



Research Article

Post Flood Study on the Incidence of Leptospirosis in Alappuzha District of Kerala, India

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A B S T R A C T

Alappuzha district was severely affected by floods due to the intense rainfall in August 2018. A three member team with the assistance of local health workers was entrusted to assess the post flood situation and to assist the local health department to extend expertise mainly to control infectious diseases and propose suggestions regarding hygiene and sanitary measures to be taken for health and wellbeing of the community. Among the infectious diseases, Leptospirosis poses a significant public health issue in the flood affected areas of Alappuzha district. Majority of households had taken chemoprophylaxis for Leptospirosis as per standard protocol as also temporary rehabilitation camps in the flood affected areas. There was no episode of Acute Diarrheal Diseases (ADD), found in clusters in any of the areas. The number of dengue fever cases reported in post flood period was less when compared to previous year. Risk assessment is essential in post-disaster situations mainly concerned with the rapid implementation of control measures through refurbishment and improvement of health care delivery. The findings presented relate to an assessment carried out in Alappuzha district in September 2018 that included epidemiological situation analysis, appraisal of laboratory facilities for microbiology investigations, evaluation of health facilities and infrastructure available at Local Self Governments (LSGs).

Keywords: Epidemiological Situation Analysis, Leptospirosis, Disease Surveillance

Introduction

Natural disasters are complex calamitous events with atmospheric, geologic and hydrologic origins. They include

earthquakes, volcanic eruptions, landslides, tsunamis, tropical cyclones, drought and floods. Natural disasters can have abrupt or slow onset and lead to serious social, economic and public health consequences.¹ Natural disasters

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displace populations, damage the existing infrastructure, and prevent developmental activities and economic growth. In addition to this, natural disasters increase the risk of infectious disease outbreaks. Over the past two decades, the incidence and immensity of natural disasters have grown in great proportion, resulting in substantial environmental damage, loss of life and economy, all affecting millions of people all over the world.

Flood disasters are the most common which account about 40% of natural disasters worldwide.² The Public health consequences of flooding are disease outbreaks mostly resulting from the movement of people into overcrowded camps or shelters and cross - contamination of drinking water sources with fecal materials and toxic chemicals. Floods can potentially increase the transmission of water-borne diseases such as typhoid fever, cholera, hepatitis A, acute diarrheal diseases (ADD), etc. and vector-borne diseases such as malaria, dengue, West Nile and zoonotic diseases such as Leptospirosis.^{3,4}

Rodent-borne diseases are often susceptible to climatic changes and may increase after heavy rainfall and floods because of diversified patterns of human-pathogen-environment and animal interactions.⁵ Leptospirosis is a widespread and potentially fatal zoonosis caused by pathogenic spirochete of the genus leptospira. The disease is endemic in many tropical regions and causes extensive outbreaks after heavy rainfall and flooding. Infection results from direct or indirect exposure to infected reservoir of host animals that carry the pathogen in their renal tubules and shed pathogenic leptospires through their urine.⁶

The rapid ecological changes occurred in the vast coastal region of our country, especially in the agro-ecosystem, resulted in the emergence of new zoonotic diseases leading to significant morbidity and mortality in humans. The outbreaks of Leptospirosis have been reported from coastal districts of Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Orissa and Andaman & Nicobar, Dadar & Nagar Haveli, Daman & Diu, Puducherry and also from Goa.^{7,8}

Kerala experienced an abnormally high rainfall from 1 June to 19th August 2018. This resulted in intense flooding in 13 out of 14 districts in the state including Alappuzha that was worst hit being comprised of back waters and estuaries. During this period, the state received 2346.6 mm rainfall and this was 42% above the normal.⁹ The peak spell of rains that led to severe flood in Kerala began on 8th August 2018 and continued up to 17th August 2018. Floods facilitate the proliferation of rodents and the spread of leptospirosis in the affected area. Lack of garbage management and accumulation following flooding where debris is left on the road sides and water holes contributes to an ideal situation for increased rodent population.¹⁰ The rats infesting sewage

networks and broken drainages, overflowing sewage during rains, flooding of roads and exposure of people to flooded roads and streets create conducive situation for infection and spread of leptospirosis.

Disease surveillance and early warning systems, together with effective prevention and response capabilities, can reduce the morbidity and mortality due to infectious diseases. Risk assessment is essential in post-disaster situations for quick and effective implementation of control measures including re-establishment and improvement of primary health care delivery. In order to assess the extent and magnitude of post flood public health challenges, a study was conducted in Alappuzha district to investigate the epidemiological situation that included assessment of infectious disease incidence and evaluation of public health intervention measures and activities undertaken in the affected area to minimize risk from diseases in post flood period.

Materials and Methods

Study Area

Flood can potentially increase the spread of water-borne diseases such as cholera, hepatitis A, acute diarrheal diseases; vector-borne diseases such as malaria, dengue, West Nile fever and zoonotic diseases such as leptospirosis. An extensive epidemiological study was done through house to house visit in selected rural and urban areas of Alappuzha district during the post flood period from 1st to 30th September 2018. The study was carried out in 21 rural Panchayaths spread over nine Community Development (CD) Blocks and two urban (Municipality) areas (Map 1).



Map 1. Study Areas (.) in Alappuzha District

Study Design

A team consisting of Public Health Specialist, Microbiologist and Entomologist deputed by Ministry of Health and Family Welfare, Government of India initiated the investigation from 1st to 15th September 2018. Another team consisting of same category continued the work up to 30th September 2018. The Entomologist who is working in NCDC, Kerala branch was entrusted to work with both the teams. Before the initiation of the study, the team members were briefed about a detailed plan of action at the Directorate of Health Services (DHS), Thiruvananthapuram, Kerala state. Both the teams worked in close liaison with the District Medical Officer (Health) and District Surveillance Officer (DSO) of Alappuzha district.

The district revenue authorities in association with the DMO (H) Alappuzha prepared a list showing low, moderate and high risk areas based on the intensity and magnitude of the disaster and the possible intervention activities to be implemented in flood affected areas on a priority basis. The study team randomly selected the areas for surveillance. Out of the total households available at Panchayaths/ Municipality level, 1207 households were selected by using simple random sampling and data were collected on water-borne, vector-borne and zoonotic diseases such as leptospirosis cases and deaths, household consumption of chemoprophylaxis drugs for leptospirosis, and also about laboratory facilities available at different levels of hospitals for confirmation of infectious diseases.

Data was collected by using standard protocol. Registers and records available at PHCs/CHCs/General and Taluk hospitals were reviewed. IDSP data for the current and previous years were reviewed. To evaluate the periodic difference of leptospirosis cases, we have categorized the disease data into three categories i.e. pre flood period (January-July 2018), flood period (August 2018) and post flood period (September-December 2018) and analyzed the data accordingly. The age and sex wise prevalence of leptospirosis cases reported in Alappuzha were also statistically analyzed. An attempt was also made to compare area-wise leptospirosis cases and deaths in pre, during and post flood periods.

Results

During the study period, a total of 133 confirmed leptospirosis cases and 2 deaths were reported in Alappuzha district. Out of 133 cases of leptospirosis, 79 (59.4%) were males and 54 (40.6%) were females. Maximum number of cases was in the age group of 41-50 years (24.81%) followed by 51-60 years (24.06%), 31-40 years (14.28%), 21-30 years (12.03%), 11-20 years (9.77%), 61-70 years (9.77%), > 70 (3.0%) and 1-10 (2.26%). Among the leptospirosis infected individuals, minimum age was 7 (male) and maximum age was 75 (female).

Kerala state receives rainfall from the South West and North East monsoons during the months from June to September and October to November respectively. Alappuzha district experienced two distinct phases in 2018 South West monsoon. The first phase began from 15 July 2018 and lasted for three weeks. The second phase started from 15 August 2018 and continued up to 22 August 2018. The second phase was more intense especially on 16th and 17th of August 2018 and flood outburst led to inundation of hitherto non-flood areas in the low lying parts of the district. The district witnessed a rainfall departure of 29% excess during the 2018 monsoon.

A research unit of NCDC is functioning in Cherthala, Alappuzha district. The present study was carried out during the period from 1st to 30th September 2018. A team from NCDC, Cherthala rushed to the office of the DMO (H) Alappuzha on 21 August 2018 and actively associated with them in the health care management of the relief camps, facilitated co-ordination with district, state and national agencies, and involved in the cleaning drive and public health awareness activities in the flood affected areas.

Out of the total of 141 leptospirosis cases reported from 21st August to 30th September 2018, 3 (2.1%) were reported in 1st week, 5 (3.5%) were reported in 2nd week, 25 (17.7%) were reported in 3rd week, 82 (58.2%) were reported in 4th week, 18 (12.7%) and 8 (5.7%) were reported in 5th and 6th weeks respectively after the flood. Immediately after the flood, the number of leptospirosis cases was comparatively low in first, second and third week and maximum number of cases were reported in fourth week after the flood. The number of leptospirosis cases was shown a declining trend after fourth week (Figure 1).

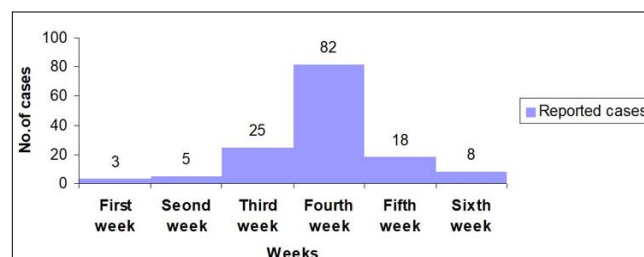


Figure 1. Leptospirosis Cases Reported Week Wise (21st August – 30th September 2018)

Out of 254 laboratory confirmed leptospirosis cases reported in Alappuzha district in 2018, 38 (14.96%) were reported during pre flood period, 16 (6.3%) were reported during intense flood month (August 2018) and the number of reported leptospirosis cases in post flood period rose to 200 (78.74%). A total of 133 leptospirosis cases (66.5%) and 2 deaths were reported during the present investigation period (September 2018). Subsequently, there was a declining trend of disease cases in the remaining months (Figure 2).

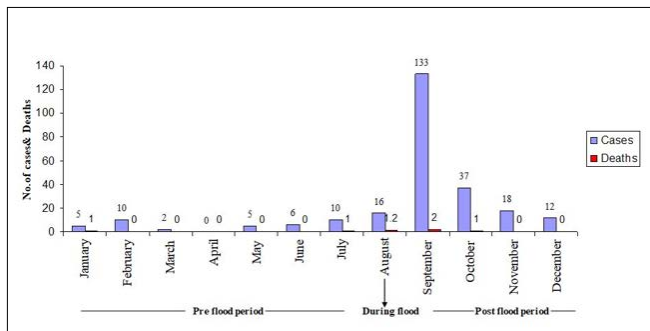


Figure 2. Number of Leptospirosis Cases and Deaths Reported in Alappuzha in 2018

An analysis of the leptospirosis cases reported in Alappuzha district in 2018 showed that among the 72 Gram Panchayaths, Kainakary Panchayath (Champakkulam CD Block) had more number (37%) of Leptospirosis cases. Epidemiological analysis also showed that among the 12 CD Blocks, Champakkulam CD Block had more number of leptospirosis cases and that too in six Panchayaths under this Block, especially during post flood period. Among the 5 Municipalities, more number (20.87%) of leptospirosis cases was reported from Alappuzha Municipality.

Of the total 254 leptospirosis cases reported in Alappuzha district in 2018, 151 (59.4%) were males and 103 (40.6%) were females. The analysis also showed that of the total 151 leptospirosis infected males, 121 (80.1%) was reported during post flood months. Similarly, of the total 103 leptospirosis infected females, 79 (76.7%) were reported during the same period. The lowest number of leptospirosis cases was reported during the flood month (August 2018). The worst affected age group was 41-50 (22.83%) followed by 51-60 (20.08%), 31-40 (14.96%), 61-70 (13.39%), and 11-20 (10.63%) (Table 1).

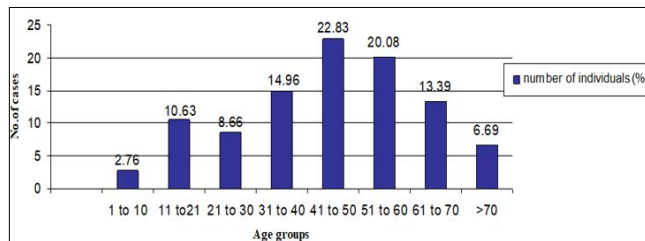


Figure 3. Leptospirosis Cases Reported in Alappuzha District in Different Age Groups in 2018

In order to find out any upsurge in infectious diseases, especially leptospirosis cases and deaths following flood, a comparative analysis was done using the IDSP reports of Alappuzha district pertaining to the preceding (2017) and succeeding (2019) years. In 2018 (flood year) 254 leptospirosis cases and 6 deaths (CFR - 2.36%) were reported. However, in 2017, only 204 leptospirosis cases and 2 deaths (CFR - 0.98%) were reported. Similarly, in 2019 the number of disease cases came down to 188 with 4 cases of deaths (CFR - 2.1%). The analysis of leptospirosis cases reported in Kerala state during the same period showed a similar disease pattern (Figure 4).

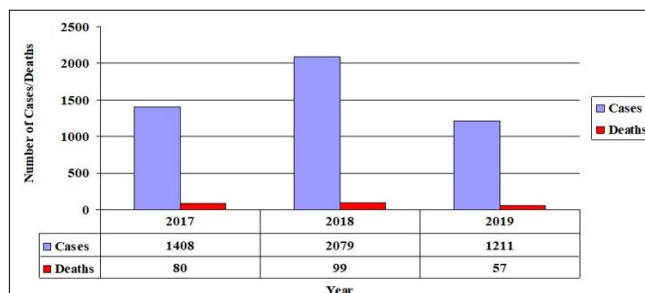


Figure 4. Leptospirosis Cases and Deaths Reported in Kerala State

Table I. Age and Sex Wise Leptospirosis Cases Reported in Alappuzha District in 2018

Age groups	Male				Female				Total members (%)
	Pre flood months	During flood	Post flood months	Total male	Pre flood months	During flood	Post flood months	Total female	
1-10	1	1	3	5	1	0	1	2	7 (2.76)
11-20	2	0	13	15	2	0	10	12	27 (10.63)
21-30	2	1	17	20	0	1	1	2	22 (8.66)
31-40	2	4	16	22	4	1	11	16	38 (14.96)
41-50	1	1	27	29	7	0	22	29	58 (22.83)
51-60	4	1	25	30	2	0	19	21	51 (20.08)
61-70	5	3	13	21	2	1	10	13	34 (13.39)
>70	1	1	7	9	2	1	5	8	17 (6.69)
Total	18	12	121	151	20	04	79	103	254

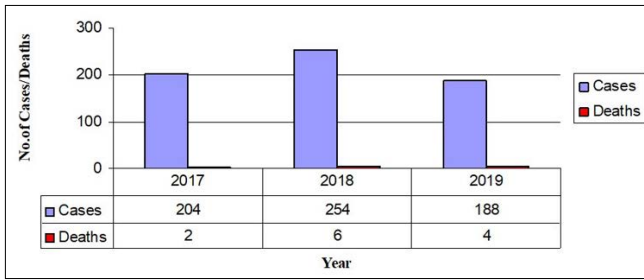


Figure 5. Leptospirosis Cases and Deaths Reported in Alappuzha District

The 2018 flood affected 13 out of 14 (92.9%) districts of Kerala. In 2018, a total of 2079 leptospirosis cases and 99 deaths (CFR - 4.76%) were reported in Kerala. The epidemiological study indicated that 1312 cases (63.1%) were reported during post monsoon period. Another significant finding is that about 65% of leptospirosis cases were reported in the month of September 2018 (Figure 6.) A very similar disease pattern was observed in the analysis of leptospirosis cases reported in Alappuzha district in the same year (Figure 2).

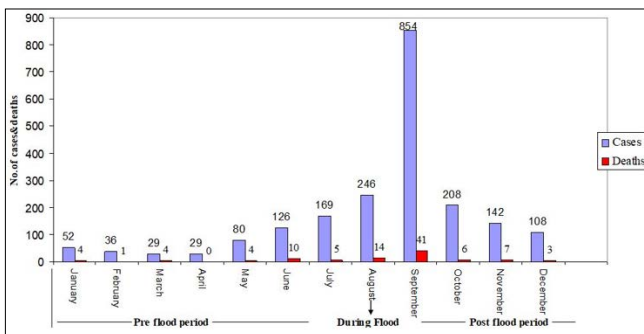


Figure 6. Leptospirosis Cases and Deaths Reported in Kerala State in 2018

During house to house survey, a total of 1207 households and 4,767 household members were surveyed. Out of the 1207 households surveyed, 825 (68.35%) had public water supply, 145 (12.01%) had wells, 98 (8.12%) had bore wells, 100 (8.29%) depended on mobile tanker water supply, 30 (2.49%) used RO water, 5 (0.41%) used river water and remaining 4 (0.33%) used rain harvested water.

Out of 1207 houses visited, more than 70% of houses received one dose of chemoprophylaxis for leptospirosis. Out of the total houses visited more than 90% of the households in eight Panchayaths (Palakkad, Champakkulam,

Table 2. Household Consumption of chemoprophylaxis Drugs for Leptospirosis in Flood Affected Areas in Alappuzha District

Number of Panchayaths/ Municipalities visited	Number of drug received houses	Number of inhabitants (n= 4,767)					Drugs taken
		2 years & above	Drugs taken	Below 2 years	Drugs taken	Pregnant/ lactating women	
23	868	4,589	2,845 (62.0%)	110	03 (2.73%)	68	06 (8.82%)

Kumarapuram, Kavalam, Kainakary, Mararikkulam South, Edatua and Veeyapuram) received chemoprophylaxis for leptospirosis. However none of the households in Alappuzha Municipality received the drug (Figure 7).

The household drug consumption analysis indicated that of the total 4,767 inhabitants, (1) 4,589 (96.27%) were 2 years and above of age, (2) 110 (2.31%) were below 2 years of age and (3) 68 (1.42%) were pregnant/ lactating women. The drug consumption of 1st, 2nd and 3rd category of inhabitants was 62.0%, 2.73% and 8.82% respectively (Table 2/ Figure 7).

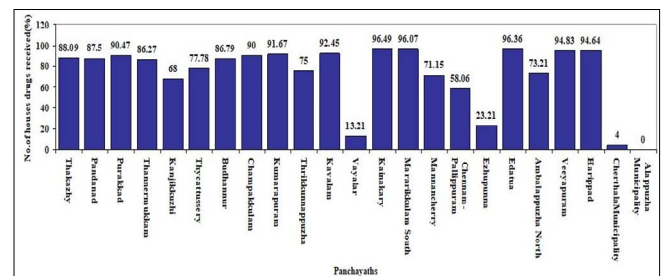


Figure 7. Area-wise Chemoprophylaxis Drugs for Leptospirosis Provided in Flood Affected Households

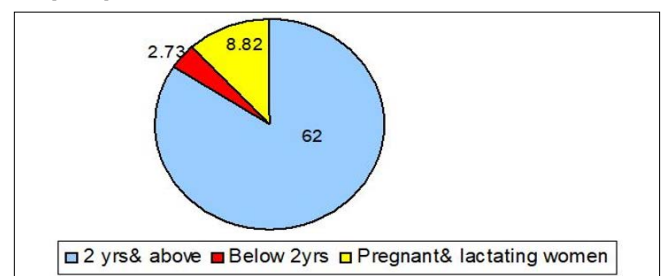


Figure 8. Household Consumption (%) of Chemoprophylaxis Drugs Leptospirosis in Flood Affected Areas in Alappuzha District

The outbreak of infectious diseases following natural disasters needs to be monitored regularly. Laboratory facilities and trained manpower are essential components in the diagnosis/confirmation of the diseases. The team members assessed the existing facilities available in each health care centers (PHCs/CHCs/Taluk and General hospitals, Central and state Research Institutions, etc.) and the salient observations are given in Table 3. The facilities available in various health centers were more or less found to be sufficient to support laboratory diagnosis/confirmation of diseases in the post flood period.

Table 3. Observation on Laboratory Facilities Available in PHCs/CHCs/Taluk Hospitals/ General Hospitals and Research Laboratories for Confirmation of Infectious Diseases

Health institutions visited (Number)	Laboratory facilities for microbiology investigations
PHCs (13)	<ul style="list-style-type: none"> Majority of PHCs (61.5%) were referring patients for microbiology testing to nearby Taluk HQ hospital (THQH), as they do not have laboratory facility Some PHCs (15.4%) had basic laboratory facility for hematology and biochemistry tests A few PHCs (23.1%) were performing card tests for dengue and leptospirosis and referring samples for confirmation to higher centers
CHCs (6)	<ul style="list-style-type: none"> Majority of CHCs (40%) were not performing microbiology investigations One CHC laboratory had been damaged following explosion of Oxygen cylinder The remaining CHCs (60%) were performing card tests for dengue and leptospirosis and referring samples for confirmation to higher center (District Public health laboratory (DPHL); ICMR-NIV, Field unit, Alappuzha)
Taluk Hospitals (4)	<ul style="list-style-type: none"> Cherthala THQH has a well-equipped laboratory providing ELISA tests for confirmation of dengue, leptospirosis and several other infections The other THQH visited are only performing card tests
General Hospital, Alappuzha (1)	<ul style="list-style-type: none"> The GH has a hospital diagnostic laboratory supported by Virus Research Center (VRC), Manipal, Tests carried out are Truenat Influenza A/B, Truenat Leptospira and dengue ICT based assay (NS1 & IgM) The samples for confirmation are being sent to VRC, Manipal
ICMR-NIV, Field unit, Alappuzha (1)	<ul style="list-style-type: none"> The laboratory receives samples referred from several districts of Kerala Diagnostic facility for dengue, Chikunguniya, influenza and other common viral infections are well established Facility for testing leptospirosis (IgM and PCR) was scaled up in response to flood situation The laboratory is well equipped with all equipments in good working condition and supply of stock is adequate

Discussion

Prior to independence, the impending role of irrigation in agricultural development was not well conceded in Kerala. Thus, the state does not have a very long history of advancement in organized irrigation systems. Post-independence period perceived incredible changes in respect of policies towards irrigation development in the state. Most of the rain water sustained during monsoon flows into sea within 48 hours. The period from December to May is almost dry and consequently the farmers could not depend on rain water alone for agriculture. Irrigation became a felt need for successful agricultural production in Kerala. Consequently, cultivation using irrigated water during summer months started in mid 1980s. Until then Leptospirosis, commonly known as ‘rat fever’, was not a public health concern in Kerala. Clinical cases of Leptospirosis started reporting in Kerala from late 1980s and have been steadily increasing over the past few decades.^{11,12}

The study on the Leptospirosis cases in Alappuzha district in the 2018 post flood period showed that, of the total 254 cases, 94 (37%) were reported from Kuttanad region

(Champakkulam, Harippad and Veliyanad Blocks) followed by 53 cases (20.87%) in Alappuzha Municipal area. Kuttanad area is of the lowest altitude in India, and is one of the few places in the world where agricultural farming is carried out in 4-10 feet below the mean sea level. This is a backwater area formed by the confluence of four major rivers- Pampa, Meenachil, Achankovil and Manimala - before their final emptying into the Arabian Sea. This area has a unique geography formed of a vast network of backwaters, the large Vembanad Lake and many lagoons crisscrossing the land.

Leptospirosis cases were reported in all age groups in both sexes. However a greater number of cases were in the age group of 41-50 years. The disease incidence was found more in males than females primarily because of greater occupational exposure of the former to infected animals and contaminated environment.^{13,14} The eco-environmental factors and agricultural practices prevailing in Alappuzha district are favorable for frequent outbreaks of Leptospirosis. The plunge of water from the backwater bodies in to agricultural fields has been stalled by the construction of Thannermukkam bund and the Thottappally spill way. However, an undesirable consequence was that

these man made barriers stopped the drainage of rain water in its natural ways and thus promoted long duration water logging in the low land areas. The water logging in paddy and pineapple fields forces the rodent population to abandon their burrows and migrate to nearby wet areas and contaminate with their urine and excreta that is further spread through rain water.

The flooding may initially wash out the pathogens along with other contaminants. Hence in the intense phase of the flood, the chance of getting leptospira infection may be less, but often resurfaces when the water is receded. Receding flood water can provide ideal habitats for furthering of spirochete. Most of the areas of Alappuzha district are suffering from water logging problem, and also of salt water tide from the sea. The salinity of the soil further enables thriving of leptospires. Those who work in this water logged, contaminated fields are at the risk of getting infection. Maximum number of Leptospirosis cases reported in the 4th week after the flood substantiates the aforesaid inference. After the fourth week, the number of cases declined progressively.

Number of Leptospirosis cases reported in Alappuzha district in 2018 was higher than that reported in 2017 and 2019. The disease trend was the same in Kerala state as a whole. Floods and heavy rainfall have been correlated with outbreaks of Leptospirosis during 2001-2006 in India.^{15,16} Thrive of rodent-borne pathogens could be related to ecologically anew situations arising out of flood such as increased availability of food that has an effect on the size of rodent population. Improper garbage management results in accumulation of garbage including food wastes on road sides, back yards and abandoned lands in the usually highly populated human habitations in the mentioned area. This will eventually result in an unusual increase of the rodent vector population.

In a natural situation, a biological equilibrium exists between rodent species, leptospiral serovars and their survival. Ecological disturbances such as floods, cyclone and human interventions consequently set in an imbalance between pathogens, host and the environment. In order to sustain the natural balancing in control of Leptospirosis, it is essential that all preparedness and measures have to be taken to do away with any situations that are conducive to the hike of rodent vector population as also the pathogen.

The investigation team visited 25 health institutions which includes PHCs, CHCs, Taluk and General hospitals, national level research and testing laboratories and evaluated the laboratory facilities attached to each center as to their capability to conduct speedy diagnosis and confirmation. Another focus of observation was about the hygiene and sanitation situation of the health care centers as well as cleanliness of their health care facilities; some of which were

found to be at par with the 'Kayakalp' program evaluation norm.

During the household survey it was acknowledged that health workers had already visited almost all the houses in the flood affected areas. More than 70% of the households had received chemoprophylaxis against Leptospirosis and majority of the inhabitants had taken the drug. There was no episode of ADD cases found in clusters in any of the areas thanks to the habit of consumption of boiled water with or without herbal medication.

A major contributory factor for the prevention and timely control of infectious diseases following the flood may be attributed to the stringent measures taken by the Local Self Governments (LSGs) and local health centers adhering to the advices of the central and the state health teams.¹⁷ Increased awareness of the community, intensified surveillance, prompt diagnosis and treatment were the important strategies adopted to prevent the outbreak of leptospirosis.¹⁸ Individual and community awareness of a comprehensive level and participatory involvement of all the stakeholders are crucial for prevention and control of infectious diseases following flood and such natural calamities. National surveillance systems and the establishment of regular practices of protocol for health information management have to be ensured to attain the finest results.

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Conflicting Interest: None

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