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RESEARCH ARTICLE

Scrub typhus infections in relation to traditional agricultural practices and food habits in Mizoram, North East India

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Scrub typhus, a disease caused by *Orientia tsutsugamushi*, is transmitted by trombiculid mites (*Leptotrombidium* spp.) and is primarily reported in the Asia-Pacific region. These mites act as both vectors and reservoirs. Small mammals, especially rodents, are important in the disease cycle as hosts for infected mites. In Mizoram, Northeast India, traditional slash-and-burn agriculture (jhum cultivation) is a widespread practice and may influence disease patterns. This study analyzed scrub typhus data from 2018 to 2022 to assess the correlation between jhum cultivation and scrub typhus infections, focusing on infected farmers. Over five years, 9,799 farmers were diagnosed with scrub typhus, making up nearly 50% of all reported cases across seven occupational groups. The highest number of cases occurred in 2022 (3,045), followed by 2019 (2,716). Of the infected farmers, 25 (0.25%) succumbed to the disease. Seasonally, infections peaked during the monsoon (33.56%), followed by post-monsoon (26.19%), winter (21.57%), and summer (18.25%). The data suggest a strong link between the seasonal intensity of jhum cultivation and increased scrub typhus infections among farmers, indicating that traditional agricultural practices may contribute significantly to disease transmission in the region.

Keywords : Scrub typhus, Mizoram, agriculture, farmers

Introduction

Scrub typhus disease in humans is caused by the obligate intracellular bacterium, *Orientia tsutsugamushi* Tamura et al., 1995 (Rickettsiales: Rickettsiaceae), which is mainly reported in the Asia -Pacific region, and sporadic cases are also reported from some other regions of the world.[1,2,3] The vectors of scrub typhus are trombiculid mites of the genus *Leptotrombidium* in the family Trombiculidae. Mite serves both as vectors and reservoirs, and transovarial transmission is important for the maintenance of the bacteria.[4]

Due to high morbidity and mortality rates, scrub typhus infection is considered a serious and life-threatening disease[5] untreated cases can reach a fatality rate of up to 70%[6]. Factors like untimely diagnosis and treatment, antibiotic resistance, the virulence of the strains, and the patient's condition, including age and comorbidities, are the major contributors to mortality due to scrub typhus.[6,7]

Small mammals particularly rodents can be infected with chigger mites[8,9] and a large number of rodent and other small mammal species have been found to be infected by *O. tsutsugamushi*[10]. Rodents play an important role in the transmission of the scrub typhus disease[11] as it is reported that rodents of the family Muridae (rats and mice) were the most important hosts of chigger mites[12]. One of the rodent species, *Rattus tanezumi*, is highly adaptable and found around residential areas and agricultural fields. Multiple pathogens, particularly numerous

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helminth species, *Trypanosoma* spp., *Leptospira* spp., *Bartonella* spp., and *Hantaviruses*, can be harboured by this rat[9,13,14,15,16]and also various arthropod ectoparasites, some of which are vectors of scrub typhus and other rickettsial diseases[16].

Shifting cultivation, also known as Jhum, swidden agriculture, rotational bush fallow agriculture, or slash-and-burn agriculture can be defined as a practice, in which the forest is cleared, the debris is burnt, the land is cultivated for a maximum of one or two spells and then allowed to put it is as fallow, where forest regrows for several years and again used for cultivation.[17,18] Slash-and-burn farming occurs across various ecosystems, including forests, grasslands, and savanna regions.[19] Various societies, from remote tribal groups to expansive civilizations, have engaged in slash-and-burn agriculture as a cultural practice.[20,21] A significant correlation between scrub typhus incidence and habitats characterized by a mosaic of cropland and vegetation was observed in Taiwan, which represents transitional land-cover use.[22] Transitional habitats such as forest edges, fallows along streams, or abandoned agricultural lands were suitable places for the spread of scrub typhus.[23]

Materials and methods

Brief information about the study area

Mizoram is a small state located in the northeastern part of India. The southern part of the state shares 722 kilometers-long international borders with Myanmar and Bangladesh, and its northern part shares domestic borders with Manipur, Assam, and Tripura. It is the fifth smallest state of India with 21,087 square kilometres. It extends from 21˚56'N to 24˚31'N, and 92˚16'E to 93˚26'E. The tropic of cancer runs through the state nearly at its middle. The climate pattern is moist sub-tropical, with average state rainfall of 254 centimeters.[24] As per 2011 census data, the total population of Mizoram is 1,097,206, of which males and females are 555,339 and 541,867, respectively. Mizoram has a population density of 52 km^2 and a total land area of 21,081 square kilometers. Around 47.89% of the state's population resides in rural areas, where they face heightened vulnerability due to limited access to medical care and socio-economic challenges. About 60% of the population is engaged in the agricultural sector.[25]

Epidemiological data source

From the Integrated Disease Surveillance Programme (IDSP) under Health & Family Welfare Department, Government of Mizoram, five years (2018-2022) line listing data of scrub typhus disease were obtained. The proforma of the line list includes patients' information such as name, age, sex, address, occupation, general symptoms, presence/ absence of eschar, date of diagnosis, diagnostic kit utilised, hospitalised or not, and outcome (recovered/expired). The line listing data were collected from all testing units, public health centres (PHCs), community health centres (CHCs), district hospitals (DHs), and private hospitals. Before the year 2018, screening was done using the scrub typhus-specific Immunochromatographic test (ICT) - InBios rapid test (SD Bioline Tsutsugamushi test, SD Diagnostics, Hagal-dong, Kyonggi-do, Korea),[26] while, from the year 2019, Weil-Felix test[27] was introduced to all Government testing units. From this master line listing data (2018-2022), data of farmers who were positive for the disease were extracted for analysis to correlate the farming activities with the distribution and magnitude of scrub typhus disease among this particular occupation.

Process of Jhum/shifting cultivation practiced in Mizoram

Shifting cultivation is commonly practiced in northeast India, where it is locally called jhum (meaning 'to group or work together'). In Mizoram, northeast India, about 60% of the population is believed to depend on Jhum/shifting cultivation for their livelihood.[28] Shifting cultivation in Mizoram is distinct from that in other north-eastern Indian states due to its characteristic steep slopes, requiring various laborious activities such as slashing, burning, sowing, weeding, and harvesting to be carried out on these challenging terrains.

This cultivation, known as '*Lo neih*' in the local language, is practiced throughout Mizoram with only slight modifications from place to place to accommodate different topography and climate. The process involves clearing the forest, followed by burning, sowing, and reaping. Traditionally, village elders or the village council select the sites in December and January, then allot land area to each family for cultivation. The jhumias clear the land by slashing the forest trees and bamboos in January and February, and burn the slashed vegetation in March and April. Seeds are sown in May prior to the onset of the monsoon. There is nowadays a slight change in the timing of these procedures because the State Government has ordered that all lands allocated for shifting cultivation should be burnt before 15th March. Moreover, the authorities issue updated orders concerning this schedule every few years. Weeding takes place three times a year, and

on each occasion, it is given a specific name in the Mizo language – *hnuhlâk*, *hnuhhram*, and *pawhchhiat*. Harvesting begins in the month of July and lasts until December, depending upon the crops. In Mizoram, the predominant practice is to crop a jhum for one year. Some of the most common crops are upland rice (*Oryza sativa*), maize (*Zea mays*), chillies (*Capsicum annuum*), and different types of vegetables.[29]

Results

During the years 2018 to 2022 (5 years), 9799 farmers were diagnosed to be infected with scrub typhus, and they contributed ~50% of all scrub typhus cases from the seven different kinds of occupational distributions. Students were the second most affected group, accounting for ~22% of cases, as detailed in Table 1.

Table 1: Distribution of scrub typhus cases by occupation

Occupation	Fe-males	Males	Total	% as a whole
Business	1004	951	1955	9.95
Construction worker	223	879	1102	5.61
Elderly	89	85	174	0.88
Farmer	5092	4707	9799	**49.8**
Govt. service	596	746	1342	6.83
Pre school	460	508	968	4.92
Student	1903	2397	4300	**21.89**
Total	**9367** (47.69%)	**10273** (52.3%)	**19640**	

During the period 2018-2022, the maximum number of cases was recorded in the year 2022 (3045 cases) and was followed by 2019 (2716 cases). Among these 9799 farmers who contracted the disease, 24 patients (0.25%) expired (Table 2).

During the study period of 5 years (2018-2022), the Maximum number of cases was observed during the month of July, recording 1340 (13.68%) cases. The second highest was observed during the month of August, having 1155 (11.78%) and thirdly during January, having 917 (9.35%) cases (Fig. 1). There were two peaks of scrub typhus cases that were observed in the month of July and January (Fig. 2).

When the seasons of Mizoram in a year are broadly divided into four, summer, monsoon, post-monsoon, and winter, a maximum number of scrub typhus cases were observed during monsoon (33.56%), post-monsoon (26.19%), winter (21.57%) and summer (18.25%) (Fig. 3).

In a jhum or shifting cultivation, a traditional agricultural practice in Mizoram, all the agricultural activities like slashing, burning, sowing, weeding, and harvesting were done manually without the assistance of agricultural machines. This requires maximum human efforts and activities in their jhums and forested areas, which leads to extensive exposure of farmers to scrub typhus vectors. Human activities in the jhums were maximum during harvesting seasons from monsoon to early winter (Fig. 3).

Discussion

As outdoor workers, farmers in rural areas have a higher risk of acquiring scrub typhus disease,30 ~50% of the total reported cases during our study

Table 2: Distribution of scrub typhus cases among farmers

YEAR	MONTHS													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL	Death
2018	249	120	76	25	32	103	296	201	61	23	29	69	1284	1
2019	255	178	180	162	132	184	324	325	328	247	259	142	2716	4
2020	112	79	45	29	63	126	179	133	134	203	192	117	1412	9
2021	111	107	123	77	77	100	134	152	114	102	152	93	1342	6
2022	190	175	191	226	350	280	407	344	239	272	211	160	3045	4
TOTAL	**917**	**659**	**615**	**519**	**654**	**793**	**1340**	**1155**	**876**	**847**	**843**	**581**	**9799**	**24**

period (2018 to 2022) were contributed by farmers who are engaged in jhum/shifting cultivation characterised by habitats mosaic cropland and other vegetation which significantly correlated with scrub typhus incidence which was observed in Taiwan which represents transitional land cover use.[21] This study also reveals that Jhum or shifting method of cultivation process had brought the transitional habitats such as forest edges, fallows along streams or abandoned agricultural lands that were the most suitable places for scrub typhus.[23]

In this study, maximum number of scrub typhus cases were observed during the month of July and August when farmers have maximum activities in their jhums, which are included under monsoon season and farmers as the tropical weather provides stable and ideal conditions for transmission of the disease. High temperature and high humidity are optimal for mite activity. In more temperate climates, the transmission of scrub typhus is more seasonal due to the temporal activity of chiggers.[31,32,33]

The present study also observed two peaks of average scrub typhus incidence during the months of July and January (2018-2022) which is correlated to the previous finding of Liu et al.[34] that 'scrub typhus has been classified as "summer type", as human infections typically occur between March

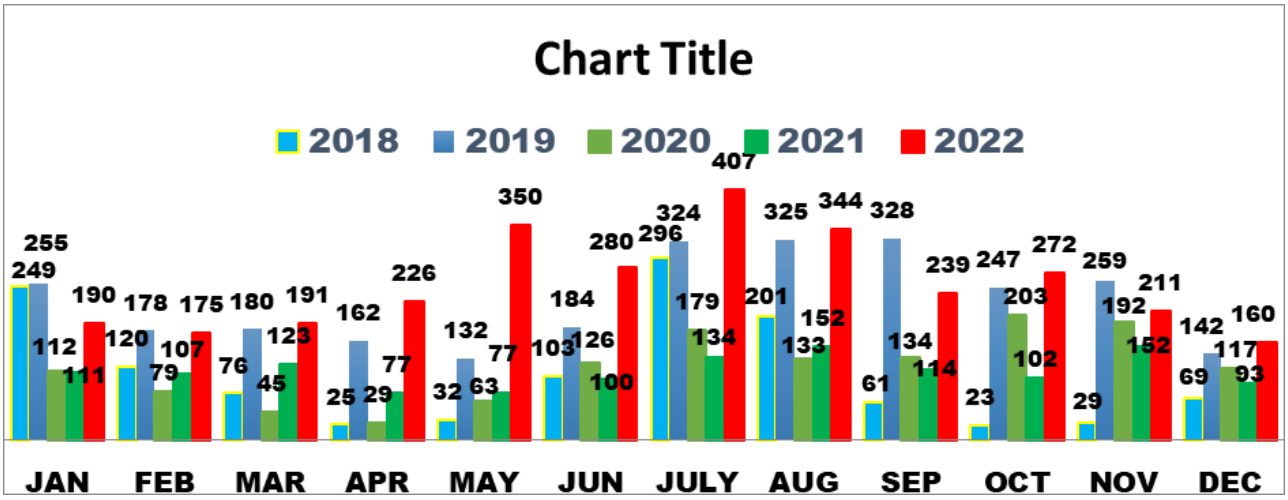

Figure 1. Year-wise distribution of ST cases and months

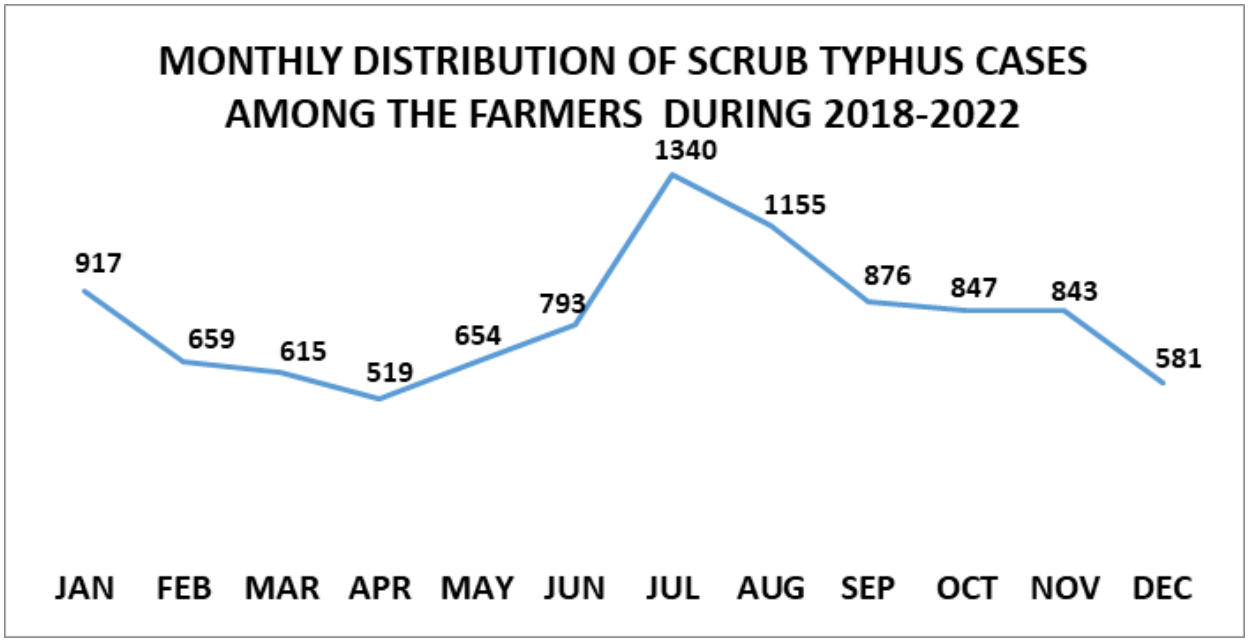

Figure 2. Overall monthly distribution of ST cases among farmers (2018-2022)

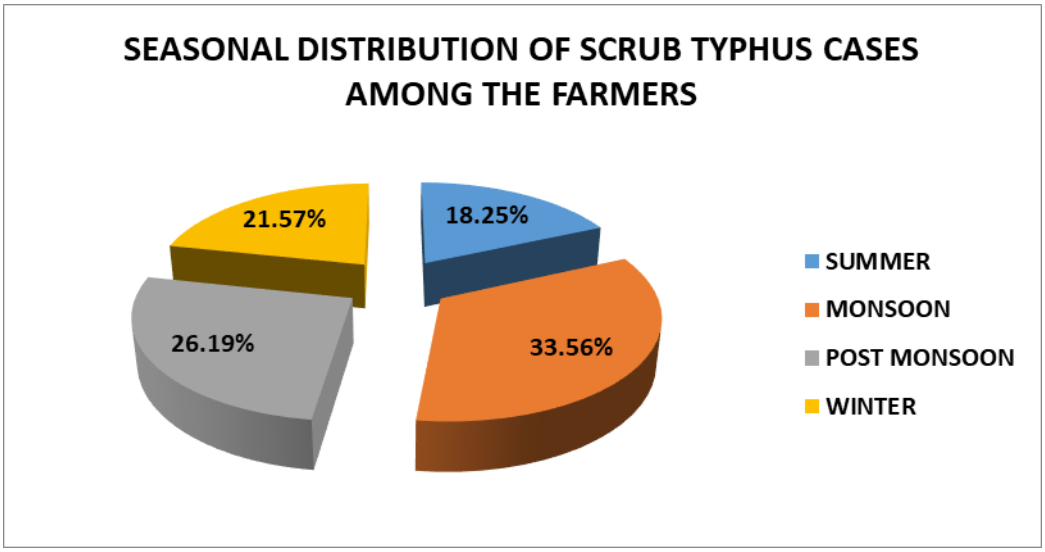

Figure 3. Seasonal distribution of scrub typhus cases

and November with a peak occurrence between June and August in summer and "autumn-winter type", as this type of scrub typhus occurs from September to December with a peak occurrence in October'. Another peak observed during this study in the month of January may be due to the handling and consumption of rats especially *Rattus tanezumi* and *Rattus nitidus* among the rural farmers as these rats locally known as "*Pawlzu*" were collected and eaten during the month of December and January in a year.[35]

Conclusion

From this study, it is observed that among the 7 different types of professions, farmers were by far the worst affected (~50%) by scrub typhus disease. It was further observed that the number of infections is closely tied with traditional agricultural practice activities in the jhums as the number of cases among the farmers increases with the increase of jhum cultivation process activities. It was also observed that the peak incidence of scrub typhus cases occurred in July, coinciding with the highest level of human activity during traditional jhum cultivation.

It was also observed that there was another peak in the month of January during which rural farmers were engaged in trapping, handling, and consumption of rice field (jhums) rodents especially *Rattus tanezumi* and *Rattus nitidus* whose blood samples were found to be infected with *O. tsutsugamushi* during this study.

It can be concluded that scrub typhus disease is directly related to traditional agricultural practices. Hence, farmers were the most vulnerable section of the population who need special attention from the concerned authorities to provide them protection from morbidity and mortality due to the disease.

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Ethical approval

The present study was approved (approval number: PUC-IAEC-2021-A09) and consent for participation was obtained from the institute ethics committee, Pachhunga University College.

Conflict of interests

The authors do not have any conflict of interest to disclose.

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