

Research Article

# Prevalence of *Aedes* Mosquitoes during the First Outbreak of Zika in Jaipur City, India

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## I N F O

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## A B S T R A C T

The entomological investigations were made in residential, commercial and public places in various localities of Jaipur city during outbreak of Zika in October 2018 with a view to assist, support, supervise and advise the State Health Authorities for mosquito control activities in Zika reported area in the city. During the study, 2035 houses were randomly checked to detect *Aedes* mosquito breeding, out of which *Aedes* mosquito breeding could be found in 651 houses in residential area. Out of 7104 domestic containers, 1054 were positive for *Aedes* mosquito breeding in all kinds of water holding containers indoors or outdoors and House Index (HI), Container Index (CI) and Breteau Index (BI) were 37.45, 21.86 and 57.59 respectively. All commercial areas and public places were found positive with *Aedes* mosquito breeding and over all CI was 39.98. *Aedes aegypti* was the predominant species in various localities like residential, commercial and public places in Jaipur, while *Aedes albopictus* breeding were also detected in outdoor breeding habitats in the garden and parks. The highest positivity of *Aedes* breeding was recorded in houses or outdoor in cemented tank left in open spaces (2.11), followed by Mud pots for drinking of birds (1.39), domestic desert coolers (1.23), fountains (1.16), flower pots (0.84), Junk materials (0.75) and discarded tyres (0.59). *Ae. aegypti* breeding was detected in all the localities, where Zika cases were recorded. *Ae. aegypti* population was most prevalent in all the entire localities irrespective to the number of Zika cases.

**Keywords:** Zika Virus Fever, *Aedes* Breeding, Jaipur, Zika Virus outbreak

## Introduction

Zika Virus Infection (ZIKVI) is a newly re-emerge mosquito borne viral disease almost common arboviral disease is caused by flavivirus (family-Flaviviridae) and spread by the infected female *Aedes* mosquitoes.<sup>1</sup> It was first identified in rhesus monkeys in 1947 and in 1952 in humans from Uganda forest and later in United Republic of Tanzania.<sup>1</sup> In 1968, Zika virus was first isolated in Nigeria from human

blood samples and many outbreaks of ZIKVI have been reported from the different countries as Asia, America, and Africa, in the Pacific in the year 2007. The South Pacific has been first experienced of Zika and its first outbreak in Yap Island in the Federated States of Micronesia. In 2013, French Polynesia of Brazil has been recorded first outbreak of Zika from the northeast part of the country and to contain outbreak of Zika successfully, but confirmed

the disease of Zika Virus (ZIKV) in October 2015. After that many other countries and territories of the Americas have been reported the disease of ZIKV.<sup>2</sup>

Since 2007, the disease of ZIKVI has been documented in 46 countries including 34 territories which reported this infection and World Health Organization (WHO) has regular monitor the epidemiologically and risk assessment.<sup>1</sup> In India, first time four confirmed cases of ZIKVI were reported in 2017, out of which three cases in Bapunagar area of Ahmedabad, Gujarat and one case in Krishnagiri district of Tamil Nadu. Recently fifth case of ZIKVI was reported on 21 September 2018, from Shastri Nagar area of Jaipur city (capital of Rajasthan), India<sup>3</sup> and first ZIKVI occurred in an elderly lady during regular monitoring in September 2018 and Govt. of India and State Health Authorities (SHAs) of Jaipur, Rajasthan confirmed the disease of ZIKVI as an outbreak in October 2018.<sup>3</sup> A total of 157 confirmed cases of ZIKVI without any death were reported and few unreported cases as of 2<sup>nd</sup> November 2018 by the National Vector Borne Disease Control Programme (NVBDCP) has been identified including 63 pregnant woman; all the cases have been laboratory-confirmed by Reverse Transcriptase Polymerase Chain Reaction (RT-PCR). Subsequent few cases of ZIKV were also reported from Bhopal, Siroh and Sagar districts of Madhya Pradesh and Siwan district of Bihar state by the NVBDCP<sup>4</sup> during September to November 2018. Recently ZIKV has also been detected in *Ae. aegypti* from Jaipur, confirmed by National Institute of Virology (NIV), Pune it's as a vector of Zika Virus Disease (ZIKVD).<sup>4</sup> *Aedes* mosquitoes are the vector of three mosquito borne viral disease namely Dengue, Chikungunya and Zika, in many cities including rural areas and almost all over India; presently the vector of these diseases is spreading in the areas because of increasing unplanned urbanization with their population, unreliable water supply and water storage practices or manmade problems.<sup>5</sup> For the prevention of vector borne disease, the vector surveillance is more essential tool to evaluate entomological data required for vector control strategies.<sup>6</sup>

There is no vaccine available for prevention of Zika Virus Infection Disease (ZIKVID) and only one DNA vaccine is being under trials. Therefore, the best method for prevention of ZIKVID is protection against day biter *Aedes* mosquitoes and controlling of mosquitoes is only one way to stop the transmission of Vector Borne Disease (VBD). Controlling of mosquitoes can be achieved by enhanced Integrated Vector Management (IVM) method.<sup>7</sup> The central team deputed to Jaipur from the Emergency Medical Relief (EMR) Division of the Directorate General of Health Services (DGHS), Govt. of India (GOI) to contain the ZIKVD spread and to supervise, assist, support and advise the SHAs for mosquito control activities and to identify high risk areas of ZIKVI in the city. During this work, the central

team also carried out entomological study to cross-check *Aedes* mosquitoes in various Zika affected municipal wards of Jaipur in October 2018 and results of the study are presented in this communication.

## Material and Methods

### Location & Geography of Study Area

Geographical area of Jaipur district of the Rajasthan state is 11143 km<sup>2</sup> and it is located on the eastern border of the Thar Desert. The city is located at a height of 1417 feet above sea level and it is popularly known as Pink city. The city is surrounded by the Aravalli hills from three sides which safeguard it from the desert and forests. The district has a total population of 6626178 (as of census 2011). The average rainfall is 650 mm, temperature ranging minimum 5°C and maximum 45°C.<sup>8</sup>

### Entomological Investigations

The entomological study was carried out in 65 localities of urban areas of Jaipur city including rural area of the district Jaipur with the officers and their field staff from National Centre for Disease Control (NCDC), Delhi, Regional Office of Health & Family Welfare (ROHFW), GOI, Jaipur and SHAs Jaipur. Daily field investigations and vector control activities included discussions with senior officers of the state health authorities were reviewed and central team also made field visits for understanding the vector prevalence and control measures during October 2018.

All localities were selected on the basis of confirmed daily Zika cases reported by the SHAs, Jaipur during the outbreak. The residential, commercial premises and public places were randomly selected to cross check to find out the *Aedes* breeding in all the wet containers present in and around the premises (Table 1). A total of 20 houses or more depend on situation of outbreak in each locality. Localities were visited and larval collections were made simultaneously in each locality following the single larval technique.<sup>5,9,10</sup> The central team also checked the public places including commercial areas, like Gardens, Parks, Bus Stand, Railway Station, Railway Hospital, Fort, Mosque, Temple and Gurdwara (Sikh temple). All types of breeding habitats in Zika reported area like cemented tanks, overhead tanks, drums, junk materials, desert cooler, discarded tyres etc. were screened properly for the presence of larval stage in all kinds of containers indoors or outdoors and with the help of flash light and pipette, having enamel tray white background for the better visibility, while bigger containers were searched with the help of the dipper of 250 mL capacity. The type of breeding habitats and their location were recorded properly and data were analyzed and calculated in terms of different indices like Container Index (CI), House Index (HI), Breteau Index (BI) as per WHO procedure.<sup>6</sup> Adult stage of *Aedes* mosquitoes identified up to species level with the help of standard identification keys.<sup>11</sup>

Table I. Aedes larval indices in Zika affected areas in Jaipur city

Localities searched	Houses visited	Houses positive	Containers searched	Containers positive	HI (%)	CI (%)	BI (%)
Residential area							
JDA Bapu. Nagar, Kachchi Basti	100	24	337	47	24	13.94	47
Ram Nagar, Shastri Nagar	48	26	123	43	54.16	34.95	89.58
Vijay Nagar, Bhatta Basti	23	13	68	35	56.52	51.47	152.12
Sanjay Nagar, Bhatta Basti	10	8	26	10	80	38.46	100
Bhatta Basti, Shastri Nagar	20	11	45	15	55	33	75
Tata Nagar, Shastri Nagar	46	25	184	36	54.34	19.56	78.26
Shivaji Nagar, Shastri Nagar	91	35	248	62	38.46	25	68.13
Shivaji Nagar, Nahari ka Naka	50	16	80	19	32	23.7	38
DP Colony, Nahari ka Naka	25	11	117	21	44	17.9	84
Subhash Nagar, Shastri Nagar	16	7	90	15	43.7	16.6	93.7
New Jalupura, Shastri Nagar	33	01	39	01	3.03	2.56	3.03
Shiv Shakti Nagar	20	14	37	17	70	45.9	85
Subhash Colony, Shastri Nagar	20	11	27	13	55	48.1	65
Housing Board Colony	19	6	22	7	31.5	31.8	36.8
Azad Colony, Nahari ka Naka	20	17	31	22	85	70.9	110
Phozi Nagar, Kachchi Basti, Amba Bari	64	22	206	27	34.3	13.1	42.1
Kailash Nagar	20	10	35	19	50	54	95
James Colony	20	7	40	14	35	35	70
RPA Colony	99	17	324	19	17.1	5.8	19.9
JP Colony, Shastri Nagar	61	8	179	12	13.1	6.7	19.6
Jyoti Nagar, Shastri Nagar	20	2	56	4	10	7.1	20
Beriya Colony I, II	65	26	202	36	40	17.82	55.38
Rajeev Nagar, Kachchi Basti	31	6	88	12	19.3	13.6	38.7
Bajarang Nagar	40	8	228	12	20	5.2	30
Khati Pura, Shastri Nagar	75	23	254	44	30.6	17.3	58.6
Swarn Kar Colony	32	7	263	7	21.8	2.6	22.8
Verma Colony, Shastri Nagar	33	5	236	12	36.3	5.0	15.1
Indra Puri Colony	51	10	213	11	21.5	3.1	19.6
Khora Bisal, Jairam Pura	109	28	377	44	25.6	11.6	40.3
Shri Ram Tila	37	5	224	6	13.5	2.6	16.2
Mohan Nagar	39	16	220	22	41	10	56.4
Shiv Nagar, Murli pura	20	3	29	4	15	13.7	20
Purohit Bara, Pathan chowk	15	9	18	9	60	50	60
Mazdoor Nagar, Rail. Colony I&II	166	36	249	67	21.68	26.90	40.36
Chand Pole	33	7	224	10	21.2	4.1	30.3

Kamala Neharu Nagar	23	17	139	23	53	16.5	71.8
Vyas Colony	35	16	181	22	45.7	12.1	62.8
Hari Nagar	33	4	163	5	12.1	3.1	13.1
Sanganer	20	14	42	26	70	61.9	130
Raigar Basti	30	11	232	26	36.6	11.2	86.1
Vidyadhar Nagar area, Kachchi Basti,	289	92	1020	163	31.83	15.98	56.4
IAS Coly, Gandhi Nagr, Govt. Bung Tonk road	34	17	188	35	50	18.61	102.94
	2035	651	7104	1054	37.45	21.86	57.59
<b>Commercial areas and Public places</b>							
Sindhi Camp, Bus stand			21	4		19.04	
Heera Bagh, (RFPIC Training Centre)			30	10		26.31	
Rajput Sabha Bhavan			13	6		46.15	
Rajput Hostel			72	6		8.33	
Sent Wilfred College, Mansarovar			18	6		33.3	
Railway station			84	19		22.6	
Railway Hospital			25	3		12	
Mosque			7	4		57.14	
Temple			8	2		25	
Gurdwara (Sikh temple)			10	7		70	
			461	113		31.98	

### Vector Control Measures to Contain Epidemics

For control of VBDs and prevention depends on reducing mosquito population through source reduction and reducing contact between mosquito and people, enhanced surveillance at community level by the Integrated Disease Surveillance Programme (IDSP) for detection of primary case and Gullian Barre Syndrome. Maternal and child health division is advised to look for clustering of cases of microcephaly among new borne including and to watch on passengers returning from affected areas of ZIKVD and suffering from febrile illness. Rapid Response Teams (RRTs) have been advised to all levels for investigation of suspected outbreaks. In laboratory diagnosis, NCDC, Delhi and NIV, Pune are to support the outbreak investigation and for confirmation of laboratory diagnosis. The SHAs have to create increased awareness among clinicians including obstetricians, pediatricians and neurologists about ZIKVD and its possible link with adverse pregnancy outcome (fetal loss, microcephaly). Non-governmental organization should also be sensitized about ZIKVD.

Vector control is the only way to interrupt the transmission of VBDs such as Dengue, Chikungunya and Zika and can be

achieved by include enhanced IVM, larval and adult surveys, for early detection of *Aedes* mosquitoes.<sup>5</sup> So that, proper control measures could be initiated to eliminate mosquito breeding and adult mosquito population, environment management methods are used to control immature stage of *Aedes* mosquitoes. Essential efforts could be taken to reduce potential larval breeding habitats in houses and around houses by covering all water containers to prevent fresh egg laying by the vector.<sup>7</sup> Additional efforts to emptying, drying water tanks, containers, coolers, bird baths, pets' water bowls, plant pots, drip trays at least once each week. Introducing larvivorous fishes (e.g. *Gambusia*/ Guppy) in ornamental water tanks/ garden. Use the endotoxin producing bacteria, *Bacillus thuringiensis* as larvicide in stagnant water while no dangerous to humans, non-targeted organism, or environment when used according to directions.<sup>12</sup> Temephos (organophate compound) is as a larvicide under public health programme. Synthetic Pyrethroids (SP) as an adulticide can be used for Indoor Residual Spray (IRS) in areas where imported cases of Dengue, Chikungunya, and Zika are detected.<sup>13</sup>

Pyrethrum spray/ malathion fogging can be applied for the control of adult *Aedes* mosquitoes. Personal protective/

prevention measures can be initiated by using insect repellent; wearing light-colored clothes preferably for the more coverage as much of the body as possible; closed doors and windows; sleeping under mosquito nets and should use insecticide-treated mosquito nets to provide more protection for mosquitoes biting.<sup>5</sup> In areas where ZIKV is transmitting, the community must follow personal preventive measures. Legislative Measures as suitable laws and byelaws should be enacted and implemented for avoidance of situations which favor mosquito breeding at various levels. Health education for community mobilization and inter-sectoral convergence like community participation to eliminate the breeding sites of *Aedes* mosquitoes with the involvement of other sectors/ departments should be encouraged as per National guidelines for prevention of ZIKVD.<sup>10</sup>

## Result

During the study 2035 houses were randomly checked to *Aedes* mosquito breeding, out of which mosquito breeding could be detected in 651 houses (in all kinds of water holding domestic containers in indoors and outdoors) in residential areas. In all the houses, 7104 domestic water containers were checked, out of which 1054 were positive for *Aedes* mosquito breeding (indoor or outdoor). The House Index (HI), Container Index (CI) and Breteau Index (BI) were 37.45, 21.86 and 57.59 respectively. Ten commercial areas and public places like Bus Stand, Railway Station, Railway Hospital, Fort, Mosque, Temple and Gurdwara (Sikh temple), Training Centre, Sabha Bhavan, Hostel and College were checked and all were found positive for *Aedes* breeding and over all CI was 39.98 (Table 1). *Ae. aegypti*

was the predominant species in various localities like residential, commercial and public places in Jaipur, while *Ae. albopictus* breeding was detected in the garden and parks. Larval stages of *Ae. aegypti* mosquito was found in all Zika affected municipal wards of Jaipur but vary from ward to ward, irrespective to Zika cases reported in these localities. *Ae. albopictus* breeding were also found in various water holding containers mostly in garden and parks in all the study areas.

The distribution pattern of immature stage of *Aedes* mosquitoes and Breeding Preference Ratio (BPR) in different types of breeding habitats (water containers) indoors or outdoors is depicted in (Table 2). The results of BPR showed the highest positivity of *Aedes* breeding in cemented tank in houses or nearby houses left in open spaces during the entomological investigations (2.11), followed by Mud pots for drinking of birds (1.39), domestic desert coolers (1.23), fountains (1.16), flower pots (0.84), Junk materials (0.75) and discarded tyres (0.59) in the entire locality (Table 2). In addition, breeding of *Aedes* was also detected in earthen pots (0.26) and drums/ tubs/ tank (0.13).

The results of this study showed that Zika cases were declined with mosquito density and larval indices, when vector control measures and special efforts undertaken by the state health authority to interrupt Zika transmission and reduce mosquitoes breeding by using temephos for larval control of *Aedes* mosquitoes and synthetic pyrethroids like pyrethrum spray/ malathion fogging for the adults control, and also SP used for IRS activities and prevention measures initiated to protect mosquitoes biting.

**Table 2. Breeding Preference Ratio (BPR) of *Aedes* in Zika affected areas in Jaipur city**

Breeding habitats of <i>Aedes</i>	Number of containers				Breeding preference ratio (BPR)
	Examined	X%	Positive for <i>Aedes</i> breeding	Y%	Y/X
Domestic desert coolers	2103	27.78	392	34.35	1.23
Flower pots	322	4.25	41	3.59	0.84
Earthen pots	564	7.45	32	2.01	0.26
Cement tanks	1541	20.35	491	43.03	2.11
Discarded tyres	213	2.81	19	1.66	0.59
Fountains	23	0.30	4	0.35	1.16
Tubs/ drums/ OHTs	1703	22.49	34	2.97	0.13
Mud pots for drinking of birds	43	0.56	9	0.78	1.39
Junk materials	1048	13.84	119	10.42	0.75
Total Containers	7570		1141		



## Discussion

During the Zika outbreak investigations in Jaipur city showed the *Ae. aegypti* is well-established within the urban area due to high breeding, thus showing the possibilities for future outbreak of dengue, chikungunya and Zika in the areas at any time. Jaipur city has irregular piped water supply resulting in establishment of water storage practices in all kinds of big or small containers in indoors or outdoors in all the residential areas for household purposes. The practices of house holders (for the water storage for household purposes) were found as main reason for high *Aedes* mosquito breeding in Jaipur city. The larval indices were recorded above the critical level in all the entire localities (i.e. >10) and most of people in Jaipur city adopted water storage practices due to insufficient and unreliable water supply as noticed. Most of people in study area, the domestic water storage containers were left in houses or outside the houses without lid, because mostly people may not be aware of these factors persuading to mosquito breeding conditions. Similar observations were observed from this area by Katyal R et al. and have suggested that IEC activities with source reduction are the 'must' activity for containing *Aedes* borne diseases.<sup>14</sup> Another similar observation was recorded by the previous workers from the residential area of Calcutta city by Tandan N et al.<sup>15</sup> and by Kalra NL in North, North-east and central India.<sup>16</sup>

During the Zika outbreak in Jaipur city, *Aedes* breeding was found in all the Zika affected wards but mosquito breeding was found to vary from ward to ward, irrespective of Zika cases, this supporting earlier research workers similar studies were conducted in different states in India as Uttarakhand, Jharkhand, Maharashtra and Delhi<sup>17-20</sup> and similar finding were recorded also in Uttarakhand and Jharkhand *Aedes* disposition varied from area to area, and similar spatial pattern of *Aedes* mosquitoes was reported from Ajmer district of Rajasthan.<sup>16</sup> However *Ae. aegypti* was recorded in domestic breeding habitats in houses or outside the houses left open space. *Ae. albopictus* breeding was detected outdoor of the house may be due to adaptation of *Ae. albopictus* in manmade habitats besides restriction of natural habitats and more attention be paid to clarify the involvement of *Ae. albopictus* in the transmission dynamics of Zika infection and could be studies on determination of possible role of *Ae. albopictus* mosquitoes in maintenance of urban cycle regarding dengue, chikungunya and Zika as earlier reported by Joshi et al.<sup>21</sup> Most of *Aedes* mosquito breeding was recorded in manmade breeding habitats in houses or outside the houses in cemented tanks, followed by Mud pots for drinking of birds, domestic desert coolers, fountains, flower pots, junk materials and discarded tyres.

During the survey, prevalence of *Aedes* mosquitoes was declined after the intervention measures for vector control

were adopted by the state health department and IRS activity should be used to control vector population during the outbreak situation as suggested by Das MK et al.<sup>13</sup> However, all the observations are suggesting that IEC with source reduction programme should be under taken before the transmission season to proper disposal of these mosquito breeding habitats with special attention to control mosquito breeding in Jaipur city for effective vector control of VBDs like Zika, dengue and chikungunya because there is no vaccine available for prevention of Zika infection.

## Conclusion

It is concluded that the most of Zika affected areas in Jaipur city showing high larval indices were above the critical level in most of entire localities may be the probable reason for Zika outbreak. The entomological studies should be undertaken and the information could be utilized to forecast the possibility of future outbreak of Zika and necessary control measures should be taken before the possible outbreak in Jaipur city including rural area. This could be achieved by the enhanced IVM with special programme for water management practices, IEC activities and community participation to contain mosquito breeding sites or proper disposal of mosquito breeding to contain epidemics in future.

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## Conflict of Interest: None

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