The economic burden of dengue disease in Mizoram state, northeast India

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Abstract

Dengue prevalence has dramatically increased during the last decade in Mizoram with the first outbreak occurred in 2016, and a total of 9,954 cases and 8 fatalities recorded between 2021 and 2024. Data from 200 confirmed dengue cases were collected through structured questionnaires and medical bill reviews in both public and private hospitals. The economic burden was estimated by calculating direct and indirect costs. In Mizoram state, dengue incidence rate increases during the past 4 years, peaking at 252.18 per 100,000 persons in 2024. The disease burden was notably high among children and the elderly. The overall annual economic burden (direct and indirect) amounted to US$ 158,585.16, 0.0014% of the gross state domestic product. The present findings emphasize the importance of integrated public health strategies such as targeted seasonal interventions, awareness campaigns, and investment in preventive infrastructure to reduce health and economic impact of dengue in Mizoram state, India.

Keywords: Dengue, economic burden, epidemiology, Mizoram.

Introduction

Dengue is a disease spread by vectors that is a major global health concern. The dengue virus (DENV, 1–4 serotypes), one of the most significant arboviruses in tropical and subtropical areas, is the cause of it. **[1]** The illness is not just found in cities; it has recently spread to rural areas as well. **[2]** In India, dengue epidemics have increased since the mid-1990s, particularly in urban areas, and have swiftly expanded to previously dengue-free areas like Orissa, Arunachal Pradesh, and Mizoram. There have been multiple outbreaks and cases throughout the nation. **[3, 4]** In India, the first dengue case was discovered there in 1921. It has been reported that the northeastern states of India are home to all four DENV serotypes (DENV1, 2, 3, and 4). **[5]** In many Indian cities and rural regions, dengue has become a serious public health issue that claims many lives each year. **[6]** The National Vector Borne Disease Control Programme (NVBDCP) has seen a rise in dengue infections in recent years. **[7]**

In Mizoram, the first dengue outbreak happened in 2016, and the first case happened in 2012. **[8]** This state has seen a sharp rise in dengue infection rates (300 per 100,000 people) in 2022 and 2023. **[9]** In line with global trends, the incidence of dengue has also dramatically increased in Mizoram.

In the nations where the dengue virus is endemic, the infections inflict significant morbidity and a significant economic cost. **[10, 11]** Research conducted in Gujarat, India, has also revealed that patients admitted to private hospitals had a much greater economic burden from dengue fever than those admitted to government facilities. **[12]** The burden of the sickness extends beyond the sufferer and their family; the government also pays for vector control measures, diagnosis, and treatment. Various studies related to dengue disease burden have been reported from America **[13]**, Asia and South Asia. **[14-19]** Additionally, a number of research have calculated India's dengue disease burden. **[20, 21]**

The economic impact of dengue in India has been the subject of very few studies. These studies are necessary to increase community awareness and draw the attention of the health care system and policymakers. A prospective study that employs data from several sites and treatment facilities and has a broad economic approach is the most effective way to estimate economic burden because socioeconomic levels differ across the country. Furthermore, data regarding the disease's economic burden and cost must be continuously assessed and updated. Assessing the financial impact of dengue in Mizoram, India, was the aim of the current study. Nearly 55% of Indian households receive their medical care from the private sector, where expenses can reach 60% of total national costs. Thus, it is crucial to assess the financial impact. **[22]** There are few studies on the dengue virus's prevalence in Mizoram, and the disease's financial costs have not yet been examined.

Materials and Methods

1. Study area

Situated in the northeastern region of India, Mizoram is one of the smallest states with eleven districts. The state's international borders with Bangladesh and Myanmar are 722 kilometers long, and lies between 21˚56ˈN and 24˚31ˈN and 92˚16ˈE and 93˚26ˈE. It has a humid subtropical climate with 46% relative humidity and receives 254 cm of rainfall annually. **[9]** According to the *Economic Survey of Mizoram 2021–22*, over half of the population of Mizoram derives a major part of their income from the primary sector (agriculture and allied activities). **[23]** However, the actual contribution of the primary sector to the state's Gross State Domestic Product (GSDP) is relatively modest. According to the *Economic Survey of Mizoram 2024–25*, Mizoram state has the projected Gross State Domestic Product (GSDP) of US dollars (US$) 4.14 billion (INR 3,557,884 crores) with the per capita income of US$ 2868.42 (INR 2.46287 crores) in 2024. **[24]** About 20% of households are classified as Below the Poverty Line (BPL) because their income is below the state's per capita income. **[25]**

2. Data source and study settings

The present study protocol was approved by the Institutional Ethics Committee, Pachhunga University College, Aizawl, in accordance with the Helsinki Declaration of 1975, and also the present study procedures followed the ICMR’s Ethical guidelines for biomedical and health research on human participants (2017). In this study, 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 Government of Mizoram's Integrated Disease Surveillance Programme provided the line-listing statistics of dengue cases in Mizoram for the year 2024. Patient details such as age, sex, address, test results, diagnosis date, symptoms, hospitalization status, etc. were included in the data. The incidence rate was computed for both sexes and various age groups. Since the population census was not conducted in 2021 due to the Covid-19 outbreak, the disease's incidence rate was calculated based on the 2024 projected population of the state. Data were electronically collected (soft copy) by automatic extraction. Participants were identified

through the line-listing data of the state government. Eligible participants were contacted, and recruitment was done via phone calls and in-person interview. Only those who met the inclusion and exclusion criteria and consent to participate were enrolled in this study. Meteorological data, including rainfall and temperature of Mizoram state for the year 2024, was also obtained from the Directorate of Science & Technology, government of Mizoram.

3. Economic burden estimation

In order to determine the state's minimal economic impact of the illness, a survey of dengue disease inpatients and outpatients was carried out. The study was conducted in 10 Public Health Centers (PHC) of the state government and 6 private hospitals within the state of Mizoram. Data on all potential expenses were gathered in order to accurately estimate the economic burden caused by dengue disease. After obtaining informed agreement from participants, 200 dengue cases in total, 100 each from inpatients and outpatients were surveyed through phone calls and personal interviews. Data was extracted through medical bill review and interviews with a planned and tested questionnaire. A well-thought-out and tried-and-true protocol was used to gather all the data, which was aimed at several government and private hospitals. Data on various dengue-related expenses, whether directly or indirectly related, comprised the main parts of the questionnaire.

4. Inclusion criteria

- Dengue patients during the years 2021 to 2024.
- Dengue patients confirmed by NS1 antigen or IgM ELISA tests.
- Residents of the study area, Mizoram.
- Willingness to participate ability to comprehend study procedures.
- Aged above 16 years.

5. Exclusion criteria

- Patients diagnosed by techniques other than the NS1 and IgM ELISA tests.
- Patients unwilling to participate.

6. Indirect cost

The total number of wage loss days was used to determine the indirect cost, which included the time in days spent by the patient and their caregiver. For patients' wage loss estimation, only patients belonging to working age groups were considered. On the other hand, the wage loss of the caregiver was also calculated for all recorded patients, as the patient caregiver, who was usually a family member, was almost always from the working-age group. The minimum wages of unskilled workers (US$ 4.95 per day) announced by the Labour, Employment, Skill Development and Entrepreneurship (LESDE), Government of Mizoram, were multiplied by the average number of sick days lost by the patient and caregiver (1 US$ = 84.78 INR at the time of conversion).

7. Direct cost

The patient's medical bills were included in the direct cost. Medical costs included hospital care, diagnosis, medication, doctor consultations, and other medical costs like nursing and doctor fees for inpatients. For this study, 200 random recovered patients, hospitalised and non-hospitalised, were surveyed through personal interviews, and medical bills were reviewed for direct cost estimation.

Results and Discussion

A total of 3390 dengue cases were reported during the year 2024. The disease prevalence was very similar between males (50.9%) and females (49.1%) (Table 1). The entire estimated population of Mizoram for 2024 was used to compute the illness incidence rate (1,344,266) (Table 1). The overall disease incidence rate during the year 2024 was 252.18 per 100,000 persons. The burden of dengue fever is significantly higher among children (0-9 years) and the elderly (>70 years). Age and the disease incidence rate were found to be negatively correlated using correlation analysis ($p<0.05$, $r=0.78$). The illness exhibited clear seasonality, with fewer instances reported in January and the highest number occurring in October (Figure 1). Temperature reaches its maximum during the month of April, while heavy rainfall is seen during the summer monsoon season, i.e., May to August.

Table 1. Age and sex-wise distribution of dengue cases in Mizoram during the year 2024.

Age group	Population *	Number of cases			
		Male	Female	Total	Cases/100,000 persons
0-9	2,64,998	628	536	1164	439.24
10–19	2,16,671	239	238	477	220.14
20-29	2,63,342	234	236	470	178.47
30-39	2,30,942	238	210	448	193.98
40-49	1,47,920	143	159	302	204.16
50-59	1,20,645	104	131	235	194.78
60-69	61,868	77	85	162	261.84
70 and above	37,880	64	68	132	348.46
Total	**13,44,266**	**1727 (50.9%)**	**1663 (49.1%)**	**3390**	**252.18**

*Projected population of Mizoram state for the year 2024.

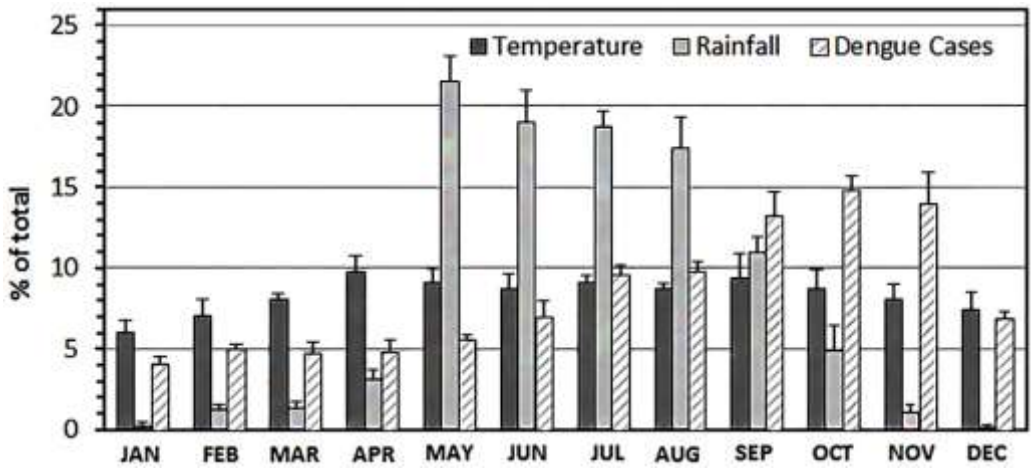

Figure 1. Graph showing seasonal patterns of temperature, rainfall, and dengue cases in Mizoram during the year 2021 - 2024. Results are expressed as mean ± S.D. of % of total, n = 4.

The indirect economic burden of illness over a four-year period (2021–2024), focusing specifically on wage losses experienced by both patients and their caregivers, are shown in Table 2. During the four-year study period, the total hospitalized patients were 728, of which 186 were in the working-age group (20 to 49 years), while the total non-hospitalized patients were 9,226, with working-age patients of 4,030. The total wage loss due to illness among the hospitalized patients was US$ 37,079.7, and among the non-hospitalized patients, the wage loss was US$ 215,432.3. The average numbers of disability days among hospitalized and non-hospitalized patients were 13.6±3.2 and 5.3±1.9, respectively. The majority of patients were non-hospitalized, so the aggregate wage loss was significantly higher, despite fewer days lost per person. The total wage loss during the study period was US$ 252,512.0, which represents the total indirect economic impact due to wage loss. The average annual wage loss over the four years was US$ 63,128.0. Non-hospitalized cases have a greater cumulative impact due to sheer volume.

Table 2: Quantification of Indirect cost (in US$) associated with Dengue illness during the year 2021 to 2024 in Mizoram.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	9
	No. of patients		**Daily wages**	**No. of disability days***		**Total loss**		**Total wage loss (7+8)**
	Total	**Working age**		**Patient**	**Caretaker**	**Patient (3x4x5)**	**Caretaker (2x4x6)**	
IPD	728	186	4.95	13.6±3.2	6.8±2.4	12,521.5	24,558.2	**37,079.7**
OPD	9,226	4,030	4.95	5.3±1.9	2.4±1.7	105,779.8	109,652.5	**215,432.3**
Total	**9,954**	**4,216**	-	-	-	**118,301.3**	**134,210.7**	**252,512.0**
Annual wage loss								**63,128.00**

*Disability days were expressed as mean±S.D.

Table 3 summarizes the costs of healthcare treatment in non-government tertiary hospitals and government primary and secondary health centers. The data includes outpatient (OPD) and inpatient (IPD) cases. Direct cost due to illness includes expenses in consultancy charges, accommodation, nursing care, medicine, investigation, and doctor charges. The total number of cases in non-government hospitals within the study period is 3,606, comprising 3,077 outpatients and 529 inpatients. The total number of cases in government hospitals is 6,348, comprising 6,182 outpatients and 166 inpatients. The overall expenditures for both outpatients and inpatients in non-government hospitals were US$ 67,694.00 and US$ 252,385.90, respectively, while a significantly lower direct cost was observed among the patients in government hospitals. The sum total of direct medical expenses of 9,954 patients during the four-year study period became US$ 381,828.64. Consultancy charges in non-government hospitals are much higher than in government centers, while costs are nearly negligible for accommodation in government hospitals. Compared to government hospitals, non-government institutions have substantially higher inpatient medication costs. The investigation charges are higher in non-government hospitals for both OPD and IPD, and hospital stays are slightly longer in non-government hospitals (7.14±2.23 days) when compared to government hospitals (6.4±2.44). The overall treatment charges are significantly higher in non-government hospitals when compared to government hospitals.

Table 3: Quantification of Direct cost associated with Dengue illness in Mizoram during the year 2021 to 2024 (in UD$).

Facilities	**Tertiary hospitals (Non-Government)**		**Primary and secondary health centres (Government)**	
	OPD	**IPD**	**OPD**	**IPD**
No of cases	3,077	529	6,182	166
Consultancy	3.61±0.48	3.61±0.38	0.12±0.02	NA
Accommodation	NA	69.62±4.34	NA	0.59±0.1
Nursing care	NA	58.41±5.33	NA	NA
Medicine	8.54±1.93	173.50±6.12	8.14±1.86	22.37±3.63
Investigation	9.85±1.55	58.47±4.76	NA	41.41±4.94
Doctor charges	NA	113.49±7.90	NA	NA
Total charges	**22.00±3.29**	**477.10±16.86**	**8.26±1.63**	**64.37±4.20**
Overall cost	**67,694.00**	**252,385.90**	**51,063.32**	**10,685.42**
Total direct cost				**US$ 381,828.64**
Annual direct cost				**US$ 95,457.16**
Annual indirect cost				**US$ 63,128.00**
Total annual economic burden				**US$ 158,585.16**

NA = Not applicable. Results were expressed as mean±S.D.

The sum total of both direct and indirect economic burdens due to dengue fever during 2021-2024 within Mizoram state accumulates to US$ 634,340.64, with the annual economic burden of US$ 158,585.16. This economic burden of dengue disease shared 0.0014% of the GSDP. Each patient lost an average of US$ 63.72 each year, which is approximately 2.22% of the state per capita income (US$ 2,868.42). The actual value may go higher than the estimated amount, as the study does not account for direct non-medical expenses such as transportation, special dietary needs, general food expenses, and other potential costs.

In the state of Mizoram, India, dengue fever has become an increasingly serious public health issue, where outbreaks were historically unknown until the first reported case in 2012. Since then, the disease has taken a sharp upward trajectory, culminating in a significant spike in cases during the period of 2021 to 2024. It began with only 8 reported cases in 2021 and escalated to a total of 9,954 cases over the four-year period, peaking at 3,390 cases in 2024 alone. This alarming rise signifies not only the increasing geographical spread of the vector-borne disease but also the vulnerability of Mizoram's population to emerging infections, especially in urban and peri-urban zones like Aizawl city. The monsoon season, characterized by high humidity and rainfall, resulted in a surge in mosquito populations due to increased breeding opportunities. **[26]** The seasonal trend of dengue cases in the present study shows the peak of transmission (October) following the monsoon season. Both genders were almost equally affected, while children aged 0–9 and those above 70 years emerged as the most vulnerable age groups.

The study goes beyond merely documenting the incidence of dengue; it undertakes a rigorous estimation of the economic burden imposed on individuals, families, and the broader healthcare infrastructure. The total economic impact of dengue in Mizoram was evaluated by analyzing both direct and indirect costs. Direct costs involved out-of-pocket medical expenditures, including doctor consultations, hospitalizations, medications, and diagnostic procedures. Indirect costs captured the economic value of productivity loss due to illness, accounting for both patients and their caregivers. The overall annual economic burden during the four-year study period (US$ 158,585.16) is likely to underestimate the true cost due to the exclusion of non-medical expenses such as transportation, food, and long-term health impacts.

A critical observation from the study was the obvious contrast in healthcare expenditures between private tertiary hospitals and government primary or secondary centers. Private hospitals charged significantly more for inpatient care, with costs over US$ 252,385.90 for 529 cases, while government facilities incurred much lower costs of about US$ 10,685.42 for 166 patients. This disparity illustrates the financial strain placed on patients who rely on private healthcare, especially in a state where nearly 20% of households fall below the poverty line. While government healthcare schemes and subsidies (such as those under PM-JAY or state-specific programs) are available, they remain underutilized or inaccessible to certain segments of the population. The study highlights a deep-rooted inequality in health access and affordability. While public hospitals offer essential and low-cost treatment, the preference for or necessity of seeking care from private institutions often pushes households

into financial misery. This is especially concerning in a setting like Mizoram, where the per capita income is relatively low and many families operate with limited financial buffers. The findings call attention to the need for improved healthcare coverage, increased awareness about government support programs, and stronger integration of public-private partnerships in health service delivery.

In terms of public health implications, the study underscores the urgent need for enhanced vector surveillance, rapid diagnostics, and targeted awareness campaigns especially before and during peak transmission seasons. Seasonal analysis indicates that interventions focused during the monsoon and immediate post-monsoon periods could significantly control the spread of the virus. Given that a large proportion of the affected population comprises children and working adults, school health programs and workplace awareness initiatives could serve as crucial tools for early detection and prevention.

Policymakers must take into account not only the health impacts but also the economic consequences of recurring dengue outbreaks. The study makes a strong case for incorporating economic assessments into health planning and budget allocations. Health departments and finance ministries should work together to mitigate the cascading effects of such diseases on public and household economies. Enhanced investment in preventive infrastructure like mosquito control, sanitation, and clean water access can yield long-term economic benefits by reducing the need for expensive curative care.

Finally, this study contributes significantly to the limited body of literature on the economic burden of dengue in India, particularly in under-researched regions like Northeast India. It provides concrete data that can inform evidence-based policymaking and prioritization of resources. It also offers a model for conducting similar research in other states or for other vector-borne diseases. Ultimately, the study calls for a holistic, multi-sectoral approach that integrates health, economics, and social welfare to address the complex challenges posed by dengue fever in Mizoram and beyond.

Conclusion

This study robustly quantifies the dual burden (health and financial) of dengue in Mizoram, demonstrating that the cost not only affects patients but also caregivers, public health systems, and the state economy at large. The data calls for urgent integration of health and economic policy to better manage the ongoing challenge of dengue in emerging hotspots like Mizoram.

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Conflict of interest statement

The authors declare no competing interests.

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