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Report of first dengue outbreak in Aizawl, Mizoram, northeast India: Epidemiological and entomological surveillance and observations

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Outbreaks of dengue disease have been reported from many parts of India including north-eastern States. There were reports of dengue disease outbreaks from Moreh town in Manipur during 2007-2008 and from Pasighat in Arunachal Pradesh during 2012 from northeast India. The first outbreak of dengue-like fever in Mizoram was reported on 30th August from Tuikual North 'C' Mual, Aizawl, followed by consecutive outbreaks at 10 localities between August and December 2016 within Aizawl city. In these localities, epidemiological and entomological studies were conducted to identify the disease and its vector. Blood serums were collected from the patients for the serological confirmation and *Aedes* mosquitoes (adults and larvae) were collected for vector identification and confirmation. There were 580 (NS1=384, IgM=196) patients confirmed with the disease from 11 localities in Aizawl and *Ae. aegypti* were identified as a potential vector species. There was no predilection towards sexes and all age group are affected with a median age 30. Parameters of entomological study revealed high density of vector mosquito in the study areas. Public health actions pertaining to the prevention and control of the disease were implemented. As dengue is included among the notifiable diseases in India, government authorities should strengthen manpower, case management and laboratory support, and regularly organizing interactive co-ordination meetings at all levels to sensitize public through IEC and awareness programmes as well as source reduction of *Aedes* mosquito breeding.

Key words: *Ae. aegypti*, Dengue, DENV, entomological study, epidemiological study, localities outbreaks, Surveillance.

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Introduction

The word "dengue" is derived from the Swahili phrase, *Ka-dinga pepo*, literally meaning 'cramp-like seizure'. It was first referred as 'water poison' associated with flying insects in a Chinese medical encyclopedia from the Jin Dynasty (265-420 CE). The first recognized dengue epidemic occurred in Asia, Africa and North America in the 1780s. Benjamin Rush coined the term 'backbone fever' because of the symptoms of myalgia and arthralgia.[1] Dengue is currently

regarded as the most important mosquito-borne human viral disease in terms of both the number of cases and the number of death and it is also considered a major global threat by World Health Organization (WHO).[2] Dengue incidence has increases by 30 folds in the last 50 years with more than 100 countries reporting the presence of the disease.[3] There has been differences in opinion of dengue global distribution from 30%[4] to 54.7%[4] of the world population (2.05-3.75 billions).[4,5] According to WHO 2009 classification, dengue is divided into two groups:- uncomplicated (DF) and severe (DHF/DSS).[2] In India, the first epidemic of clinical dengue-like illness was recorded in Madras in 1780 and the first virologically-proved epidemics of DF occurred in Kolkata and eastern coast of India in 1963-1964.[6-8] The DHF started spreading in various parts of India since 1988.[9-11] The first major widespread of epidemics of DHF/DSS occurred in India in 1996 involving areas around Delhi[12] and Lucknow[13] and then it spread to all over the country.[14]

Dengue viruses (DENV) are single-stranded RNA viruses belonging to genus *Flavivirus* of the family Flaviviridae and have four distinct serotypes (DEN 1-4) that are further classified into genotypes and clades phylogenetically.[15] The mixing infections of serotypes/genotypes are known to effect severity complications of dengue [16] and minor genetical changes in arboviruses RNA may result in increase in transmission and severity resulting in epidemic situations.[17] From the mid-1990s, epidemics of dengue in India have become progressively larger and more frequent, usually starting in urban areas and quickly spreading to neighbouring regions. India became endemic for both DF and DHF/DSS as transmission become sustained during the inter-epidemic periods in large parts of the country.[18,19] Dengue disease is transmitted to human by *Aedes* (*stegomyia*) *aegypti* (Linnaeus) and *Aedes* (*Stegomiya*) *albopictus* (Skuse) mosquito species.[20]

The first dengue-like fever outbreak was reported on 31 August 2016, to the State Vector Borne Disease Control Programme (SVBDCP) Directorate of Health Services, Mizoram from the resident of Tuikual North, 'C' Mual area within Aizawl city. Expert team consisting of medical doctors and entomologist from SVBDCP and Integrated Disease Surveillance Programme (IDSP) rushed to the locality to investigate the situations and other related issues. Following to this outbreak there were several reports of dengue outbreaks from other localities within Aizawl city. There was a report on 13 October 2016 from Electric Veng and on 18 October 2016 from Ramhlun Sport Complex localities. Another outbreaks report were received from Chhinga Veng, Ramthar, Bethlehem Vengthlang, Zemabawk, Armed Veng, Dinthar, Saron, and Chanmari localities within the month of November and December 2016. In all these outbreak localities epidemiological and entomological studies were conducted by the team.

Study area and population

Aizawl, the capital of Mizoram, India is a hilly city lies within 23.36°N and 92.8°E and having a temperature ranges from 20–30°C in summer and 11–21°Cin winter. It receives 215 cm of rainfall annually and features a humid subtropical climate but very rainy and relative humidity is 46%. According to 2011 census Aizawl has a total population of 2,93,416.[21]

This study was conducted to confirm dengue disease outbreak serologically and entomologically and to implement public health actions for the control and prevention of further spreading of the disease.

Materials and Methods

Epidemiological study

In all outbreak localities surveyed, patients were found in clusters and all were exhibiting same symptoms like fever with rash, muscles and joints pain, abdominal pain, epistaxis, vomitting etc. which resembles the symptoms of dengue. Almost all of the patients have no history of travelling outside the state. For the serological confirmation of dengue disease, blood

sample were collected from outbreak localities and sent to Sentinel site at Civil Hospital Aizawl to confirm with ELISA Reader. Continuous epidemiological surveillance and vigilance were implemented in these localities.

Entomological study

Entomological investigation as per National Vector Borne Disease Control Programme (NVBDCP) guidelines to identify the vector mosquito of dengue and to determine the density of vector population in all the outbreak localities was conducted by trained Entomologist. The species of vector mosquito was identified and the sampling technique for vector surveillance utilised in these areas were for both adults and larvae. For adult survey, per man hour density (PMHD) was utilised which indicates the number of adult vector mosquitoes collected within an hour. For larval survey the following indices were used:

1. House index (HI) =
$$\frac{\text{No. of positive houses X 100}}{\text{No. of houses searched}}$$

2. Container index (CI) =
$$\frac{\text{No. of positive containers X 100}}{\text{Number of containers searched}}$$

3. Breteau index (BI) =
$$\frac{\text{No. of positive containers X 100}}{\text{No. of houses searched}}$$

4. Pupae index (PI) =
$$\frac{\text{No. of pupae observed X 100}}{\text{Number of houses searched}}$$

Study of pupae index is very important during the on-going transmission period because, the pupae hatch out as an adult within a day or two and will feed on human blood meal and thus increase chances of transmission to enhance the on-going outbreak, if no interventions for vector control measures to cut-off the transmission were operated. Adults and larvae of mosquitoes collected in the outbreak localities were reared in the laboratory for species identification.

Public health actions

Even before the serological confirmation of the disease, public health actions were initiated in outbreak localities because the epidemiological and entomological findings supported the disease outbreak was dengue disease. Actions taken were (**Figure 1**):

1. Public awareness campaigns through public meeting and print media.

Figure 1 | Vector-mosquito control. A. Space spray/fogging; B. Source reduction.

2. Voluntary works for source reduction under the supervision of the expert team.
3. House-to-house visit and serum collection by medical personnel.
4. Thermal fogging/space spray in the affected areas and its surroundings.

Results

Prior to this dengue outbreak in Aizawl, there were several sporadic cases of dengue recorded each year. The first outbreak was identified and confirmed at Tuikual North, 'C' Mual and it was followed by another 10 consecutive outbreaks in different localities of Aizawl and one outbreak reported from Kolasib town during 2016. Due to timely introduction of interventions for the vector control, all these outbreaks were under controlled and subsided with a fortunate zero mortality case.

Epidemiological observation

In 2012, sentinel sites for dengue diagnosis was established at Civil hospital Aizawl and Civil Hospital Lunglei and were equipped with ELISA readers. Several confirmed cases are recorded each year with increased number of cases each year but the cases were found sporadic and dispersed from 2012 to 2015 (**Table 1**). But, during 2016, starting from the month of August there were several dengue outbreaks reported from different areas within Aizawl city. There were 580 confirmed cases, (cases on January and February 2017 were included for comparative purpose and to show outbreaks were subsided in these months (**Table 2**), out of which 384 = 66.20% patients confirmed with NS1 antigen and 196 = 33.80 % confirmed with IgM antibodies which shows the effectiveness of surveillance system and awareness of the disease to the mass (**Figure 2**). There was no predilection in both sexes as the percentages of males (49.48%) and females (50.25%) are almost equal, and all age groups are affected by this disease in the outbreaks (**Table 3**). The oldest patient recorded was 87-year-old male and the youngest patient was 2-year-old female. There was no record of patient less than 1 year. Age group of 21–30 has maximum number of cases, the median age was 30. There were 11 outbreak localities within Aizawl city which contributes 59.66% of dengue cases in altogether from the total cases during the year 2016 (**Table 4**). Serotypes of DENV in this outbreak could not be identified due to various constraints.

Table 1 | Dengue in Aizawl, confirmed cases (2012–2016).

Year	2012	2013	2014	2015	2016	Total	Death
No. of cases	6	7	19	43	580	655	0

Table 2 | Dengue cases confirmed with NS1 and IgM (Jan 2016 – Feb 2017).

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 2017	Feb 2017	Total
Sample tested	0	32	16	22	23	22	35	35	139	215	570	314	72	48	1543
Positive NS1	0	0	0	0	0	0	0	0	19	130	174	61	9	1	394
IgM	0	1	0	0	0	0	0	0	30	20	90	55	5	5	206
Total confirmed cases	0	1	0	0	0	0	0	0	49	150	264	116	14	6	600

Table 3 | Distribution of cases among age groups.

Age groups	Number of cases
0 – 10	36
11 – 20	137
21 – 30	141
31 – 40	102
41 – 50	60
51 – 60	59
61 – 70	31
71 & above	14
Total	580

Median age = 30; mode = 22; females = 293 (50.52%); males = 287 (49.48%); oldest = 87 yrs M; youngest = 2 yrs F.

Table 4 | Dengue case distribution at outbreak localities in Aizawl.

Sl.no	Localities	No. of cases
1	Chhinga Veng	49
2	Tuikual North	43
3	Ramhlun sport complex	41
4	Electric Veng	37
5	Ramthar Veng	32
6	Bethlehem Vengthlang	30
7	Zemabawk	29
8	Arm Veng	28
9	Dinthar Veng	24
10	Saron Veng	17
11	Chanmari	16
	Total	346

Entomological observations

All *Aedes* mosquito collected, adults and larvae are identified as *Aedes* (*Stegomyia*) *aegypti* (Linnaeus) species and no *Aedes albopictus* species were collected in the surveys although *Ae. albopictus* are found in abundant in rural and forested areas in Mizoram. The vector indices for both adult and larvae are given in the Table 5. Breeding sites of *Ae. aegypti* includes discarded tyres, flower pots, barrels, tanks, drums, plastic bags, small pots, tins, cans, buckets etc. The average per man hour density was 10.2, PMHD more than 2 is a high risk for an outbreak. Average house index was 48.4% and container index was 43.1%, where HI and CI more than 10% is a high risk. The average breteau index and pupae index were 124.4 and 115 respectively, BI and PI more than 50 is alarming. Maximum number of cases and vector mosquitoes are found in low-lying areas which are congested and lying adjacent to water courses and streams.

Discussion

In the northeast region of India, serological survey conducted during 1963 revealed the prevalence of dengue in the Lohit district of AP and Darrang district of Assam.[22,23] Another report of dengue (DENV) in Assam and Nagaland appeared during the nineties.[23,24,25] During 2009-2011, a study by Dutta and Mahanta[23] reported 143 laboratory-confirmed cases belonging to Assam, Nagaland, Manipur and Arunachal Pradesh. There was reports of dengue disease outbreaks from Moreh town, Chandel district of Manipur during 2007-2008,[25] and from Pasighat, East Siang district of Arunachal Pradesh during July-August 2012.[26] In this study, outbreaks in Aizawl were reported from August to December, this could be due to prolonged monsoon rain. Usually dengue outbreaks are started in urban areas and gradually invaded rural areas.[18,19] This epidemiological pattern was also observed in Mizoram; the first outbreaks were restricted within Aizawl city from August to December 2016 but, in the latter part of December 2016, there was a report of dengue outbreak at Kolasib town under Kolasib district which is 87 kms away from Aizawl, 38 confirmed cases were recorded.

In majority of dengue outbreak studies in the past, males outnumbered females in DENV positivity and occurrence of more cases of DENV in adults than in children is observed.[27] However, in an outbreak investigation in Narsinghpur, it was noted that both sexes were equally affected.[28] The present study also found that there

Table 5 | Vector indices for adults and larvae in outbreak localities.

Sl. No	Localities	Houses and containers searched in outbreak localities				
		PMHD	HI	CI	BI	PI
1	Chhinga Veng	18	43.1	36.2	186	177.2
2	Tuikual North	18.5	48.1	54.9	241.1	83.3
3	Ramhlun sport complex	10	46.8	40.8	125	156.2
4	Electric Veng	8	34.7	29.1	91.3	130.4
5	Ramthar Veng	14	36	38.8	70	108
6	Bethlehem Vengthlang	8.4	73.8	45.8	84.6	110.7
7	Zemabawk	4.5	67.5	54.9	153.7	103.7
8	Armed Veng	6.6	41.7	50.3	114.7	83.4
9	Dinthar Veng	8.5	48.4	43.8	130.3	109.1
10	Saron Veng	10.2	50	49.5	96.2	116.6
11	Chanmari	6	43.3	30.6	76.6	86.6

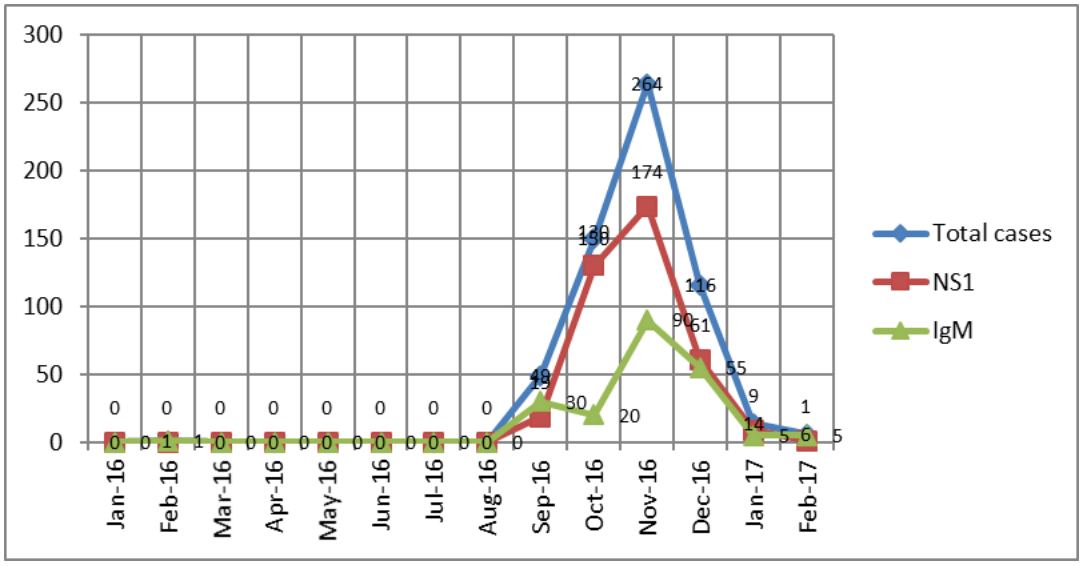

Figure 2 | Graph to represent dengue positive cases with NS1 and IgM.

is no predilection of sexes (female to male ratio of 1:0.97) and younger age groups are more affected than older age groups with the median age of 30.

Studies have demonstrated that elevated adult and larval indices contributes the upsurge of cases.[18,28,29] All the indices for both adult and larva during the entomological studies conducted revealed high density of vector mosquito in the study areas which is the indication to show the necessity of continuous operation of vector control measures such as, chemical control, biological control and source reduction to minimise the breeding habitat of the vector.

The potential vector species identified in this study, *Ae. Aegypti* is the most common vector of DENV in India followed by *Ae. albopictus*. Larval indices indicates that *Ae. aegypti* is well established in urban and peri-urban areas and is beginning to displace *Ae. albopictus* as almost all

the water-holding containers facilitates the breeding of *Ae. aegypti*.[30] Urbanization, transport developments, constructions and alteration of environment etc. immensely enhance chances of dengue outbreaks.[31]

In the absence of efficient vaccine for dengue, certain measures like personal protection, vector control and public awareness to the disease and vector's bionomics with timely and accurate laboratory diagnosis are the only way to combat dengue outbreaks. As dengue is included among the notifiable diseases in India,[32] government authorities should strengthen manpowers, case management and laboratory support, and regularly organizing interactive coordination meetings at all levels to sensitize public through Information, Education and Communication (IEC) and awareness programmes as well as source reduction of *Aedes* mosquito breeding.

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