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Review Article

Learning from Brazil's dengue outbreak for Mumbai's monsoon preparedness: a public health perspective

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ABSTRACT

The expansion of dengue fever is a growing concern globally, with over half a million cases and more than 100 deaths reported worldwide as of January 2024. Dengue is now present in 85% of Brazil's municipalities, spreading into regions where it was never seen before. The aim and objective of the study is to look into the dengue outbreak in Brazil searching for contributing factors and to compare the presence of similar factors in Mumbai region. The study involves comprehensive review of existing literature about Brazil outbreak in online. Attempting to search for articles based on relevance to dengue fever cases and its management in Brazil and potential implication for Mumbai. Conclusion were drawn from expert opinion. Brazil's situation is dire, with over 1 million cases reported early this year 2024 and projections suggesting up to 4.2 million cases by year's end. But, between January to April 2024, 5.9 million of dengue cases reported. Due to the onset of El Nino and also due to extreme weather, untimely rainfall, flooding, stagnant water pools which leads to thriving of mosquito and prolongation of active transmission period. Steps were taken to reduce the Dengue outbreak. By prediction as per El Nino cyclicity, there will be no surge of dengue cases in Mumbai. But, in sprit of staying prepare and not to caught unaware, Mumbai is making precaution for dealing with dengue outbreak.

Keywords: Brazil, Dengue, El Nino, Monsoon, Mumbai

INTRODUCTION

The burden of dengue has surged dramatically over the past two decades across the world, presenting a major public health problem.[1,2] As of early 2023, over 5 million dengue cases and over 5,000 dengue associated deaths were documented across 80 countries and five WHO regions: Africa, the Americas, South-East Asia, the Western Pacific, and the Eastern Mediterranean. The Americas were particularly affected, accounting for approximately 80% of the cases, with 4.1 million reported.[2] In 2023, dengue cases in the Americas reached an unprecedented high, surpassing 4.1 million, exceeding the 3.1 million cases reported in 2019, which included 28,203 severe cases and 1,823 fatalities. By the 12th epidemiological week of 2024, 4,257,154 suspected dengue cases were reported in the Americas, sharp increase compared to the same timeframe in 2023 and a 495% surge has been observed relative to the five-year average.[3]

Brazil is currently experiencing a severe dengue outbreak, prompting public health emergencies in Rio de Janeiro and other densely inhabited regions.[4] Dengue cases in Brazil have surged from several hundred thousand annually in the early 2000s to over a million annually in

recent years, with up to 4.2 million cases projected by the end of 2024. From January to April 2024, nearly six million dengue cases were documented in Brazil, making it the leading country in Latin America in terms of dengue cases (Figure 1).[5]

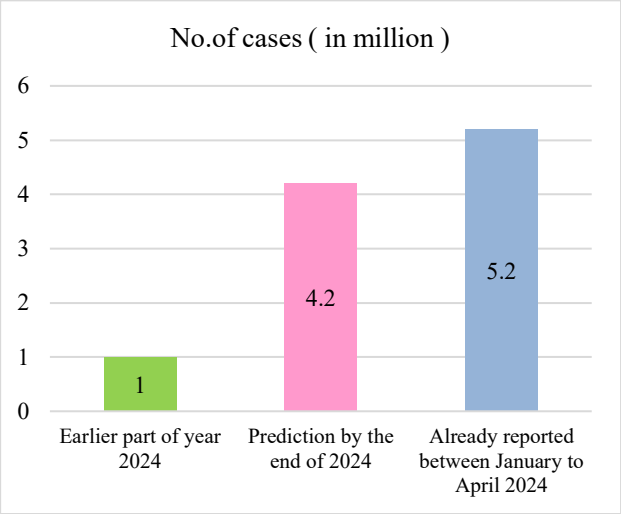

Figure 1: Number of cases detected in Brazil in the year 2024.

In contrast, Maharashtra, India, has experienced fluctuating dengue cases since 2019, with a peak of 19,034 cases and 55 fatalities in 2023. As of 2024, 1,639 cases have been reported with no deaths.[6] Mumbai, a city with a significant migrant population, struggles with the inspection and control of social and environmental factors contributing to dengue. The inconsistency in dengue cases in Mumbai from 2009 to 2018, ranging from 861 cases in 2014 to 1,756 in 2011, suggests fluctuating control measures and environmental conditions influencing dengue transmission.[7]

LITERATURE REVIEW

This study conducted a comprehensive review of existing literature on dengue outbreaks in Brazil, utilizing various sources, including scientific articles, newspaper reports, statistical publications, and data from WHO, CDC, PAHO, and other government websites.

The aim was to extrapolate lessons and implications for Mumbai, considering similarities in environmental factors, population dynamics, and healthcare infrastructure. The findings offer valuable insights for proactive dengue management and mitigation strategies in Mumbai.

OBSERVATIONS

Brazil, most expansive in South America, covers a vast geographical area of 8.5 million km² with a population of around 217.7 million.[8] It encompasses diverse climatic zones, including humid tropics, semi-arid regions, and temperate areas, leading a diverse range of ecosystems, including distinct biomes like the Amazon rainforest, Pantanal floodplain, Cerrado savannas, and Atlantic rainforest. This geographical and climatic diversity, coupled with rapid urbanization and socioeconomic vulnerability, creates favourable conditions for mosquito-borne diseases like dengue.[4,9]

Urbanization

Urbanization has significantly transformed Brazil, with over 80% of the population living in urban areas by the 21st century. Cities like São Paulo, which houses around 18 million people, have seen the emergence of favelas-informal communities lacking sufficient infrastructure, poor sanitation, and precarious waste disposal methods.[10] This leads to breeding grounds for mosquitoes like *Aedes aegypti,* vectors for dengue and other arboviral diseases.[11,12]

Similarly, Mumbai has undergone rapid urbanization over the past 60 years, facing challenges like water scarcity, inadequate sanitation, and infrastructure issues. The city's slum population, primarily from lower socioeconomic backgrounds, is concentrated in core urban areas for proximity to work, facing severe hygiene issues exacerbated during the rainy season.[13] Congested living conditions and poor sanitation in these areas contribute to mosquito breeding in stagnant water, increasing the risk of vector-borne diseases.[14]

Climate and seasonality

Brazil's extensive territorial area (8,510,345.540 km²) and with tropical climate, along with vast rainforests, create ideal conditions for mosquito proliferation.[15-18] Climate events like El Niño, characterized by warmer sea surface temperatures in the Pacific, further intensify mosquito breeding and the spread of diseases in South America by increasing temperatures and humidity, accelerating mosquito life cycles, and creating more standing water for breeding.[19-22]

Mumbai experiences a range of weather conditions throughout the year, including significant rainfall during the monsoon season.[23] The variations in temperature and humidity impact public health, particularly concerning mosquito-borne diseases like dengue. Climate change exacerbates these issues by affecting mosquito breeding patterns and virus transmission rates, while flood-prone areas due to heavy rainfall create additional breeding grounds if proper drainage is lacking.

PUBLIC HEALTH RESPONSE: CHALLENGES AND OPPORTUNITIES

Vector control strategies

Brazil implemented vector control measures to minimize the breeding of *Aedes* mosquitoes through environmental

changes, such as disposing of water containers, removing breeding sites, covering containers, and applying waste management strategies, use of fogging and insecticides, like malathion, has also been employed to control mosquito populations, although resistance to pyrethroids has necessitated changes in insecticide use.[24,25]

Public awareness and education

Public awareness campaigns in Brazil focused on educating the population on how to avoid mosquito bites and prevent breeding, emphasizing the importance of removing stagnant water and using protective measures. These campaigns also provided guidance on recognizing symptoms and seeking medical attention.[24]

Vaccination efforts

In 2024, Brazil began distributing Japan's two-dose Qdenga vaccine through its public healthcare system, targeting the most vulnerable populations. The vaccine showed an efficacy of 80% one year after the second dose. Additionally, Brazil is developing a vaccine to protect against all four strains of dengue.[24]

Innovative approaches

Brazil has pioneered innovative mosquito control methods, including releasing mosquitoes infected with Wolbachia bacteria, which inhibits the dengue virus proliferation within the mosquito vector. This approach has reduced dengue cases by up to 70% in some areas. Another method involves the release of male mosquitoes rendered sterile through nuclear radiation to reduce mosquito populations.[26]

Sterile insect technique (SIT) for mosquito control

In Brazil, the sterile insect technique (SIT) is used to control *Aedes aegypti* by releasing male mosquitoes sterilized with nuclear radiation. These sterile males' mate with native females, reducing their reproductive potential, and if done consistently, this can lead to the suppression or elimination of the mosquito population.[27]

Genomic surveillance

Brazilian scientists actively monitor genetic changes in the dengue virus through genome sequencing, which helps identify new variants, track their spread, and assess the effectiveness of vaccines and treatments.[5] This genomic surveillance enhances the understanding of transmission dynamics and informs public health responses. In both Brazil and Mumbai, the effectiveness of these measures depends on urbanization patterns, climate conditions, healthcare infrastructure, and community engagement. Planning strategies to local needs and continuously evaluating their impact are critical for controlling and mitigating dengue outbreaks effectively.

DISCUSSION

Shared epidemiological determinants between Brazil and Mumbai implies the potential vulnerability of Mumbai to dengue outbreaks in the future. Both regions face similar challenges like rapid urbanization, climate change impacts including unpredictable rainfall and flooding, and lack of sanitation and basic infrastructure. These factors leads to increase in the number of *Aedes* mosquitoes, vectors responsible for transmitting dengue fever.

Table 1: Comparative analysis of dengue control challenges and strategies: Brazil vs. Mumbai.

Criteria	Brazil	Mumbai
Geographical size	8.5 million km²	Mumbai city area is 603.4 km²
Population	~217.7 million	~21.7 million
Population density	26 people per square kilometer	36,200 people per square kilometer
Climate zones	Humid tropics, semi-arid, temperate	Tropical wet and dry
Primary ecosystem	Amazon rainforest, Pantanal, Cerrado, Caatinga, Pampas, Atlantic forest	Coastal city, slums, urban areas with inadequate infrastructure
Biodiversity	Greatest biodiversity on the planet	Limited to urban fauna and flora, significant mosquito presence
Mosquito-borne disease outbreaks	Severe dengue outbreaks, high incidence, recent surge to 5 million cases in early 2024	Persistent and rising dengue cases, particularly in slum areas due to poor sanitation and water management
Urbanization	Rapid urbanization	Rapid urbanization, large slum population
Living conditions in slums	Overcrowding, unsanitary conditions, high infant mortality, poor nutrition, lack of basic services	Overcrowded, unsanitary, inadequate sanitation facilities, prone to diseases during rainy season, significant health risks
Public health response	Fogging, community campaigns, Qdenga vaccine, Wolbachia mosquitoes, sterilized male mosquitoes	Efforts needed to address urban sanitation and water management to reduce mosquito breeding
Impact of climate	Tropical climate with high temperatures, El Niño effects increase mosquito breeding	High temperatures, heavy rainfall, inadequate drainage leads to water accumulation, enhancing mosquito breeding

Continued.

Criteria	Brazil	Mumbai
Innovative control methods	Wolbachia-infected mosquitoes, sterilized male mosquitoes, genome sequencing for virus tracking	Mainly traditional methods; need for innovative strategies and infrastructure improvements
Challenges	High urbanization, climate conditions, socio-economic vulnerability, poor infrastructure in slums	Rapid urban growth, water scarcity, inadequate sanitation, high mosquito breeding areas, significant slum population
Opportunities	Potential for vaccine rollout, community engagement for Wolbachia projects, advanced research	Need for comprehensive urban planning, improved sanitation infrastructure, potential for community-driven initiatives

Steps being undertaken in Mumbai to reduce the dengue outbreak include:

Implementation of preventive and control measures

All wards are actively executing strategies to achieve their targets for dengue control. Under the Brihanmumbai Municipal Corporation (BMC), it is mandatory to confirm every rapid diagnostic test for dengue with a smear examination. BMC has launched 'Bhag Machchar Bhag' campaign, promoting mosquito control measures through short films and messages by celebrities from the Marathi and Hindi film industries. Civic body has also requested citizens to take actions to eliminate mosquito propagation grounds, use mosquito nets, and wear protective clothing.

Adoption of 1-3-7 strategies

Adoption of the 1-3-7 Strategies: Implementing the 1-3-7 approach for efficient case detection, reporting, and response, in which cases should be reported within 24 hours, investigations conducted within 72 hours, and control measures implemented within 7 days.[25]

Vector control strategies

Employing various methods such as source reduction, engineering measures, biological and chemical controls. Crusades activities planning involves several key components to ensure effective dengue control. This includes maintaining a breeding register to monitor and address potential mosquito breeding sites, planning high-risk activities to target areas with increased vulnerability, and removing odd articles that could harbor stagnant water. Additionally, regular observations during area visits are conducted to assess and address any emerging issues promptly.

Utilization of newer technology

Incorporating drones and ladders to access inaccessible areas for vector control treatments.

Surveillance and monitoring

Conducting pre-monsoon surveys, fortnightly *Aedes* mosquito surveys, and monitoring of construction sites.

Under surveillance, the Medical Officer of Health (MOH) coordinates with the Pest Control Officer (PCO) to enhance dengue control efforts. This coordination includes identifying high-risk health posts (HP) for targeted interventions, verifying Rapid Test (RT) results, and addressing follow-up issues through detailed slides. The MOH also monitors patient treatment compliance and addresses any issues related to adherence to prescribed treatment regimens. Regular follow-ups ensure that compliance is maintained and any emerging concerns are promptly addressed. Private sector monitoring includes overseeing notification processes, maintaining a private linelist for accurate record-keeping, and monitoring RT performance in private settings. Additionally, plans are made to organize focus groups aimed at raising awareness about RT compliance and ensuring adherence to testing protocols.

Establishment of war rooms

Setting up dedicated war rooms to coordinate disease surveillance and public health actions. It was proposed to reactivate 24 ward offices to assist the citizens and follow up on the patients

Pre-monsoon preparedness

Conducting indoor residual spray, rodent control measures and mapping high-risk areas for targeted interventions.

Coordination and training

Collaborating with private hospitals, training medical and para-medical staff, and sensitizing public representatives and social workers.

Logistics and preparedness

Ensuring sufficient stocks of essential medicines, testing kits, chlorine tablets and ORS for outbreak control.

Joint action and coordination

Coordinating efforts among various governmental and semi-governmental agencies to enhance mosquito-proofing and scrap removal.

Furthermore, enhancing resilience to climate change through improved urban planning and infrastructure can reduce mosquito breeding habitats and enhance the city's capacity to respond to environmental challenges.

CONCLUSION

By adopting a comprehensive and proactive approach, Mumbai can enhance its preparedness and resilience against dengue outbreaks. Learning from Brazil's experiences and tailoring interventions to local needs will enable Mumbai to build a more robust public health system capable of mitigating future health threats posed by urbanization and climate change.

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