



Potential role of Integrated *Aedes aegypti* Monitoring (MI-Aedes) technology in improving targeted dengue vector control in Juazeiro do Norte/CE, Brazil's largest religious pilgrimage destination: a case study

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INTRODUCTION

Dengue is an arboviral disease transmitted by *Aedes aegypti* and a growing public health threat to more than 1 billion people. Integrated *A. aegypti* Monitoring (MI-Aedes) technology uses a commercially available adult oviposition sticky trap (MosquiTRAP) to capture *A. aegypti* females in large scale, generating weekly real-time entomological indices, allowing dengue risk analysis and targeting of vector control. 570 georeferenced MosquiTRAPs were installed in Juazeiro do Norte, the largest religious pilgrimage destination in Brazil. During weekly MosquiTRAP inspections, caught mosquitoes were identified and data sent to MI-Aedes on-line database via an application. Then, health managers directed vector control activities to areas of greatest risk (ECOVEC, 2021; EIRAS, *et al*, 2009; and RESENDE, *et al*, 2010).

Climatic and socioeconomics conditions have a strongly influence on vectors proliferation, including *A. aegypti* (César *et al*, 2016). The previously treatment of the water and its distribution for the population, added by urban cleaning service, can contribute to decrease water storage by the citizens.

OBJECTIVE: To compare dengue incidence before and after MI-Aedes implementation in Juazeiro do Norte and between neighboring municipalities, describing the potential impact of implementing a large-scale tool for adult *Ae. aegypti* management.

METHODOLOGY

Following MI-Aedes implementation in Juazeiro do Norte/CE, from September 2019 to September 2020, entomological data and vector control activities were recorded. Data on the incidence of dengue cases in **Juazeiro do Norte** and five neighboring cities (**Barbalha, Caririagu, Granjeiro, Jardim e Missão Velha**) were collected from State Health Department reports. A multidisciplinary approach was used to explain dengue incidence in Juazeiro do Norte compared to previous years and to other municipalities.

In June 2019 MI-Aedes were implemented in Juazeiro do Norte/CE, Brazil. With an estimated population of 276.164 habitants distributed over about 258 km² in caatinga biome, Juazeiro do Norte has a percentage of 47,2% of homes with access to sewer system (IBGE, 2021). A number of 570 MosquiTRAPs were installed in Juazeiro do Norte, covering more than 85% of its territorial extension. Weekly inspection in all of the traps led off in epidemiological week 37 and the mosquitoes were analyzed biweekly. All data were analyzed by statistics models.

RESULTS

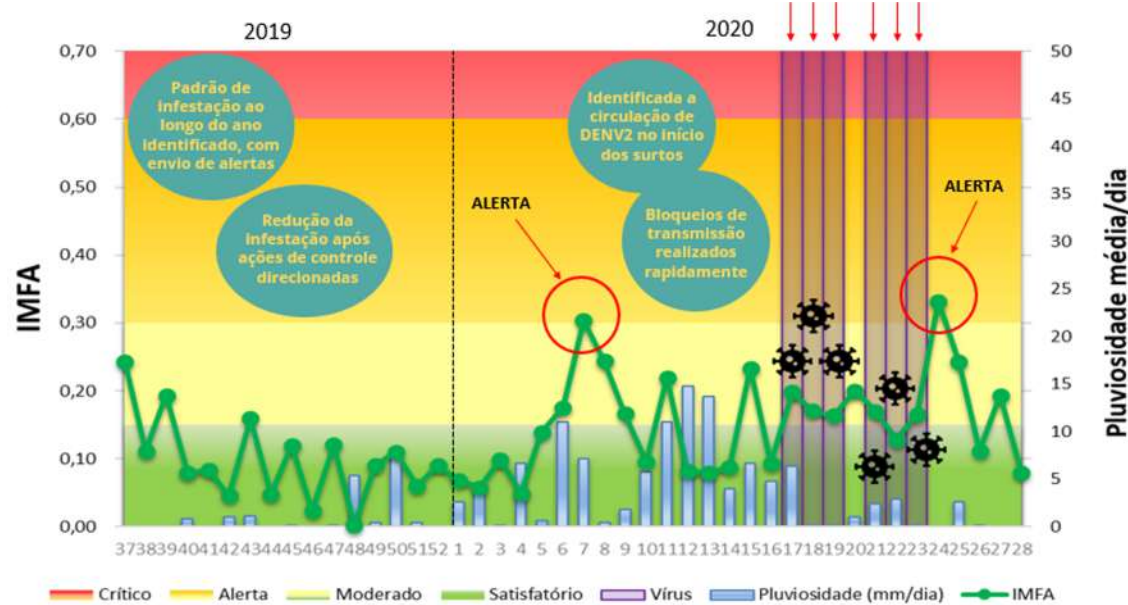
During the analyzed period (from week 37/2019 to week 38/2020), the average execution of field visits was 97.89% in 54 weeks, 3,547 *Aedes aegypti* specimens (female and male) were collected in MosquiTRAPs (711 vectors captured in 2019 and 2,836 by week 38 of 2020) and weekly submitted to qRT-PCR by MI-Virus (Intelligent Virus Monitoring) for viral surveillance (*Chikungunya* virus, *Zika* virus, *Yellow fever* virus, and all serotypes of *Dengue* virus).



Map 1. Mosquitrap locations in Juazeiro do Norte/CE

The cities of Ceará state use the mosquito surveillance methods recommended in the National Dengue Program (2002), such as LIRAA and larval survey and control. While LIRAA is carried out at intervals of several months, MI-Aedes allowed the weekly survey of the adult population (females of *Ae. aegypti* that transmit arboviruses). MI-Aedes helped to direct actions to the most infested locations (Map 1, Graph 1 and table 1).

Graph 1. Infestation of *Aedes aegypti* female weekly, MIV and climate



Municipal	Year	Dengue cases	Population	Incidence
Juazeiro do Norte	2018	498	268.248	185,65
Barbalha		32	59.343	53,92
Caririagu		1	26.414	3,79
Granjeiro		5	4.459	112,13
Jardim		11	27.074	40,63
Missão Velha	10	34.274	29,18	
Juazeiro do Norte	2019	440	274.207	160,46
Barbalha		81	593.430	13,65
Caririagu		20	29.965	66,74
Granjeiro		8	4.626	172,94
Jardim		221	26.876	822,29
Missão Velha	82	35.326	232,12	
Juazeiro do Norte	2020	1777	276.264	643,23
Barbalha		898	61.228	1466,65
Caririagu		261	26.987	967,13
Granjeiro		173	4.814	3593,69
Jardim		258	27.181	949,19
Missão Velha	176	35.480	496,05	

Before the implementation of MI-Aedes in 2020, Juazeiro do Norte / CE stood out as one of the cities with the highest incidence of dengue in Ceará. Afterwards, even during an epidemic year of the DENV2 throughout Brazil, with MI-Aedes, Juazeiro do Norte managed to contain the spread of dengue outbreak and obtained the second lowest incidence of dengue among the state of Ceará.

In the beginning of 2020 (graph 1) the average weekly infestation of female *Aedes aegypti* (IMFA) increased considerably due to environmental conditions and consequently there was an increase in the circulation of the virus in the vector population.

Following the alerts of *Aedes aegypti* infestation and viral presence sent to the city vector managers (see graph 1 and table 2 (INFODENGUE)), successive vector control actions (chemical and mechanical) occurred in the most infested locations and with the greatest viral circulation (MI-Virus and local dengue reports). MI-Aedes helped the city's epidemiological surveillance to direct their efforts to these locations in order to contain the dengue outbreak.

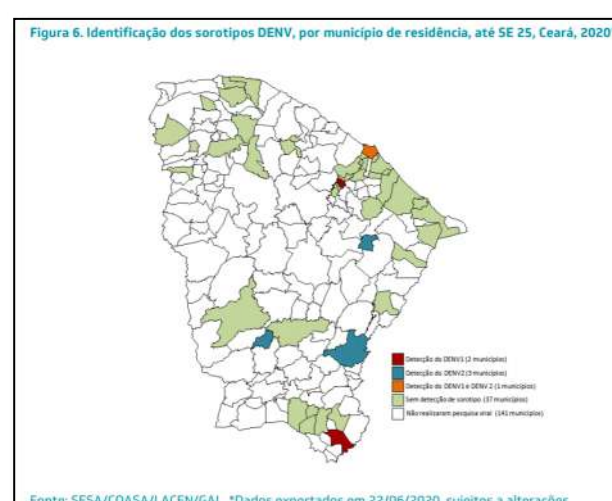
Week	Positive samples	Virus
17	2	DENV2
18	1	DENV2
19	4	DENV2
21	1	DENV2
22	1	DENV2
23	1	DENV2

MI-Aedes provided real-time georeferenced adult indexes, better directing vector control to areas with higher entomological risk. Epidemiological analyses showed a significant drop in dengue cases in Juazeiro do Norte in 2020, compared to historical baseline and other cities.

CONCLUSION

We have found evidence that suggests a role of MI-Aedes in improving targeted *Ae. aegypti* control, thus, reducing risk of dengue transmission in Juazeiro do Norte. Further studies could evaluate the individual contribution of directed control activities in reducing *Ae. aegypti* density and dengue cases.

MI-Aedes and MI-Virus identified, early in week 17, the dengue virus 2, this serotype is associated with greater virulence and severity, moreover it was the responsible for a considerable dengue epidemic that occurred in the country in 2019. By this means, the city was able to plan more assertive public health actions with this emerging vector control technology.



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