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# The economic burden of scrub typhus disease among the tribal ethnic groups (Mizo) of Mizoram State, Northeast India

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## Abstract

**Background** *Orientia tsutsugamushi* is the pathogen of scrub typhus, a rickettsial infection that poses a serious threat to many countries including India where the disease case-fatality was as high as 6%. The present study was aimed at determining the prevalence of scrub typhus disease and estimating the economic impact of the disease among the Mizo tribe of Mizoram State, Northeast India.

**Materials & Methods** The present study was a three-year retrospective, cross-sectional study conducted in 10 selected PHCs of Mizoram. The line-listing data of three years (2021—2023) on scrub typhus was used for the epidemiological investigation. The minimum economic burden of scrub typhus was evaluated using data collected by personal interviews with the scrub typhus survivors among the Mizo tribe.

**Results** A total of 22870 scrub typhus cases were recorded among the tribal ethnic groups (Mizo) in Mizoram State in the year 2021—2023, with an annual incidence of 571.48 per 100,000 persons. A positive relationship between age and disease incidence was observed, with a higher burden (1964.5 per 100,000 persons) among the elderly population (70+ years). The disease incidence rate also showed increasing trend and seasonality, with the peak of cases during August-October. The overall three years economic burden was found to be US\$ 730,003.80, with an average annual economic burden of US\$ 243,334.60 contributing 0.08% of the gross state domestic product (GSDP). An increasing trend in scrub typhus economic burden was observed during the study period.

**Conclusions** According to the current study, Mizoram State's tribal ethnic groups have a remarkably high incidence rate of scrub typhus disease causing a significant financial impact. Therefore, prevention and control measures for the disease are unavoidable.

**Keywords** Scrub typhus, Mizo tribes, Mizoram, Economic burden, Epidemiology

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## Contributions to the literature

- This study is the first to analyse the burden of scrub typhus among the tribal ethnic groups of Mizoram state, India.
- It highlights the increasing trends of the disease incidence, positive relationship between age and incidence rate, and seasonality of the disease incidence.
- It also highlights an increasing trend in the economic burden of the disease among the Mizo tribes, showing a considerable loss contributing 0.08% of the state GSDP.

## Introduction

Scrub typhus is the most widespread rickettsial infection caused by *Orientia tsutsugamushi*, an obligate intracellular bacterium, through the bites of infected larval mites (chiggers) [1]. The disease is concentrated in the rural and hilly areas of the Asia-Pacific region ('Tsutsugamushi triangle'), putting a billion people at risk and affecting a million people annually [2]. Scrub typhus is the cause of one-fourth (24.93%) of all febrile cases worldwide [3]. Globally, multi-organ failures occur in one-third of infections [4] and the median case fatality rate (CFR) is 6%, [5] but can reach up to 70% in untreated cases [4].

After a gap of 65 years, scrub typhus is re-emerging in India [6], and the disease is heterogeneously distributed throughout India in diverse ecological settings, including the North-eastern states [7] with the case-fatality rate of approximately 6%, and the mortality among the multi-organ dysfunction syndrome was reported as high as 38% [8]. Costs and outcomes of scrub typhus disease in a tertiary hospital have been studied in South India revealing a reasonably high economic burden of the disease [9]. Studies in the state of Gujarat, India, has also reported a significantly higher economic burden of Scrub typhus among the patients hospitalized in private hospitals (mean cost of UDS 86.9) compared with government hospitals [10]. In Mizoram, the first case of scrub typhus was reported in 2012 [11] and has increased to 6,542 cases in 2022, with an average annual incidence rate of 304 cases per 100,000 persons [12] and a CFR of 4 (0.38%) deaths per 1000. Farmers constituted half (50.73%) of the positive cases, which could be due to their close proximity to the rodents in households, fields, and forests, where the vector lives [13]. A seroprevalence study in Mizoram showed 46.01% (75/163) of the rodents being positive for scrub typhus [14]. The Health & Family Welfare Department, Govt. of Mizoram, has utilised State Economic Development Policy (SEDP) funds to raise awareness and provide diagnostic kits free of cost in Govt. hospitals, and research on scrub typhus [15]. In India, almost 55%

of households get their healthcare from the private sector, where the cost of care can account for up to 60% of the national costs. Therefore, evaluation of the financial impact is essential [9]. Scrub typhus disease prevalence in Mizoram has not been studied since the year 2020, and to date, the economic burdens of the disease have not been investigated. Therefore, the purpose of the current study was to ascertain the prevalence of scrub typhus in the state of Mizoram, India, and to study the disease's economic impact among the tribal ethnic groups (Mizo) in the state.

## Materials and methods

### Brief information about the study site

Mizoram is one of the smallest states in the North-eastern corner of India, surrounded by Bangladesh in the west and Myanmar in the east and South – a long international boundary of 722 km. The northern and western parts share domestic borders with Assam, Tripura, and Manipur. According to the last Indian census conducted in 2011, Mizoram has a total population of 1,096,573 [16]. Majority of the State population consist of various ethnic tribes collectively called 'Mizo', who shared a common culture and language. This tribal ethnic group, classified as 'Scheduled Tribe', contribute nearly 95% (1,036,115) of the total population of the state making it the highest concentration of protected tribal people in all states of India [17]. The economy of the state mainly depends on agriculture, as 70% of the population depends on farming and related activities. The health system comprises one State Hospital, one Tertiary Hospital, 12 district hospitals, five Sub-District Hospital, nine Community Health Centres, eight Urban Primary Health Centres under National Health Mission (NHM), 81 Main Centres, 372 Sub-centres, and 148 Clinics across the state. Mizoram has an estimated per capita income of Indian rupees (INR) 185,890.13 which is equivalent to 2240.72 US\$ (2021–2022). Approximately, 20% of households earn less than the state's per capita income and are considered to be Below Poverty Line (BPL). These families are mainly involved in low-paying jobs or are without regular income depending on agricultural and animal farming causing them at a higher risk of contracting rickettsial diseases, such as scrub typhus.

### Data source and study settings

The line-listing data of scrub typhus in Mizoram for the year 2021 to 2023 were obtained from the Integrated Disease Surveillance Programme, Government of Mizoram (unpublished data). Data included patient information such as age, sex, address, test performed, date of diagnosis, symptom, status of hospitalization, etc. The incidence rate was calculated among different age groups, and

sexes. Since the population census was not conducted in the year 2021 due to the Covid-19 outbreak, the projected population size of Mizoram state for the year 2023 was used for the calculation of incidence rate of the disease. The projected population of the state for the year 2023 was calculated based on the method of 'Linear growth' using the following formula:

$$P_t = P_0 + bt,$$

where,  $P_t$  is the projected population,  $P_0$  is the initial population (2011 census),  $b$  is the annual population change, and  $t$  is the number of years (12 years).

Disease incidence rate per 100,000 people was also calculated using the following formula:

$$\text{Incidence rate} = \text{number of new cases} / \text{total population} \times 100,000$$

In order to reveal the minimum economic burden of scrub typhus disease in the state, a survey through the personal interviews was conducted among the recovered scrub typhus patients of 18 and above years old during the year 2021 to 2023. Participants under the age of eighteen were excluded from this personal interview. The study was conducted in 10 Primary Health Centres from the rural areas of the state, one Centre from each of the 10 districts where scrub typhus cases were prevalent. For this study, patient interview chart was developed by the Institutional Advanced-Level Biotech Hub, Department of Zoology, Pachhunga University College, Aizawl, Mizoram, and an English version of the interview chart is also uploaded as a supplementary file. During the study period, a total of 300 participants (18 non-hospitalized and 12 hospitalized from each Primary Health Centre (PHC)) participated. Participants were randomly selected among the working age group (20 – 49 years old), and prior to the conduct of the personal interview, the participant's informed consent was obtained. Primary data collection through personal interview was conducted by Lalfakzuala Pautu, Entomologist (Regular employee), Integrated Disease Surveillance Programme (IDSP), Department of Health and Family Welfare, government of Mizoram, with the help of Staff Nurses and Pharmacists from each of the PHC. This assessment is also part of the programme of the Health and Family Welfare department, govt. of Mizoram, for the prevention and control of the vector-borne diseases in the state. The interviewers are well-trained persons and regular workers employed in the Department of Health and Family Welfare, government of Mizoram. In this study, the researchers did not need to seek approval from an ethics committee because the nature of the research was considered low-risk; involving readily accessible information from participants where privacy concerns were minimal, and no identifiable personal data was collected. The

expenditures of each patient for hospital care, diagnostic tests, prescription drugs, and consultations with physicians and surgeons were used to determine the least cost associated with the illness. The number of disability days due to the disease was recorded for each participant of working age group (20 to 49 years old), and the economic loss was also calculated as per the minimum wages of unskilled workers notified by the state government [18]. Since the expenditures were higher and varied greatly in secondary and tertiary hospitals, surveillance was carried out at the primary health centres in order to get a sense of the state's minimal economic burden associated with scrub typhus sickness. Based on the reported epidemiological data of Mizoram for the year 2021 and 2022 [9], and the line-listing data of 2023, the economic lost due to the disease was calculated among hospitalized and non-hospitalized patients. The economic lost was compared to the average GSDP (gross state domestic product) of the state in order to determine the intensity of the economic burden in Mizoram [19].

### Statistical analysis

Proportions, percentages, and means of cases were calculated. Seasonality and disease prevalence was also assessed. Origin Pro 8 software (OriginLab Corp., Northampton, MA, USA) was used for descriptive analysis.

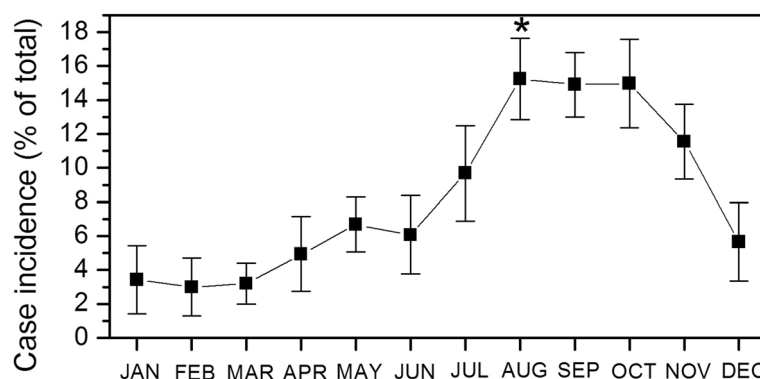
### Results

During the three years study (2021 – 2023), a total of 22870 scrub typhus cases have been recorded in the present study area. The diseases affected slightly higher among males (50.9%) when compared to females (49.1%). The disease incidence rate was calculated using the total projected population size of the tribal ethnic groups for the year 2023 (1333943). An increasing trend of the disease incidence rate was also observed during the study period with significantly higher cases in the year 2023 (932.95 per 100,000 persons) when compared to the previous years (Table 1). The annual incidence of scrub typhus was estimated to be 571.48 per 100,000 persons. The annual burden of scrub typhus among the elderly cohort (70+) is significantly higher at 1964.5 per 100,000 persons, and a remarkably high incidence among the reproductive and working age groups (20 to 49 years) is also noted. Correlation analysis revealed that there was a positive relationship between age and the burden/incidence of the disease ( $p < 0.05$ ,  $r = 0.8798$ ) in the study area, and seasonality of the disease was also noted. Based on the disease incidence data of three years (2021–2023), significantly lower cases were observed during the months of January to April. August marked the peak of cases, which then decreased until January of the next year (Fig. 1). Out of the total scrub typhus-positive individuals

**Table 1** The annual incidence of scrub typhus (Mean  $\pm$  S.E.) in Mizoram during the years 2021 to 2023

	Year	Annual cases			Annual cases per 100,000 persons
		Male	Female	Total	
	2021	1589	1516	3105	232.76
	2022	3736	3584	7320	548.75
	2023	6335	6110	12445	932.95
	<b>Total</b>	<b>11660 (50.9%)</b>	<b>11210 (49.1%)</b>	<b>22870</b>	<b>571.48</b>
<b>Age group</b>	<b>Population</b>				
0–9	290760	481.0 $\pm$ 187	405.3 $\pm$ 163	886.3 $\pm$ 351	304.8
10–19	276533	402.0 $\pm$ 160	352.3 $\pm$ 133	754.3 $\pm$ 294	272.7
20–29	260387	487.3 $\pm$ 164	439.6 $\pm$ 147	927.0 $\pm$ 311	356.0
30–39	195557	657.6 $\pm$ 239	625.6 $\pm$ 209	1283.3 $\pm$ 448	656.2
40–49	135460	637.6 $\pm$ 217	653.3 $\pm$ 231	1291.0 $\pm$ 449	953.0
50–59	91762	466.0 $\pm$ 149	516.0 $\pm$ 173	982.0 $\pm$ 323	1070.1
60–69	49450	421.0 $\pm$ 140	409.6 $\pm$ 165	830.6 $\pm$ 304	1679.6
70 & above	34034	334.0 $\pm$ 123	334.6 $\pm$ 109	668.6 $\pm$ 233	1964.5
<b>Total</b>	<b>1333943</b>	<b>3886 <math>\pm</math> 1372</b>	<b>3736 <math>\pm</math> 1328</b>	<b>7623 <math>\pm</math> 2700</b>	<b>571.48</b>

Results were expressed as mean  $\pm$  S.E. The projected population for the year 2023 was used for computing age-standardized disease incidence



**Fig. 1** Monthly percentage distribution of scrub typhus cases in Mizoram during the year 2021 to 2023. \* Peak of cases. Results are expressed as mean  $\pm$  S.E., and  $n=3$

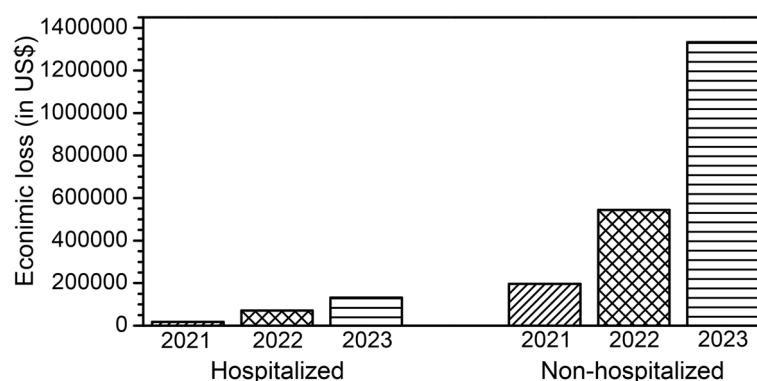
in three years, 3551 (15.52%) were hospitalized and 19,319 (84.48%) were non-hospitalized. Based on the last three years data (2021–2023), the proportion of cases (95% CI) from June to November and from December to May was 0.6424 (0.5696–0.7299):0.3575 (0.2701–0.4303),  $p<0.001$ .

Based on the data and information collected from patients randomly selected from 10 PHCs in rural areas, the diagnostic expenditure among the hospitalized and non-hospitalized patients ranges between US\$ 5.96 and US\$ 12.10 (Table 2). At the time of this study, 1 US\$=82.96 Indian rupee. The disease treatment expenditure also ranges between US\$ 11.47 and US\$ 32.22. For both hospitalized and non-hospitalized individuals, the minimum disability days were fourteen and seven days respectively. Therefore, the loss of wages for each patient of working age group, both hospitalized and non-hospitalized throughout

their sickness was found to be US\$ 63.28 and US\$ 31.64 respectively, which was calculated in accordance with the minimum salaries of unskilled workers (US\$ 4.52 per day) notified by the LESDE government of Mizoram. Therefore, the total economic burden of hospitalized patients during 2021, 2022, and 2023 was US\$ 18,791.54, US\$ 76,379.30, and US\$ 141,464.56, respectively, totalling US\$ 236,635.40. The economic burden of the non-hospitalized patients during the same years was also found to be US\$ 55,126.33, US\$ 146,669.88, and US\$ 291,572.19 respectively, totalling US\$ 493,368.40. The overall three years economic burden among the patients was found to be US\$ 730,003.80, with an average annual economic burden of US\$ 243,334.60. Comparison of annual economic burdens of scrub typhus during the three years of the present study also revealed an increasing trend of the economic burdens each year (Fig. 2), and the annual economic burden (US\$ 243,334.60) contributed

**Table 2** Minimum economic cost of scrub typhus disease in Mizoram during 2021–2023 (in US\$)

i	ii	iii	iv	v	vi	vii	viii	ix	x
Year	Total no. of patients	Average diagnostic cost	Average treatment cost	Total loss (ii x iii + iv)	No. of patients in working age group	No. of Disability days	Daily wages	Total loss of wages (vi x vii x viii)	Total loss (v + ix)
<b>Hospitalized patients</b>									
2021	338	9.64	23.49	11,197.94	120	14	4.52	7,593.60	18,791.54
2022	1279	10.2	26.66	47,143.94	462	14	4.52	29,235.36	76,379.30
2023	1934	12.1	32.22	85,714.88	881	14	4.52	55,749.68	141,464.56
<b>Total</b>									<b>236,635.40</b>
<b>Non-hospitalized patients</b>									
2021	2767	5.96	11.47	48,228.81	218	7	4.52	6,897.52	55,126.33
2022	6041	6.24	13.76	120,820.00	817	7	4.52	25,849.88	146,669.88
2023	10,511	7.07	17.50	258,255.27	1053	7	4.52	33,316.92	291,572.19
<b>Total</b>									<b>493,368.40</b>
<b>Grand total (3 years)</b>									<b>730,003.80</b>
<b>Annual economic burden</b>									<b>243,334.60</b>


**Fig. 2** The economic burden of scrub typhus disease (in US\$) among hospitalized and non-hospitalized patients in Mizoram during the study period, 2021–2023

0.08% of the state GSDP (US\$ 310,835,270.83). The result of present study also revealed that the mean annual economic burden of each individual patient was US\$ 31.92 (INR 2648.08) which is 1.42% of the per capita income.

## Discussion

In Mizoram, scrub typhus cases have been increasing for the past 12 years and have reached 12,445 cases in 2023. The disease is widespread in Mizoram in both rural and urban areas, with the highest cases in Aizawl and Serchhip districts [12]. Disturbance of public movement especially among the farmers as a result of the total lockdown during the Covid-19 outbreak (2020 and 2021) may play a role in increased number of scrub typhus cases in Mizoram state during the year 2023. The ecological niche, forest cover, and socioeconomic conditions favour a conducive environment for the rodent hosts to transmit the disease in Mizoram [14]. The cases were

reported throughout the year, with the highest case during monsoon and post-monsoon season, which has been observed for the past five years [12]. Similar pattern of seasonality was observed by several studies carried out in India [20–22], and in Southeast Asian countries like China, Taiwan, South Korea, and Japan [23]. The highest number of cases observed during the months of August, September, and October in the present study may correlate with the maximum farming activities in the process of traditional agricultural practice (Jhum/shifting system) during the monsoon season [13, 24].

The disease was mainly found in the working and elderly population, who are the breadwinners of the household. Mizoram's state economy relies on the agricultural sector, as more than 70% of the state population is engaged in agriculture and related activities [25]. It has been reported that the disease mostly affected the farmers, including daily wage workers involved in agriculture [12]. Since



daily-wage-earning workers are the most susceptible population, a severe illness can result in exorbitant health expenditure for the household [26]. Currently, scrub typhus is treated using widely used antibiotics— azithromycin or doxycycline, with appropriate supportive care [27].

Since there are slight variations in the total expenditure due to differences in the severity of the disease, this study is based on the average minimum medical cost and loss of wages during disability days of the hospitalized and non-hospitalized patients, which can be a reference to the financial burden of scrub typhus. The medical cost was almost doubled for hospitalized patients. The major contributor to the total expense was loss of wages during illness. The annual economic loss in the present study was estimated based on the minimum expenditures at the PHC level in rural areas. This annual loss of 0.08% of the state GSDP, and also 1.42% of per capita income contributed by scrub typhus disease alone in the tribal state of Mizoram may be considered as significant. Moreover, if the estimation of economic loss included secondary and tertiary hospitals, where expenditures were generally higher than the primary levels, the annual economic burden contributed by scrub typhus could be yet higher than the present findings of 0.08% of the state GSDP. Management of scrub typhus infections requires strong coordination between the general public and medical personnel due to the significant impact of undiagnosed or untreated scrub typhus on costs and disease burden. If rickettsial infections are not treated early and effectively, there may be increased morbidity and expenses for patients and the health departments of the state. Thus, it may be advantageous for the state of Mizoram to designate rickettsial diseases as a priority illness with an established and effective treatment and vector control.

However, there are certain limitations in this study. This is a partial economic evaluation, and in this retrospective study, patients from secondary and tertiary hospitals were not included, which may introduce bias or inaccuracies. Furthermore, the small sample size was a drawback as well; larger study populations should be the focus of future research.

## Conclusion

The results of the present study revealed a higher prevalence of scrub typhus among the tribal ethnic groups of Mizoram state when compared to reports from other countries, and the maximum prevalence observed during the months of August to October may correlate with the maximum farming activities of the indigenous ethnic groups during this season. The actual economic loss due to the scrub typhus disease could be much higher than the loss observed in the present study, and hence prevention and control measures for these diseases are inevitable as the poorer sections of the population in this study area are most affected by this disease.

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-22302-5>.

Supplementary Material 1.

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## Authors' contributions

GR and LP have drafted the manuscript and revised the final version. VR and LR have designed methodology, supervised and undertaken data curation. GR, LP, RL, RV and HR have undertaken the investigation and formal analysis of the work. LP and ML have undertaken personal interview with participants. All authors reviewed the final version of the manuscript.

## Funding

Nil.

## Data availability

The datasets used in the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

An informed consent was taken from the human participants using standard informed consent form, and a personal interview was conducted. The present study protocol was in accordance with the Helsinki Declaration of 1975 and was approved by the Institutional Animal Ethics Committee, Pachhunga University College, Aizawl, Mizoram, India (PUC/IAEC/2019–21/021. Date: 5 July, 2021).

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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