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# COVID-19's impacts on dengue transmission: Focus on neighbourhood surveillance of *Aedes* mosquitoes

Susanta Kumar Ghosh[1]✉, Chaitali Ghosh[2]

[1]*ICMR-National Institute of Malaria Research, Bangalore, India*

[2]*Tata Institute for Genetics and Society, Bangalore, India*

The ongoing COVID-19 pandemic has impacted the entire globe on all fronts, and vector-borne diseases are not an exception. There are certain similarities between dengue and COVID-19 since both diseases are positive-sense single-stranded RNA virus and have animal origin linkages. Interestingly, both the diseases present over 80% asymptomatic cases. Dengue is the most prevalent and fast-emerging viral infection worldwide. The dengue virus (DENV) has four serotypes, namely DENV-1, DENV-2, DENV-3 and DENV-4, and it is possible that the same person can be infected four times before full immunity is established[1]; whereas, COVID-19 is an air-borne respiratory disease caused by the severe acute respiratory syndrome coronavirus 2, and several variants have emerged over time. In late 2020, the variants posed an increased risk to global public health emergency, which prompted the characterisation of specific Variants of Interest and Variants of Concern to mitigate the COVID-19 pandemic[2]. DENV is transmitted by several species of day-biting *Aedes* mosquitoes. They are highly adaptive and invasive species and are predominantly found in the tropical and subtropical regions. In recent decades, these mosquitoes have been discovered in all continents except Antarctica. *Aedes aegypti* and *Aedes albopictus* are two major vectors of dengue. This means wherever these mosquitoes make their footprints, dengue creeps in.

Dengue has spread over the past six decades, and has increased exponentially in recent years. Over 3.9 billion people in 129 countries are at risk, recording an estimated 96 million symptomatic cases with 40 000 deaths annually, and of that Asia bore 70% of the infections[3]. India alone contributes approximately 33% of total dengue cases globally[3]. Among the top ten priority health issues presented, dengue is identified as one of the four main infectious diseases threatening the global health[1]. Chen *et al*[4] analysed the weekly data on dengue cases in 2019 and 2020 across Southeast Asia and Latin America, and observed that there were 0.72 million fewer number of dengue cases globally in the first year of the pandemic in 2020 due to lockdowns and restrictions on the movement of people. Mainly all dengue control programmes are based on reducing transmission at home. The findings of the study suggest that a renewed focus on dengue transmission reduction programme should be given priority at schools and public places[4]. This is evident that in most situations the occurrence of dengue/dengue hemorrhagic fever has no relationship with the breteau and house indices of *Aedes* mosquitoes[1].

Traditional *Aedes* surveillance is carried out on immature stages (larva/pupa). The indices of such surveillance are 'house index (HI)' (percentage of houses infested with larva and/or pupa), 'container index (CI)' (percentage of water-holding containers infested with larva and/or pupa) and 'Breteau index (BI)' (number of positive containers with larva and/or pupa per 100 houses inspected) and 'pupal index (PI)' (number of pupa detected per house)[1]. Now, 'neighbourhood surveillance' should be given priority in addition to the ongoing surveys[5]. Two important additional parameters 'premise condition index (PCI)' (percentage of premises infested with larva and/or pupa)[6], and 'location index (LI)' (percentage of locations infested with larva and/or pupa) should be carried out[6].

The most widely used HI estimates the degree of infestations at house or premise levels. Meanwhile, the CI provides information on the proportion of water-holding containers infested with larva and/or pupa. The BI provides an association between positive containers and houses inspected. This index is considered to be the most informative, but there is no indication of productivity of larva and/or pupa in a specific container. Generally, a HI of 5%, a CI of 10% and a BI of 20 is considered as standard threshold level of disease transmission in a given location. But such threshold is not applicable in all locations since dengue has been reported to transmit having 1% HI, 1.8% CI, and 1.2 BI, respectively, in Taiwan, China[1]. The PI estimates the relative adult population production is based on the

✉To whom correspondence may be addressed. E-mail: ghoshnimr@gmail.com



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pupa counts. This index may be classified as pupa per area and pupa per person[1].

PCI categorizes shade, house, and yard conditions. Premises condition as measured by PCI is related to *Aedes* habitats and is scored based on immature productivity. Premises with higher PCI scores are more productive for pupa and also supporting adults. Scoring for individual habitat is more appropriate[6].

LI is calculated on data collected from household or non-household, private or public area, type, and size. High-resolution satellite imagery and geographical information systems are very useful for evaluating locations and random selection procedures for accurate entomological surveys[6].

All properly collected data can be further analysed based on the following parameters. For example, 'breeding percentage' (percentage of larva and/or pupa infested with the total *Aedes* breeding habitats)[7], 'breeding preference ratio' (percentage of *Aedes* immatures in the each container/percentage of breeding places inspected)[8], and 'species dominance index' (total number of immatures of common *Aedes* species collected in the surveyed localities and containers/total number of all *Aedes* species)[8].

In addition to the traditional immature surveillance of *Aedes* mosquitoes, in most dengue-infested hotspots, longitudinal adult surveillance using appropriate adult traps is recommended for better *Aedes* prevention and control. In Malaysia, a simple combination of gravid oviposition sticky traps and dengue non-structural 1 antigen for early surveillance of dengue among *Aedes* mosquitoes can supplement the current dengue surveillance/control[9]. Similarly, a longitudinal study involving five entomologic indices were conducted in Brazil, *e.g.* HI and BI for assessing immature surveys and trap positivity, adult density, and mosquitoes per inhabitant indices for adult trapping. Screening for dengue, Zika, and chikungunya viruses in live adult *Aedes aegypti* mosquitoes collected from traps were analysed. The authors concluded that indices of adult mosquito sampling had higher outbreak predictive values than larval indices[10]. All these parameters will provide tempo-spatial data on the distribution and expansion of *Aedes* mosquitoes into new territories and would be a game changer for better dengue prevention and control.

In summary, the main question remains on how COVID-19 pandemic is impacting dengue transmission, and no one knew what actions would have been undertaken during lockdowns. The ongoing *Aedes* surveillance for dengue was also disrupted[8]. However, the suggested surveillance at public places by Chen *et al*[4] has entrusted for renewed focus on 'neighbourhood surveillance' system[5]. As far as we are concerned, the ongoing COVID-19 pandemic may end soon, but dengue continues to be a 'disease of concern', as no effective vaccines or drugs are available for dengue yet[3]. Moreover, the day-biting *Aedes* mosquitoes frequently feed multiple times resulting cluster infections, and also the eggs are desiccant-resistant, survive several months in dry conditions, emerge when come in contact with water[1]. Additionally the transovarial transmission makes the situation more complex[1]. Hence, appropriate vector control strategies focusing 'neighbourhood surveillance' with integrated vector management is advocated for reducing *Aedes*-borne diseases.

## Conflict of interest statement

The authors declare no potential conflicts of interest concerning research, authorship, and/or publication of this article

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## Authors' contributions

Both SKG and CG conceived, wrote and reviewed the manuscript and finally approved the version to be published.

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