental control, insecticide treated bed nets, malaria rapid diagnosis and treatment, insecticide spraying, disease surveillance and confirmation, water supply and sanitation, provision of essential equipment and commodities, and policy advice.

Consequently, the condition of you know diseases like Malaria and dengue in India especially

UP need active and integrated approach to combat this problem through carrying out all the must needed preventative measures. Regarding this idea, malaria, dengue, and other diseases similar to them should be fought in different ways and should be the team effort hence decreasing their effects, increasing our health and least effects on economies.

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