

“Seven-Plus-One Model”: A Move Toward Dengue Free Community

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Abstract

Dengue is a wide spectrum of diseases creating menace in the community. This vector-borne disease alone has a significant impact on global public health and the economy. Resources need to be mobilized to tackle the situation. The present article focused on the novice concept of “Seven-Plus-One models” as an approach to dengue prevention with vector management through community participation. A multidisciplinary approach along with exemplifying effective methods of inspectorial coordination and community participation is much required. The implementation of the Seven-Plus-One model has a positive impact on reducing dengue cases, indicating acceptance and effectiveness of the concept among the public. Dengue morbidity rate can be reduced through early detection and mobilizing the community for active participation in dengue prevention and control.

Keywords: Aedes Aegypti, dengue, community participation, Seven-Plus-One model

INTRODUCTION

Dengue is a viral infection caused by dengue virus (DENV), transmitted through mosquitoes, is ranked one among the top ten threats to public health. Globally, according to the World Health Organization (WHO), DENV causes a widespread spectrum of diseases with altered morphology and various etiologies. Many different viruses have a unique propensity to affect the immune system of human beings, which does not necessarily manifest as a serious illness to the individual, and varies between subclinical to infected cases. DENV has affected many countries including India. In 1780, patients with clinical dengue-like symptoms were recorded in Madras, reported as the first epidemics in the country. The first virologically positive dengue epidemic was documented in Calcutta and the Eastern Coast of India, in 1963–1964.^[1] However, the first devastating epidemics of dengue hemorrhagic fever occurred in Delhi with a huge rate of morbidity and mortality.^[2] It was a siren to Indian public health to initiate a stout step toward this epidemic.

The disease

An epidemiological study reported that DENV is transmitted by Aedes Aegypti mosquito.^[3] The mosquitoes have a limited flight range of 333 m.^[4] Dengue mosquito feeds on human

blood both in domestic and peridomestic conditions. The mosquitoes breed on any even surface having stagnant water which might include tyre, water coolers, pits, and flower pots.^[5] Data show that the DENV itself is not capable of infecting humans until transmitted by a vector.^[6] It is well accomplished that the virus comprises its existence and property to adversely attack the homeostasis and immune system of a human being.^[7] DENV has been a significant threat to public health which enlighten during the monsoon season. It comprises a single-stranded RNA virus with four serotypes, i.e. dengue 1, 2, 3, and 4. These serotypes do not have cross-protection to the strain but a single strain brings lifelong protection against the dengue virus.^[8]

The global menace

Globally, 390 million cases of DENV infection are estimated per year, 96 million of which manifest clinically.^[9] According to WHO, there has been an eightfold rise in dengue cases over the last two decades increased from 505,430 cases in

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2000, to 2.4 million in 2010, and 5.2 million in 2019.^[10] Findings reported 2,417,989 dengue cases that include 3336 severe cases and 1080 associated deaths.^[11] The countries that reported the highest number of cases were in Brazil (88.2%), Peru (2.4%), Nicaragua (2.2%), Colombia (1.9%), and Mexico (1.2%)¹¹. Based on the Indian global modelled data, an estimated 33 million clinically apparent dengue cases occur in India per year, contributing to a third of the total global dengue burden.^[12] The rising trend of dengue has affected almost all states of India. Data reported an increased number of cases from 2015 to 2019. However, fewer numbers of cases have been reported in 2020 due to underreporting and overinfluence of COVID-19 cases.^[13]

Life cycle of *Aedes Aegypti*

The life cycle of the adult mosquito (*Aedes Aegypti*) ranges from two weeks to a month which is further supported by favorable environmental conditions. The Seven-Plus-One model targets each stage to destroy the lifecycle. The life cycle of *Aedes Aegypti* can be completed within one-and-a-half to three weeks. Stage 1 – Egg, Stage 2 – Larvae, Stage 3 – Pupae, and Stage 4 – Adult.

The eggs convert to larvae within 2–7 days. Hence, if we destroy the egg then the further process will be halted. Development of larvae to pupae takes >4 days and finally 2 days the pupae become adult mosquitoes.

“Dengue” transmission from human to mosquito

“Dengue virus” transmits from the human host to mosquitoes when a susceptible mosquito takes a blood meal from a viremic person. Further, the viremic blood reaches into the midgut, and via the circulatory system, it reaches the salivary glands of the mosquito where further multiplication occurs and during the next feeding event, the new host may be infected through the “saliva” of the infected mosquito.

Further, it is reported that the level of viral titer in human plasma is directly related to the probability of a mosquito becoming infected after a blood meal. Hence, preventive interventions such as vaccines and antivirals must target to reduce the transmission of DENV.

Studies reported that human beings can be infectious to mosquitoes from 1.5 days before the onset of symptoms to around 5 days after the beginning of symptoms. A study was conducted among 208 patients who were randomly assigned for 2 days on which they were exposed to naïve mosquitoes. Exposure was ranged between the first day and seventh day of illness only. It was observed that some number of mosquitoes can still become infected with each of the DENV serotypes up to the sixth day after illness onset. No mosquitoes were reported to be “infected” after suckling on patients on the seventh day after the onset of the illness.^[14]

According to Nguyet MN *et al.*, “DENV-1” and “DENV-2” infections can still be infectious to mosquitoes up to 2 days after defervescence, although this was rare. However, the level of viremia among humans “infected” with “DENV-3 and

DENV-4,” get declined below the required dose of viruses to make mosquitoes infected by this time.^[15]

Furthermore, humans infected with a high early viral load have been reported to have a greater likelihood of an extended duration of infectiousness (window period).^[15]

The concept: “Seven-Plus-One”

Transmission of DENV from an infected person to a mosquito is a critical step in the spread of the disease. The rapid rise in dengue cases had a link with population growth, urbanization, lack of sanitation, long-distance travel, ineffective mosquito control, and increases in the surveillance and official reporting of dengue cases.^[16] Considering the man-made connection with the mosquito outbreak, the concept of the 7-Plus one was developed and introduced in 2019, after the outbreak of dengue in the Dehradun District in Uttarakhand.

The main objective of Seven-Plus-One was to create a trained multidisciplinary team in the community that focused especially on pseudodependency of people in tertiary care health systems and communities who express their inert behavior and resistance to their duty and responsibility for their health. This model is based on community participation and mobilization.

The “Seven-Plus-one” model envisaged the possible plausibility of these concepts from evidence:

- (1) Adult *Aedes* mosquito developed from the larva stage, this process takes 7–10 days.^[17] The Seven-Plus-One model encompasses of collective and comprehensive destruction of breeding spots by community participation every day till 7th days. Then reinforcement of similar activity along with local community members once a week is amenable to reducing the adult *Aedes* mosquito’s growth in numbers.
- (2) Extrinsic incubation period (EIP) of an *Aedes* Mosquito is the time between when mosquito takes an infectious blood meal from a viremic human host and the time it gets infectious to another human also varies from 8 to 12 days as a mean 6.5–8 approx. 7 days.^[18] Destruction of adult mosquito through adulticidal insecticide through fogging (pyrethroid, etc.) under the Seven-Plus-One activity also reduce the numbers of infectious adult mosquito in the environment within EIP. This amount reduces the human transmission of infection.
- (3) Intrinsic incubation period (IIP) of dengue is the period between the bite of the infectious mosquito to a human host to the onset of infectiousness and transmission of infection to other mosquitos. Human to “mosquito” transmission can occur 2 days before the “symptoms” to 2 days after the symptoms have resolved. The IIP also varies between 3–14 days and 4–10 days. The mean IIP was estimated at 4–7 days.^[18]
- (4) Isolation of all fever cases in the community at their home till their blood investigation for dengue comes positive is one of the steps of this model. All fever cases in the community during dengue season (August to October) are considered suspected of dengue and asked to wear

full sleeves, use mosquito net during day time, and take absolute rest with a quarterly dose of paracetamol 500 mg which will reduce the inflammatory process to avoid catastrophic cytokine storm.^[19] This preventive measure for symptomatic patients will minimize the transmission of dengue from men to mosquitos.

The Seven-Plus-One model involves the following strategies to overcome the disease spread:

1. Scratching the map of high-risk dengue-prone areas.
2. Identification of hotspots based on the preceding year's data.
3. Constitution of a multidisciplinary training team including "Accredited Social Health Activist" (ASHA), "Auxiliary Nursing Midwifery" (ANM), local leaders, municipality members, and school students.
4. Training of the multidisciplinary team to create awareness among the public.
5. Implementation of sensitization and awareness program among stakeholders and community leaders.
6. Mobilization of community at the individual, family, and community levels for the social cause of dengue.
7. Behavior change communication to promote changes in practices leading to dengue transmission through regular campaigning.
8. Collective destruction of breeding places with teamwork.
9. Active surveillance of fever cases.
10. Engaging and promoting individuals, families, and communities to come forward as volunteers and participate in the identification and destruction of breeding places.
11. To break the pseudodependency on tertiary care hospitals for their health concern and care via initiating action for own health and adoption for preventive health measures for dengue.

Dengue and Seven-Plus-One model

Based on the facts regarding the spread of dengue. The Seven-Plus-One model came into existence. The Seven-Plus-One Model has been initiated in three parts.

Part 1 – Constitution and selection of a multidisciplinary team with basic knowledge of the mosquito cycle may be addressed by ASHA, ANM, and searching of the high-risk area in the city during the first two days.

Part 2 – Active door-to-door intervention for the destruction of breeding points inside and outside the house with awareness for dengue during the next three days.

Part 3 – Reinforcement of dengue prevention activities at offices, schools, and agencies and implementation of this Seven-Plus-One program at their respective working places in the last two days.

The concept behind the "one" plus describes active intervention with breeding points destruction and awareness for dengue prevention and action, once a week most probably on Sunday for only one hour along with the active participation of the

local public. This initiative will break the mosquito life cycle and not allow *Aedes Aegypti* to grow in our domestic area.

Implementing Seven-Plus-One model

The Seven-Plus-One model has been implemented by the Social Outreach cell, All India Institute of Medical Sciences, a tertiary care Institute of National importance in Rishikesh. Rishikesh is an urban area in the Sub-Himalayan region in Uttarakhand state, situated in the northern part of India. The model was initiated within the premises of the Institute with the municipality of Rishikesh during the monsoon season from July to October 2019 in the year 2019. During the first week of September 2022, eight dengue hotspot areas were identified under municipality areas of Rishikesh, viz., Mayakund, Chandrabhaga, Santi Nagar, Ganga Nagar, Bapu Gram, Beesh Bigha, Sarvahara Nagar, and Housing Development Area, Rishikesh. On performing a house-to-house survey of dengue fever cases in these areas, there was a drastic drop in dengue fever cases following the implementation of this model [Figure 1] in September 2022.

The available data reported a reduction in a significant number of dengue cases after the implementation of the Seven-Plus-One model.

Data represent that out of the total (56) reported cases of dengue from Urban Rishikesh there was a decline in nearly half of the cases after implementation of this Seven-Plus-One model.^[20] This initiative encourages people to come forward as volunteer participants for breeding point destruction in their community which ensures community participation in action. A study conducted by Abdul Zahir *et al.* in 2016 reported a significant association between community participation and dengue control practices.^[21] An integrated community-based strategy for dengue control^[22] has also been studied with a similar concept to our study in China.

Future of Seven-Plus-One model

The magnitude of communicable and noncommunicable diseases in India is increasing day by day. This is a novel step toward curbing the deadly disease dengue in the

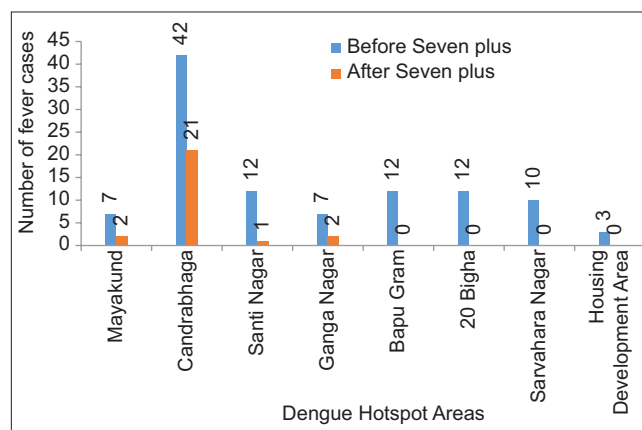


Figure 1: Number of dengue cases in hotspot areas of Rishikesh in September 2022

community through utilizing simple and effective strategies of the Seven-Plus-One model. Supportive action from local administration and police is required to encourage the public to follow the guidelines and instructions related to dengue prevention. The Health Ministry of State has also appreciated and adopted this Seven-Plus-One model as a preventive step to lessen the morbidity and mortality from dengue in state of Uttarakhand. Further, this program may achieve excellent results if endorsed by the policy maker of the country to implement this Seven-Plus-One Model at minimum cost in the entire urban community, before the menace of dengue become a potential danger to public health.

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Conflicts of interest

There are no conflicts of interest.

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