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Research Article

Entomological Investigation during an Outbreak of Dengue in 2018 in Bilaspur District, Himachal Pradesh

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A B S T R A C T

Background: Post dengue outbreak in July 2018, an entomological survey was undertaken in the Bilaspur district of Himachal Pradesh in India, to identify risk factors for *Aedes* breeding and subsequently suggest mitigation measures to control the epidemic situation.

Method: In view of the clustering of dengue cases, three wards of Diara primary health centre and surrounding villages were selected for the survey. Hand catch method was used to collect adult vectors resting indoors, whereas immature stages of vectors were collected from containers using a ladle. Man-hour density and other vital entomological indices were calculated using the standard methods.

Results: An alarming Breteau Index (129), as well as a very high House Index (75), Container Index (32) and Pupal Index (120) were observed during the survey, indicating a dengue outbreak situation. *Aedes aegypti* and *Aedes albopictus*, vectors of dengue, were collected from the affected region with man-hour density ranging between 1 and 6.4. Plastic containers and syntax tanks were the major containers observed in households to store water due to irregular water supply.

Interpretation & Conclusion: The population was hesitant to discard the stored water due to scarcity and irregular water supply. Plastic containers were the most productive for *Aedes* breeding. Community knowledge, attitude and practices towards the severity of dengue, its prevention and control were low. The present study recommends that the dengue control strategy should focus on keeping water supply and plastic containers in mind and the community should be mobilised to keep water containers covered properly, or source reduction should be done.

Keywords: *Aedes Aegypti, Aedes Albopictus*, Dengue, Entomological Indices, Himachal Pradesh

Introduction

Dengue is a fast-spreading vector-borne disease worldwide.[1] With the rapid geographical expansion of *Aedes albopictus* and *Ae. aegypti* mosquitoes, half of the world's population is already at risk of dengue, and other areas harbouring high vector density are vulnerable to a dengue outbreak.[2] India and other Asia Pacific Regions account for around 75% of the world's dengue cases.[3] It is a leading public health problem and cause of hospitalisation and death.[4] The situation is further worsened by the development of insecticide resistance in dengue vectors, different serotypes of dengue virus (DENV 1-5), and lack of a vaccine against the disease.[5]

Dengue is a viral disease, which is spread by the bite of an infected female *Aedes* mosquito. Meteorological variables such as humidity, temperature, and rainfall play a crucial role in dengue outbreaks and epidemics, and climate change establishes dengue endemicities.[6] Besides climatic factors, ecological factors viz. population density, socioeconomic status, human and vector mobility, urban sprawl, household construction, water supply, and water storage practices also influence dengue transmission.[7,8]

Earlier in the twentieth century, dengue was mainly distributed in tropical regions of India, but currently, cooler parts of the country like Assam, Arunachal Pradesh and Mizoram have also reported incidences of dengue sparing a few colder regions of northern mountain states like Himachal Pradesh, Jammu & Kashmir, and Uttarakhand.[3,9,11] Due to globalisation, global warming, climate change, and human and vector mobility, dengue outbreaks are occurring even in virgin hill states every year viz. Uttarakhand.[1,2] In addition, studies have predicted the risk of dengue outbreaks in Himachal Pradesh and Jammu & Kashmir.[13] In recent years, cases of dengue have been reported from Jammu and Himachal Pradesh.[13,14]

For the first time, dengue cases started in Bilaspur, Himachal Pradesh in the year 2016 with only 21 cases. In 2017, 157 cases were reported but in 2018, 48 dengue cases were reported till June which was many folds high in comparison with previous years by that time. Most of the cases were found clustered in the Diara extent of Bilaspur municipal council zone which indicated the outbreak of dengue in that area. Dengue cases reached 88 by Jul 4, 2018, and there was an urgent need of an entomological survey and recommendation of appropriate control strategy to the state health department for the control of the epidemic situation. Therefore, at the request of the state health department of Himachal Pradesh, this study was conducted.

The present study attempts to find the factors responsible for sudden dengue outbreaks in relatively colder areas such as Bilaspur, Himachal Pradesh. The outcome of the study will help in predicting the risk of dengue in such hilly areas and build potential risk maps for current and future epidemiological scenarios for planning effective vector control strategies.

Material & Methods

Study Area

A team from ICMR - National Institute of Malaria Research, New Delhi visited Bilaspur during the month of July 2018 for an entomological survey. Geographically, the district is located between 31°12'30" and 31°35'45" N latitude and between 76°23'45" and 76°55'40" E-longitude. The average height of the region is 673 meters. The region experiences a sub-humid climate with an average rainfall of 1478.8 mm.[15] Majority of the population resides in rural areas and is sparsely distributed (327 people/km², 1,061 villages).[16] Administratively, the district has been divided into four sub-divisions with Bilaspur Sadar as one of the major urban areas and also the district headquarters under Municipal Council (MC) where most of the district business and administration is done. Unplanned urbanisation and drought have led to water scarcity in Bilaspur.[17] Further, inadequate piped water supply during summer compels the residents to store water in their houses.

Entomological Survey

An entomological survey for Aedes was undertaken in 3 wards of PHC Diara which reported a majority of the cases of dengue. Adjacent villages showing an incidence of dengue cases were also surveyed i.e. in village Sheola of block Markand, village Sameta of block Jhanduta, and in village Muhana of block Ghumarwin. A survey for immature stages of *Aedes* vectors was undertaken in indoor as well as peridomestic habitats. Adult vectors were collected separately from the houses and working places in the study area using a hand-held aspiration tube and a torch light following standard norms.[18] A total of 120 households and their peri-domestic areas were surveyed randomly as per the standard protocol.[19] After calculating the number of houses and total containers surveyed, breeding indices were determined as % *Aedes* positive houses (House Index or HI), and % *Aedes* positive containers (Container Index or CI). Thereafter, the Breteau Index (BI) which is a more potential index was determined based on the values of HI and CI. Pupal Index (PI) was also analysed to know the *Aedes* prevalence as per the standard procedure of the World Health Organisation.[19] Adult mosquitoes were collected using mouth aspirators and torches in the houses surveyed and Man Hour Density (MHD) of collected adults was determined. The Aedes species were identified following a standard mosquito identification key.[20]

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Results

Hospital Records

From May 1, 2018 to July 4, 2018, a total of 199 fever cases for dengue were tested for NS1 antigen by Rapid Diagnostic Test (RDT), of which, 88 were found positive. Majority of the positive cases (68.1%) were residents of PHC Diara alone. In addition to Diara PHC, seven cases were reported from adjoining urban areas of Bilaspur, and 21 cases were from rural areas of three blocks viz. Markand (14) Ghumarwin (3) and Jhandutta (4).

The common symptoms noted were fever, skin rash, and joint pain. The commonest signs seen were hepatomegaly and icterus. Pathognomonic features such as haemorrhage were rare.

Epidemiological Investigations

In 2016 and 2017, an increase in dengue cases was seen in September and October (2016-17). For the first time, uneventful reporting of dengue cases (up to 22) was noted as early as June 2018 in wards 8 and 9 of the Municipal Council of Bilaspur. The highest attack/ incidence rate was observed in ward no. 9, followed by ward no. 8, and adjacent ward no. 5. By tracing the epicentre of the epidemic and case history, it was found that on May 28, 2018, a 21-year-old female from ward no. 8 was found positive for dengue who visited her home from Bengaluru while suffering from dengue. The next case was reported on Jun 8, 2018, from an adjoining relative's house. Thereafter, daily cases were being reported from surrounding areas and the disease extended to other parts of the district (Table 1).

Dengue Vector Survey (Entomological Indices)

Most of the dengue incidences were from the Diara locality and all the studied sites in MC Bilaspur were found positive for dengue vectors. In villages Sheola and Muhana of PHC Diara, majority of the households were found to store water due to inadequate water supply. Syntax tanks and plastic containers were mainly used for water storage. Majority of the containers, which were located on the ground floor harboured *Aedes* immatures (Table 2). Though % positivity of tin drums, mud containers, and tyres for immature stages of Aedes was high, such containers were scarce.

BI ranged from 80 to 175, which is alarmingly high and reflects a dengue outbreak situation. Other indices such as HI, CI and PI were also high (Table 3). Both the vectors of dengue i.e. *Ae. aegypti* and *Ae. albopictus* were field collected from houses and institutions in the affected areas from morning to evening and the MHD was high (Table 4). Adults emerging out of collected immatures were identified as *Ae. aegypti* and *Ae. albopictus* (Table 5). The entomological indices of peri-domestic parts were also high, scraps were numerous and lying open in peri-domestic places, junk yards of private and government property, and with the scrap dealers. Majority of them were filled with rainwater which provided ground for profuse Aedes breeding.

Table 1.Dengue Infection Statistics in District Bilaspur from 2016 Till Aug 20, 2018

S. No.	Area	Population	Houses	2016		2017		2018	
				Total Cases	Positive Cases (%)	Total Cases	Positive Cases (%)	Total Cases	Positive Cases (%)
1	Ward no. 1	920	220	1	0.11	0	0.00	10	1.09
2	Ward no. 2	1302	266	0	0.00	1	0.08	41	3.15
3	Ward no. 3	1248	232	0	0.00	2	0.16	17	1.36
4	Ward no. 4	1057	224	0	0.00	0	0.00	6	0.57
5	Ward no. 5	538	98	0	0.00	3	0.56	73	13.57
6	Ward no. 6	1183	280	0	0.00	0	0.00	20	1.69
7	Ward no. 7	2586	712	0	0.00	3	0.12	9	0.35
8	Ward no. 8	906	216	1	0.11	7	0.77	28	3.09
9	Ward no. 9	1098	221	0	0.00	6	0.55	64	5.83
10	Ward no. 10	1070	237	0	0.00	2	0.19	30	2.80
11	Ward no. 11	1684	379	0	0.00	3	0.18	8	0.48
12	Block Markand	153141	29268	5	0.00	63	0.04	109	0.07
13	Block Ghumarwin	112282	23683	5	0.00	18	0.02	18	0.02
14	Block Jhandutta	131093	25255	9	0.01	14	0.01	24	0.02
15	Total	410108	81291	21	0.23	122	2.7	457	34.08

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Table 2.Types of Breeding Habitats found in District Bilaspur

Container Type	Containers Searched	Containers Positive for Immature Stages of *Aedes*	% Presence of *Aedes* Larvae
Tin drum	5	4	80
Tyres	15	10	67
Mud pot/ bird pot	25	10	40
Above-ground syntax tank	84	33	39
Plastic drum/ containers	149	58	39
Underground tank	28	8	29
Scrap	11	3	27
Coolers	44	9	20
Overhead tanks	43	7	16
Refrigerators	75	2	3
Total	479	144	30

Table 3.Entomological Indices of Immature Stages of *Aedes* in District Bilaspur

S. No.	Affected Area	Houses Visited	Houses Positive	Containers Searched	Containers Positive	Entomological Indices			
						HI	CI	BI	PI
1.	Diara ward no. 8	20	14	85	25	70	29.4	125	130
2.	Diara ward no. 9	20	18	105	35	90	33.3	175	170
3.	Diara ward no. 10	20	15	86	26	75	30.2	130	130
4.	Markand	40	28	132	53	70	40.2	132.5	147.5
5.	Ghumarwin	20	13	67	16	65	23.9	80	35
Total		120	88	475	155	75	31.9	129.3	120.6

HI: House Index, CI: Container Index, BI: Breteau Index, PI: Pupal Index

Table 4.Man Hour Density (MHD) of Ae. Aegypti and Ae. Albopictus in District Bilaspur

S. No.	Name of the Affected Area	*Ae. Aegypti*		*Ae. Albopictus*	
		Male	Female	Male	Female
1.	Diara ward no. 8	0	4	0	2
2.	Diara ward no. 9	2	7	0	2
3.	Diara ward no. 10	0	6	0	1
4.	Block Markand	6	10	0	0
5.	Block Ghumarwin	5	5	0	0
Average MHD		2.6	6.4	0	1

Table 5.Emergence of Aedes Mosquitoes from Immature Stages of Aedes Collected from Containers from Bilaspur District

S. No.	Name of the Affected Area	*Ae. Aegypti*		*Ae. Albopictus*		Other Species of Aedes	
		Male	Female	Male	Female	Male	Female
1.	Diara ward no. 8	1	5	1	4	0	4
2.	Diara ward no. 9	1	1	0	10	0	3
3.	Diara ward no. 10	0	2	1	2	0	0
4.	Block Markand	1	4	0	2	0	6

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5.	Block Ghumarwin	0	2	1	2	0	0
Average emergence		0.6	2.8	0.6	4	0	2.6

Discussion

District Solan, which lies adjacent to Bilaspur, has been reporting dengue outbreaks since 2015 but for the first time, a dengue outbreak was reported from Bilaspur.[13] High *Aedes* indices and clustering of the incidences in the present study prove local transmission. Most of the cases were from the peri-urban wards of Diara. This may be attributed to inadequate water supply, especially during the summer season in 2018 compelling residents to store water to meet their daily needs. Stored water provided favourable breeding grounds for dengue vectors. Consequently, various indices of *Aedes* prevalence in and around MC Bilaspur were considerably high, making the region highly vulnerable to *Aedes*-borne diseases like dengue and chikungunya. The proximity of the region to river Sutlej favoured humid conditions even on dry days. With the onset of monsoon, rainwater got collected in numerous peri-domestic scraps and provided grounds for profuse breeding of *Aedes*. A girl infected with dengue from Bengaluru who visited her family may be the source of infection that might have been transmitted to people in and around her house through already existing *Aedes* mosquitoes, starting from her aunt and neighbours to the rest of the inhabitants and those visiting Bilaspur for work in the daytime. The moving population carried the infection with them to other places in Bilaspur. Larval indices in all the study areas were higher than the threshold values (> 10).

The most efficient container for the breeding of *Aedes* was a tin drum followed by tyres, mud pots and above-ground tanks. But as the sample size of tyres, tin drums, and mud pots was much less as compared to AGT and plastic drums, it revealed that AGT were the most productive containers. Studies in the past have also shown that shortage of water supply is a major risk factor for dengue outbreaks. Shortage of water compels the residents to store water in various containers for a long duration and these containers constitute the major mosquito breeding sources, a phenomenon that was observed in the present study as well.[21,22]

The present study has highlighted the prevalence of both *Aedes* aegypti and Aedes albopictus in the Bilaspur area. However, the adult collection points out that *Ae. aegypti* is a species that is limited to houses. Furthermore, *Aedes* aegypti may be the predominant mosquito vector transmitting dengue virus in the region. However, the role of *Aedes* albopictus in dengue transmission in this region needs to be studied in detail. In India, *Ae. aegypti* has been incriminated as the principal epidemic vector, while Ae. albopictus has been given the status of secondary vector, responsible for the maintenance of the virus.[23]

Another important finding was reluctance among the inhabitants to drain stored water despite the presence of mosquito larvae in it. As water is scarce in the affected areas, the residents preferred straining stored water over draining. Most of the inhabitants were found to be unaware of the fact that *Aedes* can breed in clean water and in small rainwater collections. Further, their knowledge of dengue treatment and prevention was also low. Therefore, it is important that the community be sensitised towards the prevention and control of vector breeding through IEC activities. Awareness should also be spread among the residents to seek prompt treatment at the earliest.[24] Further, integrated solid waste management is also essential to manage waste providing vector breeding grounds.[25] All water containers in the house should be covered to prevent egg laying by the vector, especially the most abundant and productive above-ground syntax tank plastic containers should be given focus in the control programme. Personal protective measures should be adopted to disrupt transmission from infected to uninfected persons. Containers filled with water should be emptied within five days.

Preparedness for a dengue outbreak was poor in the state health department and there was a lack of manpower and logistics. People should be made aware that dengue is a public health problem and can be prevented by community participation and simple steps such as source reduction. Long-term solutions for improving water supply, and mosquito-proofing of overhead tanks, cisterns or underground reservoirs are also warranted.[26] In addition, legislative measures are effective in such situations. As both the dengue vector species viz. Ae. aegypti and Ae. albopictus were found and the MHD of adult Aedes was also high so both indoor and outdoor space spraying is important.

Though larval positivity of water storage containers was common, larval positivity of desert coolers was rare in the present study. Breteau Index (BI) was also very high (> 50) in nearby urban and peri-urban areas from where people visited Bilaspur town for work which is indicative of a potential risk of spreading dengue to nearby places. So, attention should be given to sporadic dengue cases in nearby places for the containment of the disease.

Dengue outbreak in comparatively colder hill stations such as Bilaspur, lays an important ground to study dengue outbreaks, as the outbreak was reported for the

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first time. It appeared to be an outbreak from an index dengue case so multiple serotypes were not expected and no immunological complexity due to pre-exposure was expected in the population.[27] Therefore, studies on sero-surveillance, in addition to bionomics of dengue vectors, are required to be done for better knowledge to control dengue in such areas.

Conclusion

The findings of the study revealed that all larval indices were above the critical limits for a dengue outbreak. Keeping in view the productivity of plastic containers and tanks, vector control authorities should focus on the same and the community should be mobilised to keep water containers covered properly, or source reduction should be done.

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Conflict of Interest: None

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