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DENGUE IN DELHI-NCR- A REVIEW OF VECTOR SURVEILLANCE, PREVENTION AND CONTROL STRATEGIES

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ABSTRACT

Dengue fever has emerged as a significant public health concern in Delhi, a city in northern India, has faced numerous outbreaks of dengue fever over past decades. This situation, initially classified as an epidemic, is day by day transitioning to an endemic and hyperendemic phases, reflecting a significant shift in virus's dynamics over the years. Without the proper vector control, prevention and control strategies. it is imperative that we focus on robust virological surveillance and the implementation of effective, locally tailored programs. Dengue a persistent public health concern in India. Dengue fever is rising in Delhi, with increasing incidence, serotype diversity, and geographic expansion. Peak transmission occurs during monsoons with high disease burden in urban areas. Enhanced surveillance, vector control, and public awareness are crucial to combat Delhi's dengue threat. this review paper decisively addresses these critical issues like its mode of action, effect on human physiology. the review also identifies and explores the impact of climate change, urbanization and vector density on dengue transmission. Clinical manifestation. Furthermore, it assesses existing prevention and control strategies, including vector management, disease surveillance, and vaccination efforts.

Keywords: Dengue fever, Epidemic, Serotype diversity, Vector control, Clinical manifestation.

1. INTRODUCTION

Dengue viruses are classified within the Flavivirus genus of the Flaviviridae family and represents the most significant arboviral infection globally. There are four distinct serotypes, known as DENV 1 to DENV 4. These serotypes can lead to a spectrum of clinical manifestations, ranging from mild dengue fever (DF) to more severe illnesses such as dengue hemorrhagic fever (DHF), Understanding the impact and variability of dengue is crucial for effective prevention and treatment strategies. Each serotype has its distinct characterstics and lead to severe manifestation in specific populations, influenced by interactions with host response. The epidemiology of dengue in India is constantly evolving. All the four serotype has been reported in India. Delhi a city in northern India, has witnessed several reported outbreaks of dengue. The world health organization (WHO) guidelines for diagnosing dengue rely on several effective methods including virus culture, viral RNA detection, immunochemistry for detecting viral antigen in tissues and measuring rising titers of IgG antibodies in convalescent patients. however, it is important to recognize that in healthcare facilities access to these tests can be limited, which may hinder effective patient management. Epidemiological studies indicate that DENV infection affects approximately two-fifths of the global population, with nearly 390 million individuals infected annually. This leads to approximately 500,000 hospitalizations and 20,000 fatalities each year. The virus is primarily distributed across the Eastern Mediterranean, Southeast Asia, Africa, the Western Pacific, and South America. It is estimated that around 2.5 billion people are at risk of contracting dengue, with 100 million reported cases of dengue fever annually. From this number, up to 500,000 cases progress to potentially life-threatening conditions such as dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS). Notably, the majority of DHF and DSS cases arise from subsequent infections with different DENV serotypes or from secondary infection [1].

Currently, the factors and mechanisms contributing to the severity and pathogenicity of dengue remain partially understood. Existing knowledge indicates that various elements related to both virology and the host immune response are correlated with the incidence of DHF and DSS. Additionally, climate change plays a significant role in the distribution of Aedes mosquitoes, which subsequently influences DENV transmission dynamics. Collectively, this information underscores the complexity surrounding dengue incidence and the manifestation of severe dengue syndrome. In light of these insights, this study was undertaken to conduct a systematic review aimed at enhancing the understanding dengue pathogenesis, diagnosis, treatment, and prevention strategies .

2. HISTORY AND OVERVIEW

Dengue is an illness that has been recognized for over 200 years, with a historical significance that cannot be understated. The role of mosquitoes, particularly the Aedes aegypti and Aedes albopictus species, has been understood for more than 70 years, highlighting the important connection between these insects and the transmission of the disease. Dengue has caused widespread suffering, leading to massive epidemics in various regions including Asia, the Americas, and the Mediterranean. During World War II, it was so prevalent in the Pacific that it hindered military operations, showcasing its ability to disrupt not only public health but also critical historical events [2].

Historical investigations suggest that the chikungunya virus may have been the culprit behind a severe outbreak between 1824 and 1825, which primarily affected cities such as Kolkata, Chennai, and Gujarat. The documentation from this period reveals that from 1828 to 1824, there were numerous reports of dengue epidemics, particularly in the regions ranging from Pondicherry to Kolkata, and extending along the Ganges valley up to Varanasi, which was then known as Banaras. disease reemerged in subsequent years, with significant incidences reported in Kolkata and Kanpur in 1848, and again in 1872, when cities such as Mumbai, Pune, and Kolkata faced outbreaks [3].

The scientific understanding of dengue deepened in the mid-20th century, particularly in 1945 when Sabin successfully isolated two strains of the dengue virus from human sera in Kolkata. This was a pivotal moment in the history of the disease, as it marked the beginning of a more focused effort to understand and combat its effects. By 1952, the National Institute of Virology had recognized only two arboviruses at that time . dengue and sandfly fever. Notably, only the DEN-I strain of dengue had been isolated, indicating a limited but important understanding of the virus's complexity. Overall, the history of dengue in India is a story of resilience and ongoing challenges. Continued research and public health efforts are essential to addressing the threat of dengue and safeguarding communities against its impact [4].

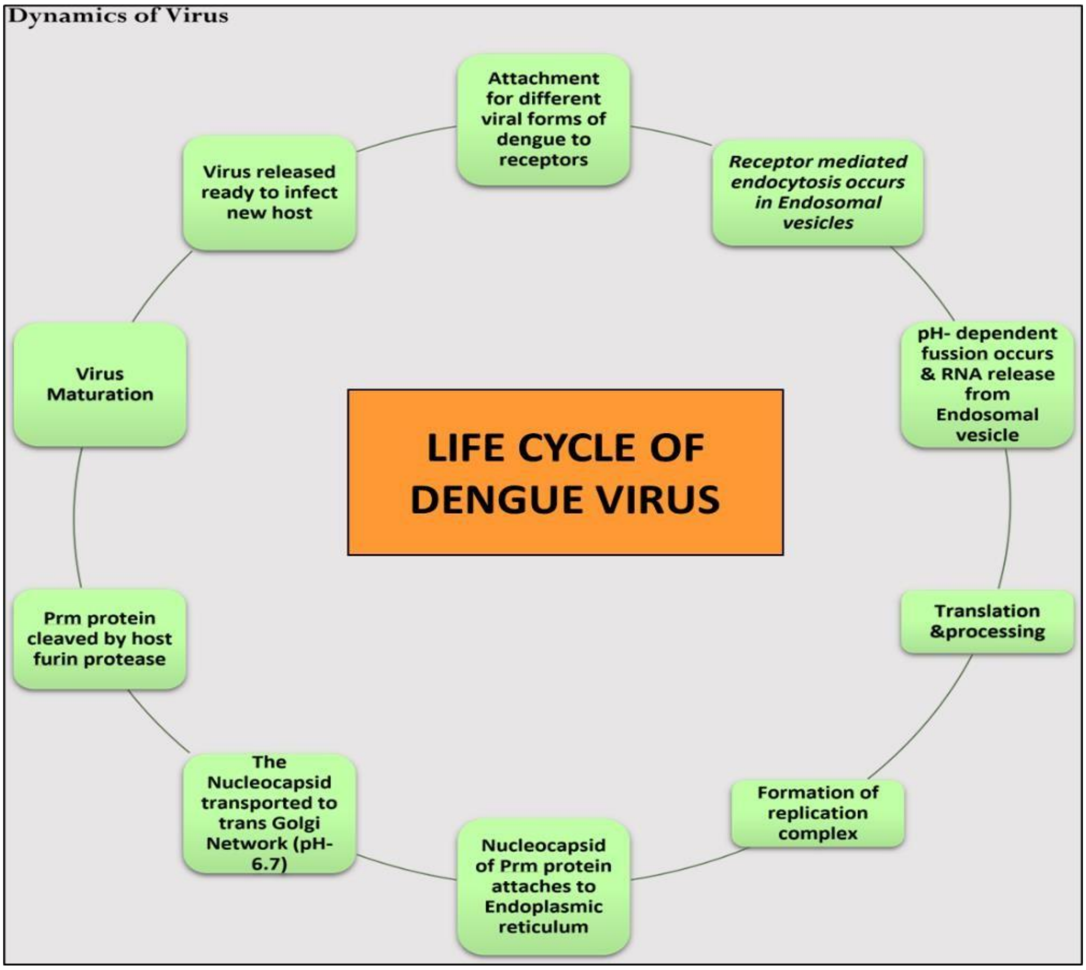

Fig1. Life cycle of dengue virus.

2.1 DYNAMICS OF VIRUS

The history of Dengue Virus (DV) in India reveals significant shifts in the circulation and dominance of various serotypes and genotypes over the years. Initially, the American genotype of Dengue Virus type 2 (DV-2) was the predominant strain in India before 1971. However, after 1971, the Cosmopolitan genotype gradually replaced the American genotype. This shift led to the evolution of a distinct subclade of DV-2 within India, demonstrating the virus's genetic adaptation in the region. From 1956 to 2011, DV-2 strains were consistently documented in India, highlighting the long-term persistence and role of this serotype in the country's dengue epidemiology. Following the replacement of the American genotype with the Cosmopolitan genotype, this strain continued to evolve contributing to the complexities of dengue transmission in the country [5].

A notable turning point occurred in 2003, when an epidemic strain of Dengue Virus type 3 (DV-3) re-emerged in Delhi. This marked a significant shift in the circulating strains of the virus and indicated a change in the patterns of dengue outbreaks in the region. The re-emergence of DV-3 emphasized the dynamic nature of dengue virus circulation, where new strains can emerge and cause significant epidemics, altering the existing transmission dynamics although there have been occasional reports of Dengue Virus type 4 (DV-4) circulating in India, this serotype has not become the predominant type in the country. It remains less common compared to DV-1, DV-2, and DV-3, which continue to be the primary serotypes causing dengue outbreaks in India.

India's dengue virus landscape has been shaped by the dominance of DV-2, its subsequent evolution into a new subclade, and the re-emergence of DV-3 in 2003. While DV-4 has been sporadically reported, it does not play a significant role in the overall dengue burden in India, where DV-1, DV-2, and DV-3 remain the most prevalent and clinically significant serotypes [6].

2.2 EPIDEMIOLOGY OF DENGUE

During the period from January to December 2003, a comprehensive study identified a total of 893 cases (57.36%) confirmed as serologically positive for dengue. Among these confirmed cases, 199 individuals (22.28%) tested positive for dengue-specific IgM antibodies, which are indicative of a primary dengue infection, signalling that these patients were likely experiencing their first encounter with the virus .

In addition to this, 381 cases (42.67%) displayed the presence of both dengue-specific IgM and IgG antibodies, suggesting that these individuals were undergoing a secondary dengue infection. This dual presence of antibodies is significant because it reflects an immune response that has been previously exposed to the virus and highlights the complexities of dengue immunity Moreover, in 313 cases (35.05%), IgG antibodies were detected in isolation. This finding may imply that these individuals could be experiencing suspected secondary dengue infections; however, it is crucial to acknowledge that the detection of IgG alone might also stem from cross-reactivity with other flaviviruses, which can complicate diagnosis and treatment. Moreover, in 313 cases (35.05%), IgG antibodies were detected in isolation. This finding may imply that these individuals could be experiencing suspected secondary dengue infections; however, it is crucial to acknowledge that the detection of IgG alone might also stem from cross-reactivity with other flaviviruses, which can complicate diagnosis and treatment [7].

According to the Municipal Corporation of Delhi's (MCD) weekly vector-borne disease report, Delhi has reported 2,115 cases of vector-borne diseases. Notably, 2,010 of these infections were within the MCD's jurisdiction. It's worth mentioning that Delhi has seen a significant number of dengue cases, with over 5,000 reported till mid- September last year . The MCD has been taking measures to control the spread of vector-borne diseases, including domestic breeding checking, fogging, and larval control. The public health division of MCD has thus far pinpointed 43 high-risk areas in the city, where concentrations of dengue cases have been detected. Nevertheless, a substantial number of 'unaccounted cases' where the addresses of dengue patients are either incomplete or erroneous continues to hinder efforts to combat dengue, according to officials from the department.

Delhi is divided into 11 districts, which are further divided into 32 sub-divisions including Central Delhi, East Delhi, New Delhi, North Delhi, North East Delhi, North West Delhi, Shahdara, South Delhi, South East Delhi, South West Delhi, West Delhi amongst them, The areas which are drastically been affected by dengue within Delhi are - Najafgarh, Shahdara,Raj Nagar- II, Bagdola in past few years[8].

1) Najafgarh Zone; This area has reported the highest number of dengue cases,
2) South Delhi Zone: This zone has also seen a significant rise in dengue cases.
3) West Delhi Zone: Most malaria cases have been reported in this zone including dengue cases are also on high peak.

Shahdara has seen significant rise after Najafgarh. Various factors contribute to it. Such as water logging, Proximity to Yamuna River, High population Density, Lack of sanitizations, climate and weather pattern, poor awareness and vector control. In terms of water logging, Najafgarh has bad drainage system that creates a water logging issues and develops breeding sites for Aedes mosquitoes. Inadequate waste sanitization in some areas of Najafgarh leads to proliferate mosquito breeding sites, Limited awareness about dengue prevention and inadequate vector control measures in some areas of Najafgarh leads to increase number of cases. Unplanned urbanization has also contributed to creation of slum areas which lacks sanitization, waste management and vector control measures. Delhi's climate characterstics influenced by the hot summer and humidity also play a key role in mosquito breeding including monsoon & pre -monsoon conditions. All the factors create an environment that is conductive to mosquito breeding and dengue transmission, resulting in a higher number of cases in Shahdara after Najafgarh [9].

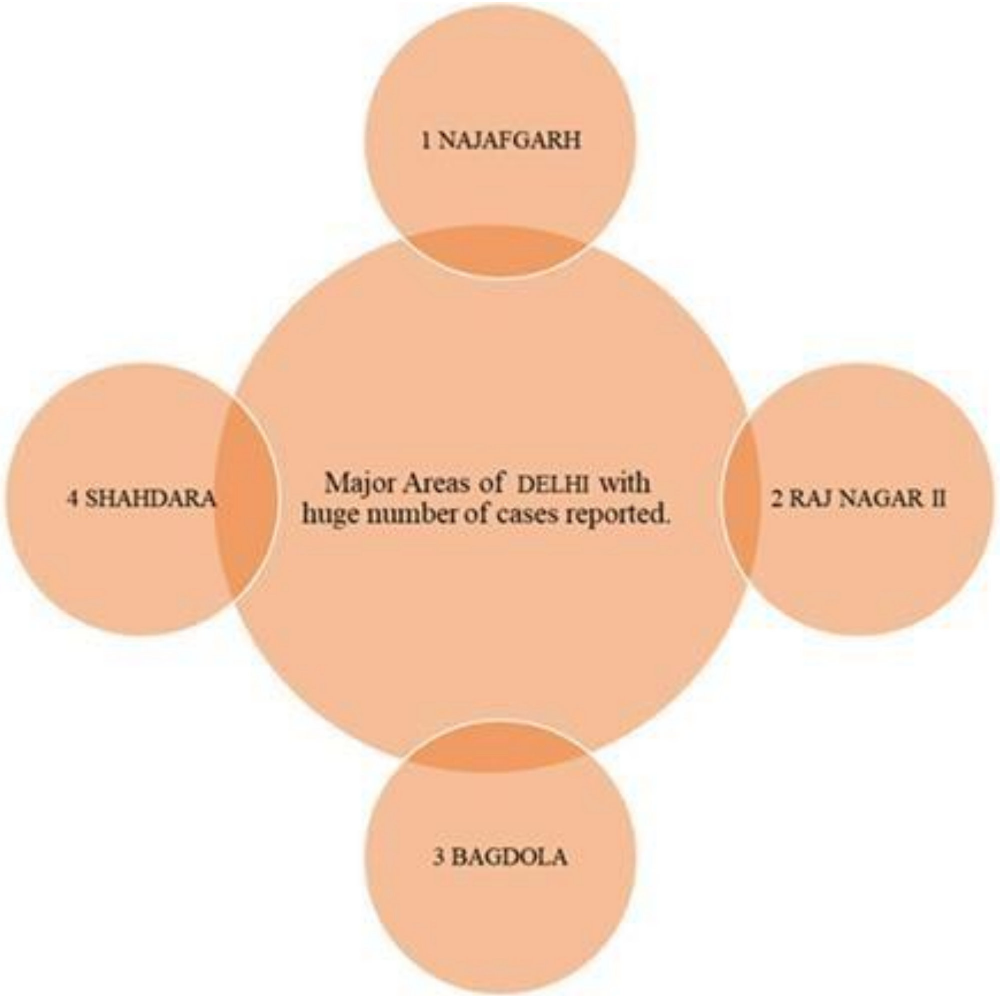

Fig 2. Areas that have been affected by dengue in Delhi.

The statistical analysis of the data reveals significant differences in the number of serologically positive cases reported across various years, indicating noteworthy fluctuations in dengue incidence. These findings emphasize the need for ongoing research and adaptive strategies to enhance our understanding, prevention, and response to dengue infections throughout the year [10].

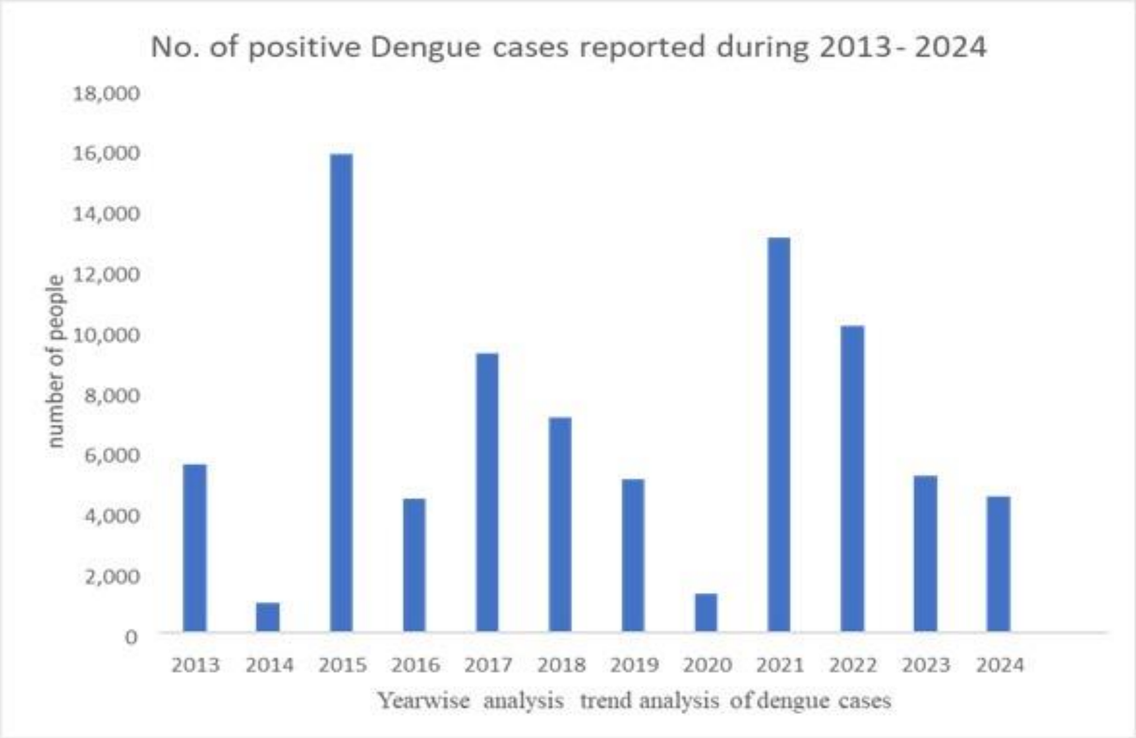

Fig 3. Year wise Analysis of Dengue Cases reported in Delhi.

2.3 VECTOR CONTROL

The genetic material of the dengue virus comprises three genes responsible for producing structural proteins, which work in conjunction with several non-structural proteins, including NS1, NS2A, NS2B, NS3, NS4A, NS4B, and NS5. Additionally, there are envelope (E), membrane (M), and core proteins (NVBDCP, Dengue-National-Guidelines-2014). The NS1 protein interacts with the host's immune system, triggering T-cell responses. It is detectable in the bloodstream of infected individuals, serving as an indicator of infection (NVBDCP, Dengue-National-Guidelines-2014). Often, dengue infection is symptom-free, and infected persons can unknowingly transmit the virus to new regions [11].

To effectively address the ongoing threat of dengue virus transmission, it is crucial to prioritize vector control as an essential strategy. Many countries affected by dengue recognize the urgent need to incorporate effective vector control into their prevention and management programs. Unfortunately, the efforts of public health practitioners can sometimes be inadequate, leaving communities vulnerable to this disease When a female Aedes mosquito bites someone, it can spread virus to other people, its is the primary vector in most Indian cities, especially in Delhi, The egg deposit solitary on damp surface, above water surface. In the ideal circumstances the larvae emerges after seven days, there are various challenges encountered by the mosquito in order to grow and survive which includes drying out for more than a year, The extended survival rate increases the transmission of virus. The principal vector, Aedes aegypti, has a close association with human environments, underscoring the need for a thoughtful and comprehensive approach to vector control. It is vital to employ a combination of environmental management practices and chemical control methods, including larvicides and adulticide space sprays.

These chemical controls should be carefully applied to stored water for domestic use, including drinking water. The International Programme on Chemical Safety (IPCS) has taken measures to ensure that the active ingredients in various larvicides are safe for use in drinking water at dosages effective against Aedes spp. Larvae.

While the organophosphate temephos has served as an important tool since the 1970s, we acknowledge that increasing resistance among mosquito populations, along with community concerns regarding water treatment and the challenge of achieving consistent coverage, complicate efforts to safeguard public health [12].

Furthermore, although biological control agents such larvivorous fish and copepods can provide valuable alternatives for managing A. aegypti populations, their broader implementation has been limited by practical challenges. The insufficient availability of facilities and expertise for mass rearing, coupled with the continuous need to reintroduce these agents into specific habitats, underscores the complexities faced in our fight against dengue It is essential to address the concerns of our communities and collaborate on overcoming these challenges. By ensuring that our vector control strategies are both effective and considerate of those impacted by dengue virus transmission, we can work together toward creating a healthier and safer environment for all [13].

2.4 CLIMATIC INFLUENCE

Dengue cases exhibit a distinct seasonal pattern, with their onset typically coinciding with the monsoon season, followed by a surge in reported cases during the post-monsoon period, and eventually, a decline as the early winter months set in. This seasonal fluctuation is largely driven by the breeding habits of the Aedes mosquito, which is the primary vector for transmitting the dengue virus. The monsoon season's increased rainfall and humidity create ideal breeding conditions for the mosquito, leading to a rise in dengue cases. As the post-monsoon period brings a slight decrease in temperature and humidity, the mosquito population continues to thrive, resulting in a surge in reported cases. However, with the onset of early winter, the cooler temperatures and reduced humidity make it difficult for the mosquito to survive, ultimately leading to a decline in dengue cases [14].

Numerous studies indicate that dengue transmission patterns are changing due to factors like globalization, climate shifts, and human behaviour. The Intergovernmental Panel on Climate Change (IPCC) warned in 2007 that by the 2080s, 1.5 to 3.5 billion people could be at risk for dengue due to ongoing climate trends. Key climatic factors influencing mosquito populations and dengue incidence include temperature and precipitation [15].

Integrating climate considerations into public health strategies is essential for mitigating dengue spread. The burden of dengue during the winter months is predominantly felt in socio-economically disadvantaged neighbourhoods, where the combination of higher mean temperatures and the presence of urban heat islands exacerbates the situation. These areas, often lacking adequate resources, are particularly vulnerable to the spread of the disease [15].

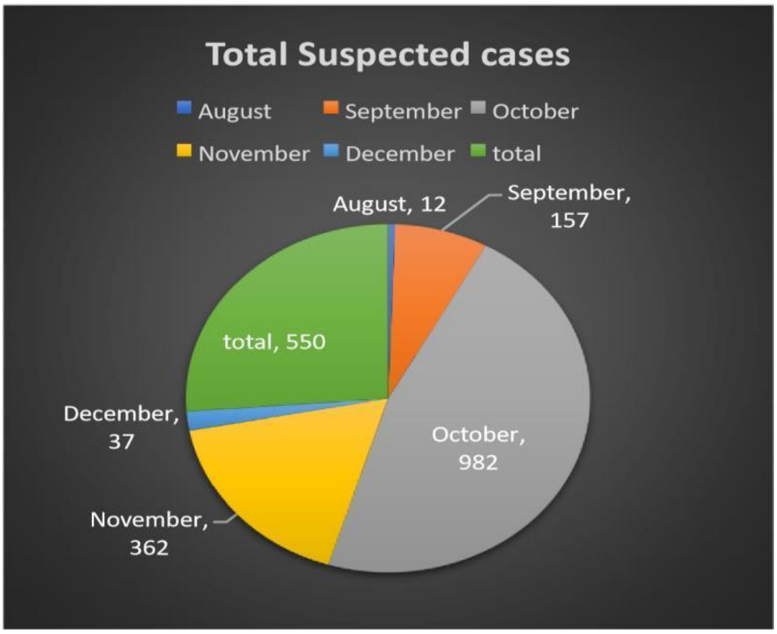

Fig 4. Analysis of the monthly distribution of clinically diagnosed and serologically confirmed cases among primary and secondary cases during the Dengue Fever outbreak in year 2023.

Enhancing access to tap water could play a crucial role in mitigating the impact of dengue, benefiting both those directly affected by the virus and the larger community. Furthermore, implementing targeted mosquito control measures in these socially disadvantaged regions during the winter months could serve as a strategic approach to maximize the effectiveness of dengue control efforts. By focusing on these critical areas, we can tackle the root causes of the outbreak and work towards a healthier population [16].

2.5 PUBLIC AWARENESS & PRACTICES

The examination of sanitation awareness and practices in the dengue hotspot region of Delhi is encapsulated. The primary garbage disposal method observed was self-dumping at communal sites, which exhibited a significant correlation with dengue incidence. Households that employed self-dumping or utilized common collection points faced a higher risk of reporting dengue cases compared to those relying on organized collection via common vehicles or door-to door services. This finding suggests that the methodology of waste management could be a contributing factor to the prevalence of dengue in the area [17].

Furthermore, various community-driven cleanliness initiatives were reported, including the maintenance of drainage systems, elimination of stagnant water, and application of insecticides. These activities were notably associated with dengue case trends, with the removal of standing water being the most frequently implemented practice to mitigate risk. Additionally, a significant relationship was observed between the frequency of community-led efforts to control mosquito populations and the reported cases of dengue. Overall, households adopted a variety of strategies [11]. To effectively minimize mosquito populations, various measures such as mats, coils, bed nets, creams, and sprays can be implemented. These practices have demonstrated a significant association with the prevention of dengue at the household level.

Dengue cases are on the rise, and we've confirmed these infections by detecting IgM antibodies against the dengue virus (DENV) using the innovative MAC ELISA method. ultimately This cutting-edge technique utilizes a specialized kit developed by the National Institute of Virology in Pune, India, playing a crucial role in the National Vector Borne Disease Control Programme [18].

2.6 IMMUNIZATION OBSTACLE

The ongoing battle against dengue fever is sparking a revitalized surge of interest and investment in the development of a groundbreaking tetravalent dengue vaccine! As the disease continues to spread and intensify, making the creation of a safe, effective, and affordable vaccine a top global public health priority, the stakes have never been higher. For decades, researchers have been pushing the boundaries of science to tackle dengue vaccine development. Yet, the complex nature of this illness presents unique challenges—most notably, the daunting task of simultaneously targeting four distinct virus serotypes. Compounded by a lack of sufficient investment from vaccine developers, progress has been slow. The intriguing link between severe dengue cases, such as Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS), particularly in individuals with secondary infections, adds another layer of complexity to this urgent quest. Vaccines must not only elicit a powerful immune response against all four serotypes but also cater to those with previous exposure to the virus. While animal models offer some insights, they fall short of fully capturing the intricacies of human immunity. The enigma surrounding how to induce protective immunity against dengue remains a thrilling challenge for scientists. To make matters more riveting, recent findings show that cases of DHF and DSS can emerge as much as 20 years after the initial dengue infection—introducing an unsettling and fascinating twist to this ongoing battle. The race is on, and the world is watching as researchers strive to unlock the secrets of a safe and effective dengue vaccine! Recognizing the challenges posed by dengue, particularly when it comes to effective antiviral treatments, it's crucial to approach management with empathy and urgency. For those facing severe dengue, timely and supportive care, including volume replacement, can make all the difference in preventing complications and saving lives. While vaccines and antiviral medications represent hopeful avenues for controlling viral diseases, the complexity of the four dengue serotypes (DENV1 through DENV-4) along with the risks of antibody dependent enhancement in severe cases have made the journey toward a viable dengue vaccine quite complex. It’s important to understand and support those affected during these difficult times.[19].

2.7 Clinical Manifestation

Approximately 80% of primary dengue virus (DENVs) infections are asymptomatic, with less than 20% of infected individuals exhibiting clinical manifestations. The clinical presentation of dengue fever typically includes severe headaches, mild fever, rashes, myalgia, arthralgia, nausea, and vomiting [16]. Various studies have highlighted the presence of the DENV NS1 protein in notably high concentrations within the serum of patients. This protein exists in two distinct forms: it circulates as a soluble lipoprotein that is not bound to cells and can also be found anchored on the surface of cells. This dual presence may play a crucial role in the pathogenesis of dengue virus infections [20].

3. Prevention and Control

Enhance surveillance healthcare services. In rural and sub urban area also so, that the disease spread due to human mobility also reduce .Organize community involvement &clean up efforts to remove debris & stagnanent water from public areas .using natural predators and introducing viviparous species into confined water bodies (such as huge water tanks ,ponds).can help us.Using sprays or thermal fogs based om oil can prevent evaporation Ensure clean environment and make sure that the trash is discarded in an appropriate manner. Streghthening policies to enforce law against stagnant water, and promote eco- friendly control measure . Fill potholes and repair road sites before monsoon approaches to prevent water accumulation, which serves as an active breeding sites for mosquitoes . Effective public interventions needs to educate people about dengue virus By spreading information about virus and its effect.by implementing additional features in reporting areas. Eliminating breeding sites use of mosquito repellents at homes wearing protective clothes as a precaution . Enhance testing strategies can all together can help minimize the effect of dengue. There should be season specific dengue control initiative by developing season specific preventive control measures it will be easily manageable and effective [21].

4. DISCUSSION

Understanding how environmental factors affect dengue is essential for improving management and control strategies.the review emphasizes New Delhi has provided some useful information, regarding, vector control, strategies, climatic influences, surveillance strategies. it is important to explore how weather and landscape changes affect dengue cases within the city this review focusses, to look at how different weather conditions relate to dengue incidence. Our findings show important connections: an increase in mean temperature, especially between 30° and 35°C is linked to higher dengue cases after a lag of 5 to 15 weeks, suggesting warmer temperatures may create better conditions for dengue transmission In contrast, lower rainfall amounts between 20 and 40 mm seem to have a delayed effect, showing a lag of 15 to 20 weeks . Heavy rainfall above 100 mm relates to a quicker rise in dengue cases, with a shorter lag of 5 to 10 weeks. Additionally, higher humidity levels (above 60 g/m^3) are associated with increased dengue cases within a lag of 5 to 15 weeks These results highlight how important weather conditions are in influencing dengue cases in Bhopal . By using this information, we can create targeted interventions and public health strategies that address changes in the environment. Such initiatives can help reduce the impact of dengue and improve health outcomes in the region, ultimately supporting community well-being.

5. CONCLUSION

Over the past decade, diagnostic methods and procedures for detecting dengue viral infection have seen tremendous improvements, significantly enhancing our ability to identify this critical health issue. Despite these advancements, the unique characteristics of the dengue virus (DENV) and the wide range of diseases that can result from infection present ongoing challenges that demand further investigation. Addressing these key issues is imperative for advancing our understanding of dengue and optimizing our response strategies.

The study identified rain, temperature, and relative humidity as key climatic factors linked to dengue outbreaks. It suggests that further research could clarify the relationship between climate changes and outbreaks, aiding in the development of strategies for early outbreak forecasting.

CONFLICT OF INTEREST

The author declares no competing interest.

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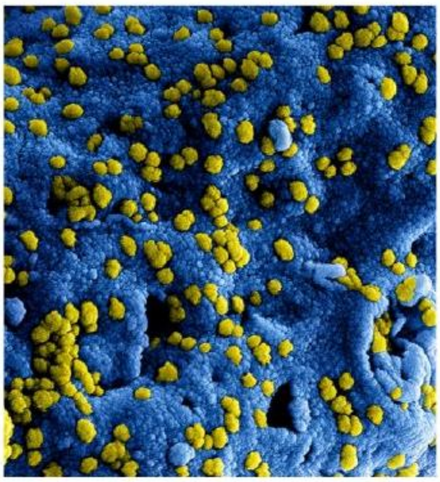

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