Effect of control measures in terms of change in Entomological Indices during first Zika outbreak in Jaipur (Rajasthan)

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Abstract*—Zika virus third epidemic of India occurs in Jaipur (Rajasthan) India. This study was conducted to found the effect of control measures in the form of change in entomological indicies. Entomological surveillance was undertaken in the Zika affected areas of Jaipur Rajasthan in 29 kilometer square area in radius of 3 km around 1st index case. Vector indices House Index (HI) & Breteau index (BI) were used as indicators for assessing control activities. It was observed that out of total 159 cases of this outbreak, 108 cases were found in study area having 1.85 Zika case per 1000 household and 0.37 case per 1000 population rate of occurrence. There was 95.65% and 97.1% reduction in House Index and Breteau Index respectively in six week of control measures taken. Significant reduction in HI and BI starts from 2nd week onwards.*

Keywords: Aedes Aegypti, Zika Virus, House Index, Breteau Index, Containment of Zika.

I. INTRODUCTION

Zika virus is a re-emerging mosquito-borne flavivirus diseases which is very much similar to dengue. It is mainly spread through bite of infected mosquitoes. Zika virus can spread from mother to child also during pregnancy.[1] Zika virus was first identified in Uganda in 1947 and in humans in 1952.[2,3] On February 1, 2016, WHO declared Zika as a "Public Health Emergency of International Concern".

Presence of Zika virus in India was first time reported in year 2017 where three cases were reported from Gujarat and one case was reported from Tamil Nadu. However, in both the areas there was no evidence of local transmission.[4]

Public health official of Cuba found and reported that *Aedes aegypti* is primarily vector of Zika.[5,6,7] This mosquito breeds in densely populated areas where people store water due to poor water supply and areas with the lacking of solid waste management and sanitation. *Aedes aegypti* is normally a day biter and a container breeder it likes to breed in small containers like, cups, discarded tyres, coconut shells, tins, cans, flowerpots, coolers, cement tanks etc.[5] Density of *Aedes* vector can be monitor in terms of House Index and Breteau Index, which shows positivity of immature (larvae) form in wet container with respect to observed house.

Third epidemic of Zika virus occurs in September and October of 2018 in Jaipur Rajasthan, India. This study was conducted in Zika virus affected area with the aim to find out the effect of control measures in the form of change in entomological surveillance.

II. METHODOLOGY

This community based quincy experimental study was conducted in collaboration of Directorate and Medical Heath Services (DMHS) with SMS Medical College, Jaipur (Rajasthan) India in 2018.

A patient was found positive in microbiology laboratory in SMS Medical College Jaipur in routine surveillance of Zika virus during the second week of September 2018. Entomological survillance was conducted and baseline House Index & Breteau Index was also recorded. Every step of government was noted after that event. Again after every week these indexes were found upto 6th week. These indicies were compared to find out the effect of intervention done by state government.

2.1 Intervention

On September 22, 2018 a female (85 year old), resident of Shastri Nagar, Jaipur district was found positive for Zika virus infection. In response to this state team visited the house of Zika positive patient for taking immediate preventive activities. Thereafter, two teams were deputed for house to house surveillance for fever cases and pregnant women. Simultaneously Indoor space spray was done in about 100 houses with pyrethrum extract 2%. Fogging was also done in surrounding areas.

A map was prepared with a 3 km radius of the index case in Shastri Nagar (ward no. 23). Initially 8 wards of the city i.e. ward 9, 10, 23, 24, 79, 81, 82 and 83 were involved in study. Thereafter case emerge in few more wards (i.e. ward 4, 14, 22, 27, 79B, and 80) but due to lack of data information these six wards were not included in the present study.

Micro plan for containment of Zika as per Ministry of Health and Family Welfare was implemented wherein, containment area was defined (29km^2 around 3km radius of 1st Index case), 149 teams were designated consisting of Health worker and ASHA workers. Different departments such as health, ICDS, Medical education, administrative officers, nursing students and municipality were also involved for surveillance of active fever, anti larval & space spray activities. During 7th October 2018 and these teams were further increased to 344 on 30th October as more cases appeared from the surrounding areas also. Fogging in the designated area was carried out with Cyphenothrin EC 5% (7ml Cyphenothrin EC 5% per 1L diesel) repeatedly on first, third and seventh day in the affected area during morning 6.00 to 9.00 am and in the evening 5.00 to 7.00 pm.[8] For anti larval activities including source reduction, and application of temephos (1ppm) was also carried out in positive containers in addition to this IEC activities using house to house approach, with loud speakers campaigning and using mass media was also done. National Guidelines on Zika virus disease were followed.[9,10] Torch and ladle were provided to survey teams to identify the larva. Open cement tanks, coolers, bird water pot, metallic, tyres, coconut shells, bamboo plants, fridge tray, tray under flower pots and fountains were included in container checking. Source reduction was done by empting small containers and chemical control in larger water containers where water could not be drained. The water supply department solved the problem immediately and made the supply continuous. Thereafter the community was found supportive and agreed for removal of old stored water. Daily debriefing and monitoring of intervention was done at Additional Chief Secretary (M&H), MD (NHM), AMD (NHM), Director (PH) and other senior officials (DMHS) with the MOICs level.

As an outcome indicators of intervention along with appearance of number of cases, House index and Breteau Index were taken as indicators. House positivity was assessed by presence of any breeding of

mosquitoes in the house premise and numbers of containers found positive versus containers checked were noted. House Index and Breteau Index were calculated using following formulas.

House Index (HI)= (No of House positive for presence of Larvae/ No of House Inspected X 100). **Breteau Index** (BI)= (No of Container positive/No of House Inspected X 100)

After finding House Index and Breteau Index at baseline and various interval (weekly upto 6 weeks) of intervention, it was compared to assess the effect of intervention at various interval by observing change in House Index (HI) and Breteau Index (BI) of that area after intervention.

III. RESULTS

Total 159 cases of Zika virus reported from Jaipur, Rajasthan in year 2018. Out of these 108 (67.92%) emerged from the study area alone which includes 54821 households of 8 wards covering 292225 population. Maximum cases (30.6%) were in Bhatta basti (ward no. 82) followed by Shastri Nagar (ward no. 23), Shivaji Nagar (ward no. 81), Subhash colony (ward no. 24), Indrapuri (ward no. 83), Swami Basti (ward no. 79), Bapu Kachhi Basti (ward no. 9) and Vidhyadhar Nagar (ward no. 10). On further analysis there was 1.85 Zika case per 1000 household and 0.37 case per 1000 population. (Figure 1 & 2 and Table 1).

Figure 1

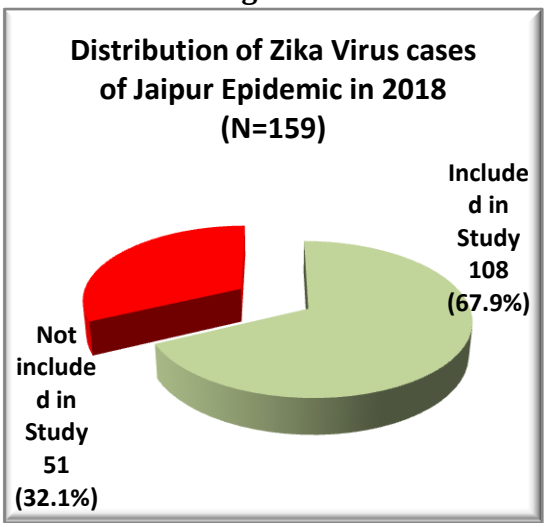


Figure 2

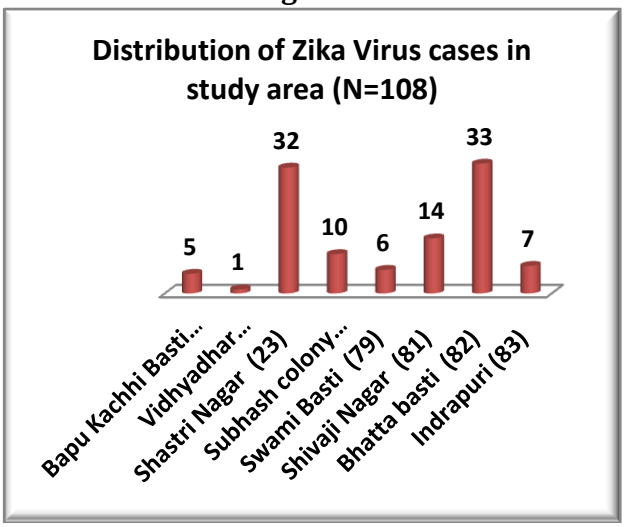


Table No. 1
Distribution of Zika virus cases in study area

Area (Ward No.)	Zika Virus Cases		House Holds Surveyed	Population	Zika case per 1000 Household	Zika case per 1000 Population
	Number	%				
Bapu Kachhi Basti **(9)**	5	4.6	7629	38145	0.66	0.13
Vidhyadhar Nagar **(10)**	1	0.9	8096	40481	0.12	0.02
Shastri Nagar **(23)**	32	29.6	7600	38101	4.21	0.84
Subhash colony **(24)**	10	9.3	5741	28708	1.74	0.35
Swami Basti **(79)**	6	5.6	6472	32362	0.93	0.19
Shivaji Nagar **(81)**	14	13	8370	41863	1.67	0.33
Bhatta basti **(82)**	33	30.6	8737	43685	3.78	0.76
Indrapuri **(83)**	7	6.5	5776	28880	1.21	0.24
Overall	108	100	58421	292225	1.85	0.37

Entomological surveillance was conducted in 54821 households of 8 wards covering 292225 population. Continuous control and IEC activities were conducted in all the study areas for 6 weeks from 5th October to 15th November 2018. In first week HI was averaging 25.3±10.2 (ranging from 9.25 to 38.5) which was decreased as intervention started and reached to an average of 1.1±0.5 with 95.65% decreased in House Index. There was significantly decrease in HI every week when compared to first week due to control measures taken. (Table 2 & 3 and Figure 3)

Table No. 2
Week wise House Index (HI) after intervention in study area (N=108)

Area (Ward No.)	Zika case per 1000 Population	Week 1st (5-11 Oct)	Week 2nd (12-18 Oct)	Week 3rd (19-25 Oct)	Week 4th (26 Oct-1Nov)	Week 5th (2-8 Nov)	Week 6th (9-15 Nov)
Bapu Kachhi Basti **(9)**	0.13	18	9.7	3	1.5	1	1.5
Vidhyadharnagar **(10)**	0.02	9.3	16.8	9	3.9	1.2	0.9
Shastri Nagar **(23)**	0.84	37.3	16.5	8.7	4	0.8	1.4
Subhash colony **(24)**	0.35	28.8	11	7.2	4.6	1.4	0.6
Swami Basti **(79)**	0.19	17	11.8	10.3	4.5	1.6	1
Shivaji Nagar **(81)**	0.33	28.8	19.8	15	4	2.7	1.7
Bhatta basti **(82)**	0.76	38.5	18.7	13.5	8	0.5	1.6
Indrapuri **(83)**	0.24	25.3	15.8	7.2	5.4	1.1	0.3
Overall Mean		25.3	15	9.2	4.5	1.3	1.1
Overall SD		10.2	3.7	3.8	1.8	0.7	0.5
***P Value**		****R	<0.05	<0.05	<0.05	<0.05	<0.05

Repeated ANOVA=421.42 ***P Value < 0.001 (Significant)***
****Dunnett Test*** ***** Reference value***

Table No. 3
Week wise House Index (HI) after intervention in study area

Area (Ward No.)	Zika case per 1000 Population	Week 1st (5-11 Oct)	Week 6th (9-15 Nov)	Change in HI	Percentage Change
Bapu Kachhi Basti **(9)**	0.13	18	1.5	16.5	91.67
Vidhyadharnagar **(10)**	0.02	9.3	0.9	8.4	90.32
Shastri Nagar **(23)**	0.84	37.3	1.4	35.9	96.25
Subhash colony **(24)**	0.35	28.8	0.6	28.2	97.92
Swami Basti **(79)**	0.19	17	1	16	94.12
Shivaji Nagar **(81)**	0.33	28.8	1.7	27.1	94.10
Bhatta basti **(82)**	0.76	38.5	1.6	36.9	95.84
Indrapuri **(83)**	0.24	25.3	0.3	25	98.81
Overall Mean		25.3	1.1	24.2	95.65

Likewise HI, BI also decreases with control measures. In first week BI was averaging 37.9±15.2 (ranging from 21 to 58) which was decreased as intervention started and reached to an average of 1.1±0.5 with 97.1% decreased in Breteau Index. There was significantly decrease in BI every week when compared to first week due to control measures taken. (Table 4 & 5 and Figure 3)

Table No. 4
Week wise Breteau Index (BI) after intervention in study area

Area (Ward No.)	Zika case per 1000 Population	Week 1st (5-11 Oct)	Week 2nd (12-18 Oct)	Week 3rd (19-25 Oct)	Week 4th (26 Oct-1Nov)	Week 5th (2-8 Nov)	Week 6th (9-15 Nov)
Bapu Kachhi Basti **(9)**	0.13	27.5	15.8	4.2	1.6	1.1	1.5
Vidhyadharnagar **(10)**	0.02	21	43.5	10.3	5.2	1.3	0.7
Shastri Nagar **(23)**	0.84	49.5	25.2	11	4.7	1	1.4
Subhash colony **(24)**	0.35	31	12.2	7.8	5	1.2	0.6
Swami Basti **(79)**	0.19	21.8	15.5	13.2	5.5	2.4	1.1
Shivaji Nagar **(81)**	0.33	37.3	36.3	21.2	5.1	2.4	1.8
Bhatta basti **(82)**	0.76	57	27.7	18.5	8.8	0.6	1.7
Indrapuri **(83)**	0.24	58	35.7	14.2	8.1	1.4	0.3
Overall Mean		37.9	26.5	12.5	5.5	1.4	1.1
Overall SD		15.2	11.4	5.5	2.2	0.7	0.5
***P Value**		****R	<0.05	<0.05	<0.05	<0.05	<0.05

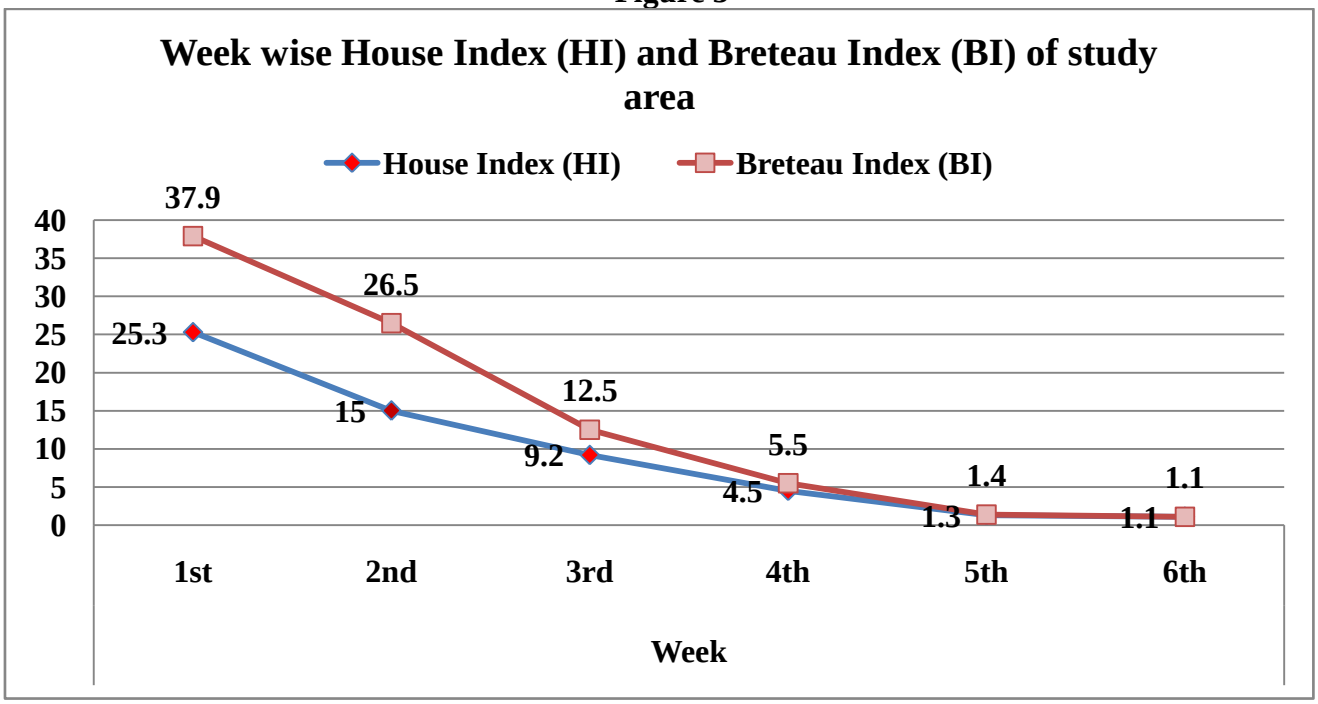
Repeated ANOVA=368.06 ***P Value < 0.001 (Significant)***
****Dunnett Test*** ***** Reference value***

Table No. 5
Week wise Breteau Index (BI) after intervention in study area

Area (Ward No.)	Zika case per 1000 Population	Week 1st (5-11 Oct)	Week 6th (9-15 Nov)	Change in BI	Percentage Change
Bapu Kachhi Basti **(9)**	0.13	27.5	1.5	26	94.55
Vidhyadharnagar **(10)**	0.02	21	0.7	20.3	96.67
Shastri Nagar **(23)**	0.84	49.5	1.4	48.1	97.17
Subhash colony **(24)**	0.35	31	0.6	30.4	98.06
Swami Basti **(79)**	0.19	21.8	1.1	20.7	94.95
Shivaji Nagar **(81)**	0.33	37.3	1.8	35.5	95.17
Bhatta basti **(82)**	0.76	57	1.7	55.3	97.02
Indrapuri **(83)**	0.24	58	0.3	57.7	99.48
Overall Mean		37.9	1.1	36.8	97.10

The reduction was mainly achieved in the 4th week irrespective of the initial high variability in the Indices i.e. HI ranging from 9.25-38.5 showed high SD ($\sigma = \pm 10.14$); BI ranged from 21-58 with SD (σ) = ± 15.14 shows high variability. However, after intervention the variability range reduced in sixth week i.e. HI ranging 0.3-1.7, with SD (σ) = ± 0.50 shows low variability and BI ranging 0.3-1.8, with SD (σ) = ± 0.55 shows low variability (Table 2 & 4 and Figure 3).

Figure 3



IV. DISCUSSION

Zika have been reported as a new emerging vector borne diseases spread through mainly mosquitoes. More than 85 countries have reported Zika, India is one of them. In year 2017 few cases appeared in Gujarat and Tamil Nadu states. The current outbreak was considerably larger and transmitted locally. The global resurgence initiated 2015 onwards form Brazil where Zika caused microcephaly in neonates.

In 2018 September second week (22nd September 2018) a case was detected from a routine surveillance in Jaipur, India. The State health department and Central teams conducted investigations about the case history which showed no travel history. Jaipur is also a well-known tourist destination for overseas tourists due to its glorious culture and forts, more than 10 million International tourist visit India in year 2018.[11] This may be suspected to be introduced through overseas tourist from Zika affected country and aggravated in mosquitoes and was transmitted locally before a 1st index case was detected.

The efforts by RTs gained reduction in both HI & BI of more than 90% in about 4th week and maximum reduction was attained in 5th week. Similarly the appearance of cases stopped from the intervention area after 28th October 2018 i.e. during the third week of intervention. Thereafter the intervention was continued for another three weeks. There was 95.65% and 97.1% reduction in House Index and Breteau Index respectively in six week of control measures taken. There was significant reduction in HI and BI from 2nd week onwards.

The water supply department solved the problem immediately and made the supply continuous. Thereafter the community was found supportive and agreed for removal of old stored water. Supplying of water in plastic tanks also helps to avoid water storage and to reach entomological indices as targeted Studies have shown that implementing reliable water supply, solid waste management, changing water storage practices and modification in water storage helps dropping down the density of Aedes in an area.[12,13]

In present study, almost all vector control measures suggested by WHo for containment of vector born disease were taken in terms of as per Integrated Vector Management (IVM) which aims to improve the efficacy, cost-effectiveness, and overall sustainability of the strategy.[14] Since *A. aegypti* which is the vector responsible in spread of Zika, uses a wide range of confined larval habitats, specially man-made and sometimes natural, it is critical to consistently and continuously apply the three-pronged IVM, incorporating the following considerations.[14,15,16]

Many risk factors contribute in the rapid spread of transmittable diseases epidemic in an area i.e. fragile health systems, weak surveillance, population size and its mobility, rapid urbanization, climate change, and limited laboratory diagnostic capacity etc.[17] There is also a need to address critical gaps in knowledge of diseases, technical expertise, fund adequacy, comprehensive response plans.[18] Other studies[19,20] also suggested these type of intervention in Zika virus control.

Successful transmission containments have been achieved by proper coordination between departments responsible for basic supplies, enhancing treatment facilities availability of testing kits, mass mobilization awareness in media and by strengthening public health system.[21,22] Almost similar containment measures were taken in Bapunagar area, Ahmedabad District, Gujarat, State, India.[23]

This timely intervention and containment plan worked through good coordination from all levels from minister to the ground worker level and proper declaration of work progress. The effort can be taken as a success story for future reference.

V. CONCLUSION

In the present study, there was 1.85 Zika case per 1000 household and 0.37 case per 1000 population. There was 95.65% and 97.1% reduction in House Index and Breteau Index respectively in six week of control measures taken. There was significant reduction in HI and BI from 2nd week onwards.

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CONFLICT OF INTEREST

None declared till now.

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