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Research Article

Re-Emergence of Scrub Typhus as a Public Health Problem in India: Its Spatial and Temporal Distribution Based on Analysis of 15-Year Data of the National Integrated Disease Surveillance Programme

Rina Tilak[1], Vivek Anand[2], Mohan D Gupte[3], Ravi Devarakonda[4], Rajpal S. Yadav[5]

[1]PhD, Armed Forces Medical College, Pune, India (retired).
[2]MD, Armed Forces Medical Services, Guwahati, India.
[3]MD, National Institute of Epidemiology, Chennai, India (retired).
[4]MD, Armed Forces Medical Services, Chennai, India.
[5]PhD, Academy of Public Health Entomology, Udaipur, India.
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I N F O

Corresponding Author:
Rina Tilak, Armed Forces Medical College, Pune, India (retired)
E-mail Id:
rinatilak@hotmail.com
Orcid Id:
https://orcid.org/0000-0003-3781-0210
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A B S T R A C T

Introduction: The Integrated Disease Surveillance Programme (IDSP) in India monitors trends in epidemic-prone diseases for an early response to outbreaks. Being the only authentic programmatic source of national scrub typhus data, we analysed the burden of this disease and assessed the sufficiency of the IDSP system to control the disease.

Method: In this descriptive study, we analysed all 7564 IDSP weekly reports since its inception in 2009 until 2023, and assessed disease burden, mortality, clinical features, diagnostic modalities, treatment protocols, and prevention and control measures undertaken.

Results: Among the 756 IDSP weekly outbreak reports, 127 scrub typhus outbreaks were reported with 3751 cases and 93 deaths (case fatality rate: 2.48%). Thirty-two reports were excluded from the analysis that listed scrub typhus under outbreaks of other diseases or as co-illnesses with unclear diagnoses. The highest number of outbreaks, cases, and deaths were reported in the north-eastern zone of India, but most deaths were in Rajasthan state in the western zone. The outbreaks occurred year-round but mostly in the wet season from July to September.

Conclusions: The IDSP data represents only a partial picture of the true burden of scrub typhus in India. It reported limited or no information on vectors, antigenic strains of *Orientia tsutsugamushi*, risk factors, clinical presentations, diagnostic tests, treatment, and preventive and control measures undertaken by health services. This warrants improving the performance and functionality of the system.

Keywords: Descriptive Study, India, Integrated Disease Surveillance Programme, Outbreak, Rickettsial Diseases, Scrub Typhus

Introduction

Scrub typhus is a zoonotic disease caused by an obligate intracellular bacterium, *Orientia tsutsugamushi*, which is transmitted through the bites of chigger larvae of the mite *Leptotrombidium* species.[1] Scrub typhus poses a risk to one billion people worldwide, and with poor or non-existent surveillance systems in a majority of the endemic countries, it is challenging to contain its further expansion.[2–4] It mostly occurs in the "tsutsugamushi triangle", a nearly 13 million km^2 area in the Asia-Pacific region. In India, the disease has been reported in the whole of the Shivalik hill ranges from Kashmir to Assam state, the Eastern and Western Ghats, and the Vindhyachal and Satpura ranges.[5] The most common clinical manifestation of scrub typhus is fever with chills, headache, and myalgia. The eschar rashes, although rare, may appear around day 5 after the onset of fever. There are also reports of unusual clinical presentations of the disease causing a very high case fatality rate.[6]

A global increase in the number of patients with Rickettsial infections and scrub typhus has been speculated to be the fallout of the likely emergence of drug-resistant *O. tsutsugamushi*, which needs further validation.[7] In the scrub typhus endemic regions, scrub typhus is ranked as one of the most under-diagnosed and under-reported febrile illnesses requiring hospitalisation in severe cases resulting in up to 70% case fatality rate.[8,9] While several accurate methods are available to diagnose the disease, the lack of a vaccine is a major limitation to contain its spread.[6]

In India, an Integrated Disease Surveillance Programme (IDSP) was established for the surveillance of notifiable diseases and their outbreaks by the National Centre for Disease Control in November 2004. The IDSP started reporting online data on scrub typhus in its Weekly Outbreak Reports in the calendar Week 25 of 2009.[10] Scrub typhus is a notifiable disease in India; therefore, medical practitioners and public and private health facilities are required to report cases and deaths to the public health authorities. The IDSP is the only programmatic source of scrub typhus data in India.

While earlier isolated studies reported incidences of scrub typhus, none of them analysed its geographical distribution and trends using the IDSP data. Therefore, in this paper, we present a descriptive analysis and mapping of the scrub typhus cases and deaths in India in the period 2009–2023 and the adequacy of the IDSP surveillance data to inform measures for the prevention and control of the disease.

Methodology

A descriptive analysis was performed of the scrub typhus data published online by the IDSP in 15 years (calendar week 25, 2009–2023). In all, 756 weekly IDSP outbreak reports with scrub typhus cases were analysed. Thirty-two weekly reports were excluded from the analysis that had scrub typhus cases listed under outbreaks of other diseases or reported with other co-illnesses making the diagnosis unclear.

The main parameters of analysis were the number of scrub typhus outbreaks, cases and deaths reported, the clinico-epidemiological profile of scrub typhus patients, diagnostic tests done, treatment given, geographical and temporal (seasonal) distributions of the disease, and preventive and control actions undertaken by the public health authorities.

Results

In the 15-year period, IDSP reported 127 outbreaks of scrub typhus in India, with just one outbreak each in 2009 and 2010, and the highest number of 27 outbreaks in 2023. In all, 3751 cases and 93 deaths with a confirmatory diagnosis of scrub typhus were included in the study.

The geographic location, number of scrub typhus cases and deaths, their signs and symptoms, diagnostic tests done, treatment given, and preventive and control actions undertaken are summarised in Table 1. The Weil–Felix and/ or IgM Elisa diagnostic tests were used on different occasions to confirm the infections. Certain reports were found incomplete due to the absence of information on the main disease symptoms, type of treatment provided, number of cases and deaths or lack of confirmatory diagnostic tests for scrub typhus e.g., for cases presenting with other illnesses such as acute febrile illness (Rajasthan state, week 37 data; 2011), leptospirosis (Tamil Nadu state, week 6; 2018), dengue (Tamil Nadu state, week 24; 2019), and hepatitis (Punjab state, week 37; 2019). The weekly outbreak reports with scrub typhus cases mentioned under outbreak of other illnesses or reported with co-infections of other pathogens, are summarised in Table 2 and were excluded from the final analysis.

Spatial Distribution of Cases by Geographic Regions and States

The main geographic regions in India and the number of outbreaks of scrub typhus in different geographical regions in 2009–2023 are summarised in Table 3 and shown in Figure 1. The highest number of outbreaks of scrub typhus were reported in the north-eastern region (62) followed by the Western region (17), central region (16), southern and northern regions (13 each), and eastern region (6).

The relative proportion of scrub typhus cases, deaths, and case fatality rates in different geographical regions of India in 2009–2023 are given in Table 4. The north-eastern region reported the highest number of cases and deaths followed by the northern and other regions, although the highest case fatality rate of 6.4% was reported in the western region.

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The distribution of the cases and deaths by state over the 15-year period is shown in Figure 2. The eight states of Mizoram, Arunachal Pradesh, Rajasthan, Nagaland, Meghalaya, reported most of the 3751 cases (> 100 cases each), followed by the other 17 states (2–95 cases each).

Table 1.Cases and Deaths Attributable to Scrub Typhus in India from 2009–2023 based on the Weekly Reports by the Integrated Disease Surveillance Programme

Year	State	Area or District	No. of Cases	No. of Deaths	Diagnostic Test Done	Symptoms	Treatment Given	Preventive and Follow-Up Action Taken
2009	Meghalaya	Shillong, East and West Khasi and Jaintia Hills	16	0	Weil–Felix	NA	Symptomatic	IEC
2010	Assam	Sonitpur	4	1	4 of 12 samples positive	Fever, rash	NA	NA
2011	Karnataka	Bellary	5	0	IgM ELISA (1/3 samples positive)	Fever, rash	NA	IEC, Fever survey
	Himachal Pradesh	Mandi	21	0	NA	Fever, myalgia	Doxycycline	IEC, Active surveillance of new fever cases with eschar
	Nagaland	Peren	9	3	Weil–Felix (3 samples positive)	NA	Tetracycline	IEC
	Nagaland	Kohima and Phek	113	8	Weil–Felix (OXK antigen)	Fever and rash	Tetracycline	IEC and follow-up of fever and rash outbreak in all districts of Nagaland
	Uttarakhand	Haridwar	6	0	2/6 samples positive for *O. tsutsugamushi* IgM antibodies	NA	NA	IEC
2012	Tamil Nadu	Erode	16	1	IgM ELISA (6/16 samples positive)	NA	NA	Destructions of rodent burrows, pyrethrum spray, fogging and source reduction. Active survey.
			22	1	IgM ELISA (4/7 samples positive)	-	-	
	Arunachal Pradesh	East Siang	512	0	40/118 samples positive	NA	NA	Entomological survey

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	West Bengal	Singbuli, Mirik,Darjeeling	35	0	Weil–Felix (29/35 samples positive)	NA	Doxycycline	IEC
		Kurseong Darjeeling	75	2	Weil–Felix (69/75 samples positive)	NA	Doxycycline	IEC
	Rajasthan	Jaipur	89	7	6/16 sample positive	Fever, vomiting, abdominal pain and arthralgia	Doxycycline	Entomological survey, IEC, pyrethrum spray
	Himachal Pradesh	Mandi	52	3	Weil–Felix (10/10 samples positive)	Fever, cough and body ache	NA	IEC
	Uttarakhand	Uttarkashi	63	4	3/7 samples positive	Fever	Symptomatic treatment and doxycycline	IEC done regarding personal protection, anti-rodent measures and sanitation
2013	Karnataka	Gulbarga	8	0	Weil–Felix (4/8 samples positive)	Fever with chills, myalgia, and headache	NA	HEd.
	Rajasthan	Jaipur, Alwar, Dausa, Karauli and other districts	357	8	NA	Fever with chills, myalgia and headache	NA	HEd.
	Arunachal Pradesh	West Kameng	9	0	NA	Fever with chills, myalgia, headache, cough, malaise	Doxycycline	NA
2014	Meghalaya	Jaintia hills	72	0	72/150 samples positive	Fever with chills, myalgia	NA	IEC
	Tamil Nadu	Theni	10	1	6/6 samples positive (3 also for leptospirosis)	NA	NA	Source reduction, fogging, IEC
	Manipur	Ukhrul	20	0	2/5 samples positive	NA	NA	IEC

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	Nagaland	Mon	100	0	100/256 samples positive	NA	NA	HEd.
2015	Assam	Dima Hasao	7	0	IgM ELISA (2 samples positive)	Fever, cough, epistaxis, conjunctival congestion and skin rash	NA	HEd.
	Arunachal Pradesh	Upper Subansiri	4	0	NA	NA	Symptomatic	HEd.
	Tamil Nadu	Kancheepuram	9	0	NA	NA	NA	HEd.
	Maharashtra	Nagpur	4	0	IgM ELISA & Weil–Felix	Fever with uneasiness and breathlessness	NA	HEd.
	Rajasthan	Jaipur	102	4	5/11 samples positive	NA	Symptomatic	HEd.
	Meghalaya	East Jaintia Hills	47	0	Weil–Felix	NA	Symptomatic	HEd.
	Maharashtra	Nagpur	5	1	NA	NA	Doxycycline	Spraying of vegetation with 5% malathion, HEd.
	Assam	Kamrup (M)	3	1	IgM ELISA	NA	Symptomatic	HEd.
2016	Arunachal Pradesh	West Siang	4	0	IgM ELISA	NA	Symptomatic	HEd.
	Gujarat	Gandhinagar	2	2	IgM ELISA	NA	Symptomatic	HEd.
	Rajasthan	Kota	3	1	2/15 samples positive	NA	Symptomatic	HEd.
	Mizoram	Champhai	41	0	41/73 samples positive	NA	Symptomatic	HEd.
2017	Manipur	Kangpokpi	11	0	Rapid diagnostic kit	NA	Symptomatic	HEd.
	Assam	Kamrup Metro	1	0	IgM ELISA	NA	Symptomatic	HEd.

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	Assam	Nagaon	6	0	IgM ELISA (6/70 samples positive)	NA	Symptomatic	HEd.
	Maharashtra	Nagpur	2	1	2/10 samples positive	NA	Symptomatic	HEd.
	Rajasthan	Pratapgarh	17	0	2/7 samples positive	NA	Symptomatic	HEd.
	Assam	Marigaon	2	0	IgM ELISA	NA	Symptomatic	HEd.
	Sikkim	West Sikkim	29	2	29/60 samples positive	NA	Symptomatic	HEd.
	Nagaland	Mon	14	0	3/4 samples positive	NA	Symptomatic	HEd.
	Tripura	Several districts & Dhalai	19	0	NA	NA	Symptomatic	HEd.
2018	Mizoram	Aizawl East	81	1	Rapid diagnostic test	NA	NA	Health awareness campaign
	Mizoram	Lunglei	195	0	SD Bioline Tsutsugamushi rapid diagnostic kit (195/430 samples positive)	NA	NA	Public awareness campaigns
	Puducherry	Puducherry	45	0	6/45 samples positive	NA	Symptomatic	HEd.
	Pondicherry	Pondicherry	37	0	IgM ELISA (11/37 samples positive)	NA	NA	HEd.
	Puducherry	Puducherry	6	0	6/53 samples positive	NA	Symptomatic	HEd.
	Puducherry	Puducherry	6	0	IgM ELISA (6/26 samples positive)	NA	Symptomatic	HEd.
	Manipur	Imphal West	4	0	3/12 samples positive	Fever	Symptomatic	HEd.
	Mizoram	Lunglei	112	1	Weil–Felix	Fever, body ache	Doxycycline	HEd.
	Mizoram	Aizawl East	79	0	79/254 samples positive	NA	Doxycycline	HEd.

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	Maharashtra	Nagpur & several Districts	63	6	NA	NA	NA	HEd.
2019	Mizoram	Aizwal East	25	0	ELISA (25/32 samples positive)	NA	Symptomatic	HEd.
	Mizoram	Serchhip	141	0	IgM ELISA (17/62 samples positive)	NA	Symptomatic	HEd.
	Nagaland	Mon	8	0	Weil–Felix	NA	Symptomatic	HEd.
	Kerala	Wayanad	24	1	IgM ELISA (6/11 samples positive)	NA	Doxycycline Symptomatic	HEd.
	Arunachal Pradesh	West Kameng	3	0	Immuno Chromatographic Assay Rapid Test	Typical Eschar seen	Symptomatic	HEd.
	Assam	Nalbari	4	0	NA	Fever, headache, body ache, gastrointestinal pain and chest pain	Symptomatic	HEd.
	Arunachal Pradesh	East Siang	18	0	NA	NA	NA	HEd.
	Maharashtra	Kolhapur	4	0	Weil–Felix	NA	NA	HEd.; anti-mite dusting
2020	Assam	Nagaon	1	1	NA	Fever, vomiting and pain abdomen	NA	HEd.
	Assam	Sonitpur (Tezpur)	33	6	NA	NA	NA	HEd.
	Maharashtra	Amravati	1	1	IgM ELISA	fever, headache and vomiting	NA	HEd.
	Arunachal Pradesh	Kumey	10	3	IgM ELISA (4/5 NA)	NA	Symptomatic	HEd.
	Maharashtra	Wardha	6	0	NA	NA	Symptomatic	HEd.
	Manipur	West, Churachandpur, Kakching, Senapati & Bishnupur	14	0	6/34 samples positive	NA	Symptomatic	HEd.

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	Mizoram	Lawngtlai	105	2	Weil–Felix	NA	NA	HEd.
	Assam	Sonitpur (Tezpur)	2	0	NA	NA	NA	HEd.
	Assam	Dima Hasao	3	1	IgM ELISA (1/3 samples positive)	NA	NA	HEd.
	Arunachal Pradesh	Kurung Kumey	51	2	IgM rapid diagnostic kit (51/51 samples positive)	Fever and eschar in the deceased	NA	HEd.
	Puducherry	Puducherry	1	0	RT PCR (1/44 samples positive)	Eschar in the right axilla	NA	HEd.
	Arunachal Pradesh	Leparada	2	2	Rapid diagnostic kit	High fever, vomiting and hypotension; high fever, photophobia and seizure	NA	HEd.
	Madhya Pradesh	Jabalpur	7	0	NA	NA	NA	HEd.
	Madhya Pradesh	Katni	2	0	NA	NA	NA	HEd.
	Madhya Pradesh	Umaria	1	1	NA	NA	NA	HEd.
	Nagaland	Longleng	65	1	NA	High fever, headache and myalgia	NA	HEd.
	Meghalaya	East Khasi Hills	19	2	Weil–Felix (8/13 samples positive)	Fever	NA	IEC
	West Bengal	Purba Medinipur	23	0	5/15 samples positive	Fever, body ache, muscle pain and dark scab	NA	-

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2021	Assam	Dibrugarh	3	1	IgM ELISA (3/11 samples positive)	Fever, headache, abdomen pain and jaundice	NA	HEd.
		Dhemaji	1	0	NA	NA	NA	HEd.
		Lakhimpur	1	0	IgM ELISA	Abdominal pain and weakness	NA	HEd.
		Dhemaji	1	0	IgM ELISA	NA	NA	HEd.
		Dhemaji	1	0	IgM ELISA	NA	NA	HEd.
		Darrang, Mangaldoi	1	0	IgM ELISA	NA	NA	HEd.
	Jharkhand	Latehar	8	0	IgM ELISA	Fever	NA	HEd.
	Assam	Lakhimpur	1	0	IgM ELISA	NA	NA	HEd.
	Assam	Nagaon	1	0	IgM ELISA	Fever, headache	NA	HEd.
	Uttar Pradesh	GautamBudha Nagar	3	0	IgM ELISA	NA	NA	HEd.
	Maharashtra	Gadchiroli	18	1	IgM ELISA (7/18 samples positive)	NA	NA	HEd.
	Assam	Darrang, Mangaldoi	1	1	IgM ELISA	NA	NA	HEd.
	Assam	Darrang, Mangaldoi	2	0	ELISA	NA	NA	HEd.
	Odisha	Nabarangpur	7	0	IgM ELISA (7/10 samples positive)	Fever, headache	NA	HEd.
2022	Tamil Nadu	Thanjavur	35	0	IgM ELISA (4/7 samples positive)	Fever, body pain	NA	HEd., Disinfection
	Arunachal Pradesh	Kamle	2	0	Rapid antigen test	High fever of > 5 days with eschar and enlarged lymph node, lethargy, and loss of appetite	NA	NA

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	Madhya Pradesh	Katni	8	0	IgM ELISA (1/8 samples positive)	Fever, joint pain	NA	HEd., rapid fever survey
	Madhya Pradesh	Mandla	6	0	IgM ELISA	Fever and black eschar	Symptomatic	HEd., fever survey, insecticide spray
	Uttar Pradesh	Fatehpur	11	0	NA	Fever and rash	NA	Rodent control measures, and health awareness through audio messages
	Andhra Pradesh	Srikakulum	14	0	IgM ELISA (4/7 samples positive)	Fever and abdominal pain	NA	HEd., door-to-door fever surveillance, prophylactic treatment with doxycycline/ azithromycin
	Maharashtra	Bhandara	8	1	IgM ELISA (1/1 samples positive)	Fever, chest pain, breathlessness and altered sensorium	NA	HEd.
	Chhattisgarh	Balod	2	0	NA	Fever	NA	HEd., door to door survey
2023	Assam	Marigaon	2	0	IgM ELISA	Fever and jaundice	NA	HEd., door to door survey
	Meghalaya	West Khasi Hills	9	0	ELISA (5/9 samples positive)	Fever, headache, joint pain, body ache	NA	HEd., Fever surveys, Mosquito control activities
	Haryana	Karnal	28	0	IgM ELISA (9/58 samples positive)	Fever, lower abdominal pain, breathlessness	NA	HEd., House to house survey
	Uttar Pradesh	Ballia	14	0	IgM ELISA (4/14 samples positive)	Fever	Symptomatic	HEd., House to house fever survey
	Arunachal Pradesh	Papumpure	7	0	IgM & IgG by card test (4/14 samples positive)	Fever, vomiting and loss of appetite	Symptomatic	HEd.

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	Arunachal Pradesh	Tawang	5	2	IgM ELISA (3/3 samples positive)	High-grade fever, body ache and breathlessness	Symptomatic	HEd.
	Madhya Pradesh	Satna	13	0	IgM ELISA (13/22 samples positive)	Fever with chills, headache	NA	HEd., Insecticidal spray, house to house fever survey
	Maharashtra	Gadchiroli	2	0	IgM ELISA (2/2 samples positive)	Fever with chills, itching, and pain at the wound site	NA	HEd.
	Maharashtra	Wardha	21	1	ELISA (1/5 samples positive)	Fever, weakness	NA	HEd., house to house fever survey
	Mizoram	Aizawal	42	0	Weil–Felix test (28/46 samples positive)	Headache, fever, nausea	NA	HEd.
	Uttar Pradesh	Ballia	27	0	IgM ELISA (6/27 samples positive)	Fever	NA	HEd., house to house fever survey
	Gujarat	Amreli	6	0	IgM ELISA	Fever, chills, swelling in leg and dark scab on both legs	NA	HEd., house to house fever survey
	Madhya Pradesh	Mandsaur	45	0	IgM ELISA (9/45 samples positive)	Fever with body ache	Symptomatic	HEd.
	Maharashtra	Wardha	10	1	IgM ELISA (10/10 samples positive)	Fever, weakness	Symptomatic	HEd.
	Rajasthan	Tonk	98	0	IgM ELISA (14/98 samples positive)	Fever	Symptomatic	HEd.
	Uttar Pradesh	Jaunpur	13	0	IgM ELISA (3/13 samples positive)	Fever	Symptomatic	HEd.
	Uttar Pradesh	Jaunpur	9	0	IgM ELISA (1/9 samples positive)	Fever	NA	IEC activities, house-to-house fever survey

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	Madhya Pradesh	Sehore	6	0	IgM ELISA (1/6 samples positive)	Fever with rash	Symptomatic	HEd.
	Maharashtra	Nanded	10	1	RDT (1/10 samples positive)	Fever	NA	HEd.
	Madhya Pradesh	Bhopal	11	0	IgM ELISA (2/2 samples positive)	Fever	NA	HEd., house to house fever survey
	Maharashtra	Nagpur	3	1	IgM ELISA (1/4 samples positive)	Fever	NA	HEd., entomological survey
	Arunachal Pradesh	Papumpare	34	0	IgM ELISA (34/722 samples positive)	Fever, body ache, myalgia	Symptomatic	HEd.
	Meghalaya	West Khasi Hills	17	0	IgM ELISA (8/17 samples positive)	Fever, body ache, headache	Antibiotics & supportive measures	HEd.
	Odisha	Malkangiri	8	0	IgM ELISA (8/8 samples positive)	Fever, loss of appetite, vomiting	NA	HEd.
	Madhya Pradesh	Anuppur	1	1	IgM ELISA (1/1 samples positive)	Abdominal pain, headache	NA	HEd.
	Uttar Pradesh	Mirzapur	16	0	IgM ELISA (1/16 samples positive)	Fever	NA	IEC activities, house-to-house fever survey
	Madhya Pradesh	Umaria	12	0	IgM ELISA (1/5 samples positive)	Fever	NA	HEd.
	Total	-	3751	93	-	-	-	-

IEC: Information, Education, and Communication

HEd.: Health Education

NA: No data reported or available

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Table 2.Sporadic Deaths and Cases due to Scrub Typhus with Co-Infection of Other Pathogens and Confirmed by Laboratory Diagnosis by IgM ELISA or Weil–Felix Tests (2009–2023)*

Year	State	Area or District	Diagnosis of Outbreak	No. of Cases	No. of Deaths	Diagnostic Test Done and Test Outcome	Confirmed Cases of Scrub Typhus
2011	Rajasthan	Alwar	Acute febrile illness	NA	37	Positive for scrub typhus, dengue, chikungunya and influenza A and B	-
2012	Tamil Nadu	Thiruvarur	Dengue/ scrub typhus	55	0	IgM ELISA (4/9 samples positive)	4
2014	Tamil Nadu	Dharmapuri	Dengue/ scrub typhus	55	0	IgM ELISA (2/5 samples positive)	2
	Rajasthan	Alwar	Scrub typhus/ dengue/ chikungunya	Several 1000 fever cases	22	11/26 samples positive (test not specified)	11
	Tamil Nadu	Vellore	Leptospirosis	15	0	1/4 samples positive for scrub typhus	1
	Tamil Nadu	Madurai	Chikungunya	22	0	1/8 samples positive for scrub typhus and chikungunya	1
	Tamil Nadu	Tiruvannamalai	Fever	10	0	1 sample positive for dengue & Scrub typhus	1
2015	Tamil Nadu	Vellore	Chikungunya	14	0	1 sample positive for dengue, chikungunya and scrub typhus and 1 Sample positive for Chikungunya, Scrub typhus & Typhoid	2
	Rajasthan	Jhunhunu	Fever (mixed infections)	100	0	2/16 samples positive for scrub typhus	2

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2016	Tamil Nadu	Madurai	Leptospirosis	50	0	1/7 samples positive for scrub typhus and leptospirosis	1
	Rajasthan	Alwar	Scrub typhus and dengue	34	0	3/13 samples positive for scrub typhus	3
	Tamil Nadu	Dindigul	Dengue and scrub typhus	92	0	2/11 samples positive for scrub typhus and dengue	2
	Rajasthan	Alwar	Scrub typhus and chikungunya	220	0	1 sample positive for scrub typhus and 2 positive for scrub typhus and chikungunya co-infection out of 21	3
	Tamil Nadu	Tiruvannamalai	Fever	27	0	1 positive for scrub typhus and leptospirosis co-infection	1
2017	Tamil Nadu	Tiruvannamalai	Typhoid, scrub typhus, dengue	33	0	NA	1
	Tamil Nadu	Cuddalore	Leptospirosis, dengue and scrub typhus	57	0	1/5 samples positive for scrub typhus	1
2019	Tamil Nadu	Dharmapuri	Dengue	52	0	1/5 samples positive for scrub typhus	1
	Punjab	Bathinda	Hepatitis E	56	0	IgM ELISA (3/13 samples positive for scrub typhus)	3
	Punjab	Bathinda	Hepatitis A	156	1	1 sample positive for scrub typhus and 1 positive for scrub typhus & hepatitis-A co-infection out of 25	2
	Maharashtra	Sindhudurg (Kudal)	Leptospirosis and scrub typhus	5	0	IgM ELISA (2/7 samples positive for scrub typhus)	2
	Rajasthan	Sawai Madhopur	Fever	1053	0	1/28 samples positive for scrub typhus	1

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2021	Assam	Dhemaji	Leptospirosis and scrub typhus	1	0	IgM ELISA (the sample positive for both scrub typhus and leptospira)	1
	Madhya Pradesh	Damoh	Leptospirosis	1	1	Sample positive for leptospirosis and scrub typhus	1
	Bihar	Jahanabad	Japanese encephalitis	1	1	IgM ELISA	1
	Assam	Lakhimpur	Japanese encephalitis	2	0	IgM ELISA (2 samples positive for both scrub typhus and JE)	2
	Uttar Pradesh	Mathura	Dengue	182	6	29/121 samples positive for scrub typhus	29
	Tamil Nadu	Dindigul	Dengue, scrub typhus	25	0	3/5 samples positive for scrub typhus	3
	Uttar Pradesh	Fatehpur	Scrub typhus, dengue, leptospirosis	5	1	IgM ELISA (5/17 samples positive for scrub typhus)	5
	Tamil Nadu	Thanjavur	Mixed fever	45	0	IgM ELISA (2/17 samples positive for scrub typhus)	2
2022	Tamil Nadu	Krishnagiri	Food poisoning	11	0	IgM ELISA (1/3 samples positive for scrub typhus)	1
	Tamil Nadu	Krishnagiri	Dengue, scrub typhus	12	0	Two samples positive for scrub typhus	2
	Tamil Nadu	Virudhunagar-Sivakasi	Dengue and scrub typhus	9	0	IgM ELISA (1/5 samples positive for scrub typhus)	1
					69		93

NA: Data not reported or available

*The data presented in this table were excluded from the final analysis.

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Table 3.Number of Outbreaks of Scrub Typhus in Different Geographical Regions of India (2009–2023)

Year	Regions						
	North-Eastern	Southern	Western	Central	Northern	Eastern	Total
2009	1	0	0	0	0	0	1
2010	1	0	0	0	0	0	1
2011	2	1	0	1	1	0	5
2012	1	1	0	1	2	2	7
2013	1	1	0	0	1	0	3
2014	3	1	0	0	0	0	4
2015	4	1	2	0	1	0	8
2016	2	0	1	0	1	0	4
2017	7	0	1	0	1	0	9
2018	5	4	1	0	0	0	10
2019	11	1	3	0	0	0	15
2020	6	1	0	3	0	1	11
2021	10	0	1	1	0	2	14
2022	1	2	1	4	0	0	8
2023	7	0	7	6	6	1	27
Total	62	13	17	16	13	6	127

Table 4.Relative Proportion of Scrub Typhus Cases, Deaths, and Case Fatality Rate (CFR) in Different Geographical Regions of India

Regions	Cases		Deaths		CFR
	n	%	n	%	
North-Eastern	2149	57.29	41	44.08	1.90
Northern	748	19.94	23	24.73	3.07
Southern	238	6.35	4	4.30	1.68
Eastern	156	4.16	2	2.15	1.28
Central	197	5.25	6	6.45	3.05
Western	263	7.01	17	18.29	6.46
Total	3751	100.0	93	100.0	2.48

n: Number of scrub typhus outbreaks

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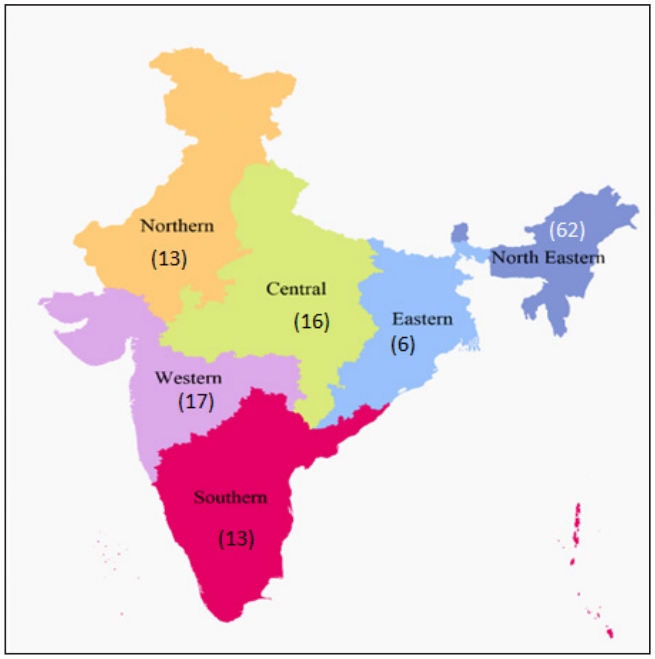

Figure 1. Main Geographic Regions of India and the Number of Outbreaks of Scrub Typhus Numbers in parentheses indicate the number of outbreaks of scrub typhus in that region during 2009–2023

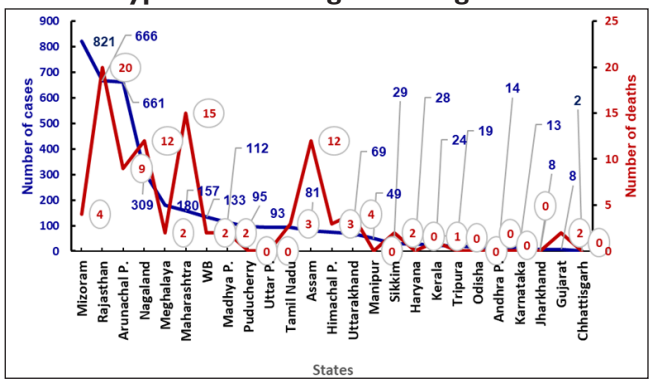

Figure 2.Number of Scrub Typhus Cases and Deaths in Different States of India, 2009–2023

West Bengal, Madhya Pradesh and Maharashtra

Temporal Distribution of Scrub Typhus Outbreaks, Cases and Deaths

The temporal distribution of the reported outbreaks of scrub typhus is shown in Figure 3 for the four main seasons in India i.e., winter (January–March); summer (April–June); monsoon (July–September) and autumn (October–December). The highest number of outbreaks occurred in the monsoon season, although the scrub typhus outbreaks occurred in all seasons during the years 2018, 2021 and 2022. The temporal distribution of the reported scrub typhus cases and deaths pooled for the 15-year period is shown in Figure 4. It also shows that maximum scrub typhus cases were

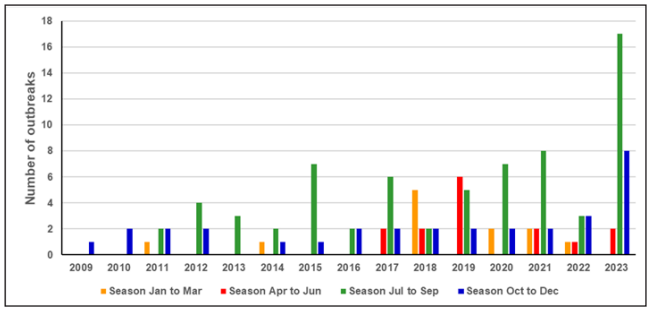

Figure 3.Temporal Distribution of the Reported Outbreaks of Scrub Typhus in India in Main Seasons (Winter: January–March; Summer: April–June; Monsoon: July–September; Autumn: October–December)

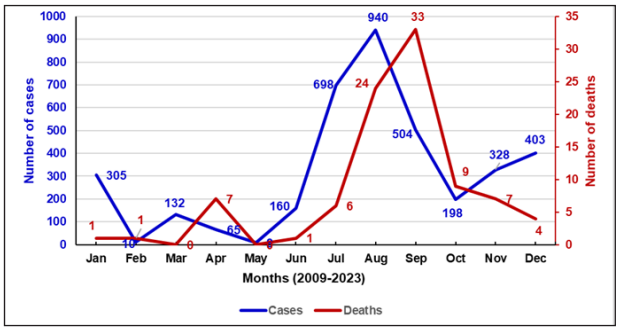

Figure 4.Temporal Distribution of the Monthly Reported Scrub Typhus Cases and Deaths (Cases Pooled by Month for All 15 Years)

reported from July to September in the 15-year period.

Symptoms, Diagnosis and Case Management

The IDSP reports provided limited information on the clinical symptoms of scrub typhus. The most common symptoms of illness reported were fever with chills and myalgia. Previous studies had reported varied clinical manifestations of headache, nausea and vomiting associated with fever.[4,11–15] Until 2014, the Weil–Felix Agglutination test was the most used confirmatory test. This test is not very sensitive but is a rather specific test.[16] The IDSP data showed that since 2014 the use of the Weil–Felix test was gradually replaced with superior diagnostic tests such as the IgM ELISA and RT PCR.[17] The analysis of the IDSP data provided limited information on the case management practices in various outbreaks reported on the IDSP portal. Most of the cases presumed to be with scrub typhus infection were symptomatically treated with doxycycline, and there was no information on the use of alternative regimens, disease complications and clinical outcomes. Previous studies reported good clinical outcomes with the use of alternative regimens of antibiotics.[12,18–21]

Other Information

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The IDSP data provided scanty details of vector control or preventive measures undertaken, and no information on the pathogen incrimination, diversity of vectors, chigger index and animals studied during scrub typhus outbreaks, which is essential to determine the most preferred host and distribution of index animals and other rodents involved in the transmission of the disease.

The antigenic strain of *Orientia tsutsugamushi* implicated in various scrub typhus outbreaks did not find any mention in the IDSP reports. The association of antigenic strain with virulence is a well-established fact, hence information on the circulating antigenic strain is of vital importance.[6] The individual patient-level information collected at the district and state IDSP mainly features demographic information, patient history, sample collection and testing details, incriminated pathogen, diagnostic test used and rapid response, however even that is not detailed in the weekly outbreak reports.

The association of disease outbreaks with meteorological data such as relative humidity and temperature, which are important for vector propagation, were also missing in the IDSP weekly outbreak reports, although meteorological data are available from the India Meteorological Department and other sources.

Discussion

The IDSP weekly reports reporting scrub typhus outbreaks (since the beginning of reporting of outbreaks in 2009 till 2023) were analysed and the adequacy of the surveillance programme was assessed against scrub typhus. The IDSP under the 'National Health Mission' of India has a primary objective of maintaining a disease surveillance system for epidemic-prone diseases along with monitoring disease trends and responding to outbreaks including scrub typhus. The major strength of the IDSP is that it is the only authentic government source for any kind of data on scrub typhus available in the public domain. The IDSP is a well-established information technology-enabled disease surveillance system, which extends to all regions and districts of India and has contributed to controlling outbreaks of various diseases in the country over the years. Notwithstanding its success in providing vital information for other outbreak-prone diseases, the effectiveness of the IDSP in providing surveillance inputs for scrub typhus in India is inadequate.

A total of 127 outbreaks of scrub typhus with 3751 cases, 93 deaths, and a case fatality rate of 2.48% were reported in the 15-year period of data analysis. This reported burden was found to be much less than the previously reported incidence of 18,781 cases with a case fatality rate of 6.3% in scientific literature in the same period in India.[4] The seroprevalence of scrub typhus reported in various publications on scrub typhus was in excess of 30% among acute undiagnosed fever cases than the IDSP data, indicating that the actual number of cases is much higher than those diagnosed and reported.[4,22–24] Overall, the IDSP reporting was less representative of the true situations as a primary surveillance system for scrub typhus but at best presents geospatial and temporal trends of the disease in India.

Many publications on hospital-based analysis of scrub typhus cases were missed in the IDSP reporting, which may be either due to the hospitals not notifying cases or a lack of adequate coordination within the existing surveillance system. Reports of acute encephalitis syndrome cases and 'mystery fever' with lack of proper follow-up and testing in real time may also have led to discrepancies in disease burden.[25] A similar surveillance system in China for diseases such as scrub typhus is a real-time web-based Geographical Information System-enabled system, which was developed following the pandemic of severe acute respiratory syndrome and which improved disease reporting significantly.[26] Although the IDSP is gradually migrating to an Integrated Health Information Platform to provide real-time surveillance and timely actions, even in the proposed new system the amount of information in the public domain for scrub typhus is likely to remain low due to the absence of any newer form of reporting or any other source of information.

Contrary to the highest proportion of cases reported in the northeastern states, the systematic review reports most of the cases originated in south India followed by north India. Previous studies reported scrub typhus cases in the states and Union Territories that were not reported in the IDSP weekly reports.[21,22,27–30] The highest case fatality rate of scrub typhus was reported in the western zone, with fewer positive cases in the other zones.

Most of the outbreaks occurred in the tropical monsoon periods (July to September) than the colder months (October to March). The high occurrence of outbreaks in warmer climates is likely due to high relative humidity and rainfall, which provides a favourable environment for the breeding and survival of mites.[31] The outbreaks of scrub typhus during the warmer period of April to June in 2017–2023 clearly indicate that temperature is an important predictor for scrub typhus cases in similar regions with similar weather patterns, and that scrub typhus incidence can be correlated to temperature variations.

The knowledge of the predisposing risk factors of scrub typhus may be specific to different settings and is essential for designing preventive strategies against the disease. The IDSP weekly reports lacked this most important information, which is a limitation.

The absence of essential data capture and reporting prevents the prediction of disease outcomes and implementation

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of measures preventing outbreaks in the future, especially in the absence of any other source of scrub typhus data. The IDSP captures data on various disease outbreaks and publishes weekly outbreak reports, but it does not present a holistic report about a particular disease in India. Various diseases monitored by the IDSP have various sources of data collection and reporting such as malaria and dengue monitored by the National Centre for Vector-Borne Disease Control. Scrub typhus is a neglected tropical disease and with the increase in the number of reported cases of scrub typhus, it is fast emerging as a serious public health threat in India. This disease, however, remains underdiagnosed and underreported. The current format of the IDSP reporting is less productive in capturing true and complete information on scrub typhus because the dynamics and information needed for reporting on scrub typhus outbreaks are very different from the other diseases covered by the IDSP.

Early diagnosis and prompt case treatment can significantly reduce the complications and case fatality of scrub typhus. Although awareness of the disease among healthcare workers is increasing, the current surveillance activities, notification systems and prevention and control programmes are inadequate and must be reinforced. Massive outbreaks of scrub typhus are likely in the near future due to the high seroprevalence of scrub typhus in India, the presence of conducive environmental conditions and the varied clinical presentations of the disease. There is a need for a separate registry/ sub-registry or organisation that can be equipped to provide real-time data coupled with relevant information on the outbreaks, which will facilitate ascertaining the disease burden, monitoring trends, improving private notification and early diagnosis of cases. It is thus opportune that a better and more robust surveillance and reporting system with targeted control measures is implemented for predicting and containing the scrub typhus outbreaks in the country. This calls for establishing a dedicated 'Rickettsial Diseases Registry' for better surveillance of scrub typhus and other emerging rickettsial diseases.

This separate registry will provide vital information on vector presence, density and diversity, animals studied with chigger index, prevalent antigenic strain, diagnostics used, various risk factors, undertaken vector control measures and preventive strategies, meteorological parameters (humidity and temperature), line listing of cases along with information on treatment modality to help monitoring and mapping of development of drug resistance, if any. An illustrative modality of data collection on scrub typhus cases is presented in Appendix 1. The disease burden data can be presented in a very detailed manner with tables and graphs.

An important information technology-based tool can be a real-time, online interactive threats map for scrub typhus cases in India. GIS mapping using modern medical software can be incorporated into this registry to capture, store, analyse, and display geographically referenced information on the disease. It will help in drawing inferences on the disease in terms of common risk factors, regional spread, antigen-specific measures, effectiveness of available clinical and preventive tools and research priority areas. This will not only help in getting a holistic view of the disease status but generate a dataset that can be utilised for designing targeted awareness modules and developing area-specific preventive and control strategies for effective control of scrub typhus outbreaks. A warning can be provided through this registry that may help prevent impending outbreaks of scrub typhus and the public health challenges posed by the disease. This registry additionally can be developed to address the felt need for establishing surveillance of the other emerging mite and tick-borne diseases as their prevalence is also reported to be on the rise and their control is impacted for want of an adequate surveillance mechanism at the present.[32] A critical analysis of the scrub typhus outbreak data will also help in better channelling our limited resources towards surveillance of the disease in India.

Conclusion

The IDSP data presents only a partial picture of the true burden of scrub typhus in India. It reported limited or no information on vectors, antigenic strains of *Orientia tsutsugamushi*, risk factors, clinical presentations, diagnostic tests, treatment, and preventive and control measures undertaken by health services. These limitations in the present system along with environmental conditions, high seroprevalence and drug resistance warrant improving the performance and functionality of the system. The application of a separate registry or organisation to aid in surveillance activities for scrub typhus is the need of the hour.

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Conflict of Interest: None

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Appendix

Demographic Information							Assessment of Risk Factors									Signs & Symptoms			
Pt ID	**Age (Years)**	**Sex**	**Address**	**Village/ City**	**District**	**State**	**Occupation**	**Season**	**High Risk Group**	**Temperature (°C)**	**Humidity (%)**	**Monthly Average Rainfall (Inches)**	**Rural/ Urban**	**Terrain/ Ecology Characteristics**	**Peri-Forested Region**	**Date of Onset of Symptoms**	**Presenting Symptoms**	**Other Symptoms**	**Presence of Eschar**
AG1	18	M	xyz	abc	Guwahati	Assam	Student	Summer	Nil	32	70	3	Urban	Plain	No	21-03-21	Fever, vomiting	Headache	Present
AG2	22	M	tvx	def	Guwahati	Assam	Govt service	Summer	Nil	32	70	3	Urban	Plain	No	21-03-21	Fever	Headache, cough	Absent
AG3	35	F	wef	wsx	Guwahati	Assam	Agricultural worker	Summer	Pregnancy	30	70	3	Rural	Hilly	Yes	23-03-21	Fever	Headache	Absent
AG4	58	M	qwe	edc	Guwahati	Assam	Agricultural worker	Summer	Nil	30	70	3	Rural	Hilly	Yes	24-03-21	Fever	Headache	Present
AG5	41	M	ert	rfv	Guwahati	Assam	Agricultural worker	Summer	Nil	30	70	3	Rural	Hilly	Yes	24-03-21	Headache, dizziness	Bodyache	Absent
AG6	28	M	tyu	tgb	Guwahati	Assam	Agricultural worker	Summer	Nil	30	70	3	Rural	Hilly	Yes	24-03-21	Fever	Headache, Cough	Absent
AG7	50	M	uio	yhn	Guwahati	Assam	Agricultural worker	Summer	Nil	30	70	3	Rural	Hilly	Yes	25-03-21	Fever, seizure, photophobia	Headache	Absent
AG8	21	M	iop	ujm	Guwahati	Assam	Agricultural worker	Summer	Nil	30	70	3	Rural	Hilly	Yes	25-03-21	Fever	Headache	Present
AG9	24	M	sdf	iko	Guwahati	Assam	Carpenter	Summer	Nil	32	70	3	Rural	Hilly	Yes	26-03-21	Acute abdomen	Headache, myalgia	Absent
AG10	31	M	fgh	nhp	Guwahati	Assam	Govt service	Summer	Nil	32	70	3	Urban	Plain	No	27-03-21	Fever	Headache	Absent

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Hospital Visit & Admission				Management														Entomological Surveillance		
Pt ID	**Date of Hospital Visit**	**Mode of Treatment**	**Date of Admission to Hospital**	**Diagnostic Test**	**Date of Testing**	**Date of Reporting**	**Test Result**	**Pathogen Name**	**Antigenic Strain**	**Other Laboratory Tests**	**Date of Start of Treatment**	**Treatment**	**H/o Chemoprophylaxis**	**Preventive Measures**	**Complications**	**Date of Discharge/ Death**	**Treatment Outcome**	**Animals Studied**	**Chigger Index**	**Presence of Vector**
AG1	25-03-21	Inpatient	25-03-21	Weil-Felix Test	25-03-21	28-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	25-03-21	Doxycycline	Nil	IEC, screening for febrile illness	Nil	04-01-2021	Recovered	Rat	11.8	*L. deliense*
AG2	25-03-22	Inpatient	25-03-21	IgM ELISA	25-03-21	28-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Typhoid neg, Dengue neg, Malaria neg	25-03-21	Azithromycin	Nil	IEC, screening for febrile illness, anti-mite spraying	Nil	04-05-2021	Recovered	Shrew	0.7	*L. deliense*
AG3	27-03-21	Inpatient	27-03-21	IgM ELISA	27-03-21	30-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	27-03-21	Doxycycline	Nil	IEC, screening for febrile illness, removal of vegetation	Nil	04-02-2021	Recovered	Rat	23.8	*L. deliense*
AG4	27-03-21	Inpatient	27-03-21	Weil-Felix Test	27-03-21	30-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	27-03-21	Doxycycline	Nil	IEC, protective clothing while on field	Nil	04-02-2021	Recovered	Rat	12.9	*L. deliense*
AG5	27-03-21	Inpatient	27-03-21	Weil-Felix Test	27-03-21	30-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	27-03-21	Doxycycline	Nil	IEC, rodent control measures	Nil	04-05-2021	Recovered	Rat	112	*L. deliense*
AG6	27-03-21	Inpatient	27-03-21	IgM ELISA	27-03-21	30-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	27-03-21	Azithromycin	Nil	IEC, impregnation of permethrin on clothing	Nil	04-04-2021	Recovered	Rat	56.2	*L. deliense*
AG7	27-03-21	Inpatient	27-03-21	Weil-Felix Test	27-03-21	30-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Leptospirosis neg, Dengue neg, Malaria neg	27-03-21	Doxycycline	Nil	IEC, screening for febrile illness	Myo-carditis	04-10-2021	Died	Rat	14.4	*L. deliense*

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AG8	28-03-21	In-patient	28-03-21	IgM ELISA	28-03-21	30-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	28-03-21	Chloram-phenicol	Nil	IEC, removal of vegetation, rodent control measures	Nil	04-05-2021	Recovered	Rat	28	*L. deliense*
AG9	28-03-21	In-patient	29-03-21	IgM ELISA	29-03-21	31-03-21	Positive	*Orrentia tsutsugamushi*	Kato	Dengue neg, Malaria neg	29-03-21	Doxy-cycline	Nil	IEC, screening for febrile illness	Nil	04-07-2021	Recovered	Shrew	19.3	*L. deliense*
AG10	29-03-21	In-patient	29-03-21	IgM ELISA	29-03-21	31-03-21	Positive	*Orrentia tsutsugamushi*	Karp	Dengue neg, Malaria neg	29-03-21	Azithro-mycin	Nil	IEC, screening for febrile illness	Nil	04-07-2021	Recovered	Rat	115.6	*L. deliense*

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