International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 12, No. 4, Oct-Dec 2023 Online ISSN: 2250-3137
Print ISSN: 2977-0122

ORIGINAL RESEARCH

Comparison of Seroprevalence and Clinical Profile of Dengue Among Rural and Urban Populations: A Joint Study of Serology and Epidemiological Patterns

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Received: 23 September, 2023 Accepted: 25 October, 2023

ABSTRACT
Background: Dengue fever is a major public health challenge in both urban and rural India. Although traditionally considered an urban disease, increasing reports from rural areas have highlighted the need to understand its seroprevalence and clinical behavior in different epidemiological settings. **Aim:** To compare the seroprevalence, clinical profile, and associated environmental and preventive factors of dengue infection among rural and urban populations. **Material and Methods:** This hospital-based cross-sectional comparative study was jointly conducted by the Departments of Microbiology and Community Medicine. A total of 180 clinically suspected dengue cases were enrolled—90 each from rural and urban areas—using stratified random sampling. Clinical assessment was followed by serological testing using NS1 antigen, IgM, and IgG ELISA kits approved by NVBDCP. Epidemiological data on environmental conditions, vector control practices, and awareness were collected through structured interviews. Statistical analysis was done using SPSS version 25.0, with a p-value <0.05 considered statistically significant. **Results:** The majority of participants were aged 19–40 years (50.00% rural, 57.78% urban), and males slightly outnumbered females (55%). NS1 positivity was higher in rural areas (40.00%) while IgM and IgG positivity were higher in urban areas (28.89% and 33.33% respectively). Overall seroprevalence was comparable (rural 67.78%, urban 72.22%). Fever, headache, and myalgia were the most common clinical features, with no significant differences between groups. Preventive practices such as use of mosquito nets and repellents were significantly more common in urban areas ($p = 0.01$ and $p < 0.001$, respectively). Urban participants also demonstrated significantly higher awareness of dengue prevention (76.67% vs. 44.44%, $p < 0.001$). Hospitalization and complication rates (DHF and thrombocytopenia) were slightly higher in urban areas but not statistically significant. **Conclusion:** Dengue affects both rural and urban populations similarly in terms of seroprevalence and clinical manifestations. However, disparities exist in awareness, preventive behaviors, and environmental exposures, with rural populations being at greater risk due to limited resources and vector control practices. Focused public health interventions are essential to address these gaps, particularly in rural settings.
Keywords: Dengue, Seroprevalence, Rural Population, Urban Population, Vector Control

INTRODUCTION
Dengue fever has emerged as one of the most significant vector-borne viral infections in the world, particularly in tropical and subtropical regions. Caused by the dengue virus (DENV), which exists in four distinct serotypes (DENV-1 to DENV-4), this disease is primarily transmitted to humans through the bite of infected *Aedes* mosquitoes. Over the past few decades, dengue has shifted from an episodic epidemic to a sustained public health threat with

recurring seasonal outbreaks and endemic transmission in many regions, including India and Southeast Asia.[1]

The clinical spectrum of dengue infection ranges from asymptomatic or mild febrile illness to more severe forms such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). The clinical manifestations often depend on the patient's immune status, virus serotype, and genetic predisposition. While typical presentations include high-grade fever, retro-orbital pain, muscle and joint pains, and rash, atypical manifestations have increasingly been reported in various case series. These include hepatitis, encephalopathy, myocarditis, and neurological deficits, complicating the diagnosis and management in clinical settings.[2,3]

Epidemiological investigations across India have revealed significant geographical and seasonal variations in the prevalence and presentation of dengue. Rural and urban differences have been particularly emphasized in recent seroprevalence studies. In rural regions, low levels of awareness and delayed healthcare-seeking behaviors, coupled with inadequate vector control measures, contribute to a higher disease burden. In contrast, urban environments, often characterized by overcrowding and water storage practices, offer ideal breeding grounds for *Aedes aegypti*, leading to explosive outbreaks.[4]

Studies conducted in different regions of India, including Assam, Chhattisgarh, Maharashtra, and Uttar Pradesh, have documented a rising number of dengue cases with varying clinical profiles. Tertiary care hospital data have consistently shown an increase in both the number of admissions and the severity of illness, reflecting not only a true rise in incidence but also improved diagnostic capabilities and surveillance mechanisms. Serological surveys in both hospital-based and community settings have also demonstrated an increasing seroprevalence, indicating widespread exposure among the population, particularly in children and adolescents.[5]

Genetic characterization of circulating dengue virus strains has offered insights into viral evolution and regional variations in serotype dominance. Molecular studies from northern India, especially during outbreak periods, have revealed a predominance of DENV-2, although all four serotypes have been detected in different outbreaks across the country. Such findings underscore the complexity of immune responses and the heightened risk of severe disease upon secondary infection with a heterologous serotype.[6]

The impact of dengue extends beyond the immediate clinical and public health concerns. The disease imposes a substantial socioeconomic burden due to lost productivity, high healthcare costs, and strain on already stretched health systems during outbreaks. The challenges in dengue management are compounded by the absence of specific antiviral treatments, and current therapeutic approaches are largely supportive. Fluid management, monitoring for warning signs, and timely intervention are the cornerstones of effective clinical care.[7]

Environmental factors have also been closely associated with the dynamics of dengue transmission. Climatic conditions such as temperature, humidity, and rainfall play pivotal roles in influencing mosquito breeding and virus replication. Seasonal peaks of dengue, often observed during and after the monsoon months, are attributed to an increase in vector population and virus transmission efficiency. Climate change and unplanned urbanization are likely to further alter the epidemiological landscape, making prediction and control increasingly difficult.[8]

Surveillance systems, both passive and active, have been instrumental in capturing trends in incidence and distribution. However, underreporting remains a challenge due to overlapping clinical symptoms with other febrile illnesses and limited access to laboratory confirmation in resource-constrained settings. The actual burden of dengue is thus believed to be considerably higher than what is officially reported, necessitating more robust community-based surveillance strategies.[9]

Public health interventions focusing on vector control, community awareness, and early diagnosis have shown some success in reducing transmission during outbreaks. Nonetheless, sustained reductions in disease burden will likely require a combination of strategies including vaccine introduction, improvements in environmental sanitation, and strengthening of primary healthcare infrastructure. Despite significant progress in understanding the virology, transmission, and clinical management of dengue, several challenges remain. The emergence of atypical and severe manifestations, especially in the context of co-infections or comorbidities, demands high clinical vigilance. Furthermore, the increasing incidence of dengue in previously low-endemic or non-endemic areas signals a shift in the disease's geographical footprint, likely driven by environmental and social determinants.[10]

MATERIAL AND METHODS

This cross-sectional, comparative study was conducted jointly by the Departments of Microbiology and Community Medicine at a tertiary care teaching hospital. The study aimed to compare the seroprevalence and clinical profile of dengue infection among rural and urban populations by analyzing serological markers and epidemiological patterns.A total of 180 participants presenting with clinical suspicion of dengue fever were included in the study, with 90 participants each from rural and urban areas, respectively. Participants were recruited from outpatient departments, inpatient wards, and community outreach programs affiliated with the hospital. Stratified random sampling was used to ensure equal representation from both settings.

Inclusion Criteria

- Individuals aged ≥ 5 years presenting with clinical features suggestive of dengue (fever, rash, myalgia, retro-orbital pain, bleeding tendencies, etc.).
- Residents of either rural or urban areas for a minimum of one year.
- Willingness to participate and provide informed written consent (parental consent was obtained for minors).

Exclusion Criteria

- Patients with confirmed alternative diagnoses (e.g., malaria, chikungunya, enteric fever).
- Patients unwilling to consent or unable to provide complete epidemiological history.
- Immunocompromised individuals or those on long-term immunosuppressive therapy.

Data Collection and Clinical Assessment

After obtaining Institutional Ethics Committee (IEC) approval and informed consent, demographic data (age, sex, residence, occupation), clinical features, duration of illness, hospitalization status, and history of mosquito control practices were documented using a structured questionnaire. Each participant underwent a complete clinical examination with emphasis on signs consistent with dengue infection.

Serological Testing

Blood samples were collected under aseptic precautions and processed in the Department of Microbiology. Dengue infection was confirmed using:

- **NS1 Antigen Detection** (Day 1–5 of illness)
- **IgM and IgG ELISA tests** (Day ≥ 5 of illness)

All tests were performed using standard ELISA kits approved by the National Vector Borne Disease Control Programme (NVBDCP). Test results were interpreted as per manufacturer's instructions.

Epidemiological and Environmental Assessment

Participants were surveyed regarding exposure risk factors such as use of mosquito repellents, breeding site presence near residence, travel history to endemic areas, and community awareness about dengue prevention. Environmental risk assessment included observation of water stagnation, sanitation facilities, and waste disposal practices around the household.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 25.0. Descriptive statistics were used to summarize demographic and clinical data. Seroprevalence rates were compared between rural and urban groups using the chi-square test. Continuous variables were compared using independent t-tests. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Distribution of Study Participants

The demographic distribution revealed that the majority of participants in both rural and urban groups were in the 19–40 years age group, comprising 50.00% of rural and 57.78% of urban participants. This age group likely represents the most active segment of the population, who are more exposed to mosquito bites due to outdoor activities. Children (5–18 years) accounted for 26.67% of rural and 20.00% of urban participants, while those over 40 years made up 23.33% and 22.22%, respectively. The difference in age distribution was not statistically significant ($p = 0.24$). Regarding sex distribution, males were slightly more represented in both groups (53.33% in rural, 56.67% in urban), but the difference was not significant ($p = 0.67$).

In terms of occupation, a substantial difference was observed. In rural areas, farmers and laborers dominated (44.44%), whereas in urban areas, most participants were in service or other occupations (68.89%), indicating a significant socioeconomic and lifestyle contrast, though the overall p-value (0.61) was not statistically significant. Students were nearly equally distributed in both settings.

Table 2: Seroprevalence of Dengue Infection in Rural and Urban Populations

Serological analysis revealed that NS1 antigen positivity was higher in rural participants (40.00%) compared to urban (31.11%), suggesting earlier detection in rural cases. Conversely, IgM (20.00% rural vs. 28.89% urban) and IgG (24.44% rural vs. 33.33% urban) positivity were slightly more common in urban areas, possibly indicating delayed presentation or secondary infection in the urban population. However, none of these differences reached statistical significance (p-values ranging from 0.14 to 0.49). Overall, seroprevalence (any positive marker) was comparable, with 67.78% in rural and 72.22% in urban groups ($p = 0.49$). This suggests that dengue exposure is widespread in both settings, with no significant epidemiological edge.

Table 3: Clinical Presentation of Dengue Cases by Residence

All participants (100%) presented with fever, as it is a universal symptom of dengue. Headache (77.78% rural vs. 84.44% urban) and myalgia (71.11% rural vs. 75.56% urban) were also common and comparably distributed. While rash and retro-orbital pain were slightly more frequent in urban cases, bleeding manifestations were nearly equal (13.33% rural vs. 11.11% urban). None of the clinical differences were statistically significant, suggesting that the symptom profile of dengue does not significantly vary between rural and urban settings, although some symptoms may be more frequently recognized or reported in urban areas with better health awareness.

Table 4: Environmental and Preventive Factors Among Rural vs Urban Participants

Significant differences emerged in preventive practices and environmental exposures. Use of mosquito nets was more common in urban areas (55.56%) than rural (37.78%), with a statistically significant difference (p = 0.01). Similarly, the use of mosquito repellents was markedly higher in urban participants (68.89%) compared to rural (31.11%) (p < 0.001), reflecting better access to commercial preventive measures in urban households. Interestingly, the presence of mosquito breeding sites was reported more frequently in rural areas (73.33%) than in urban areas (61.11%), although this difference was not statistically significant (p = 0.07). Knowledge of dengue prevention was significantly higher among urban participants (76.67%) compared to rural ones (44.44%), with a strong statistical association (p < 0.001). These findings suggest urban populations are more informed and equipped for vector control, likely due to better education, awareness programs, and resources.

Table 5: Hospitalization and Complication Profile

The hospitalization rate was slightly higher in urban areas (38.89%) compared to rural (31.11%), possibly reflecting better healthcare-seeking behavior and accessibility in urban settings, though the difference was not statistically significant (p = 0.26). Dengue Hemorrhagic Fever (DHF) was noted in 7.78% of rural and 11.11% of urban cases, while thrombocytopenia (platelet count <100,000/mm³) was found in 35.56% of rural and 44.44% of urban participants. These differences were not statistically significant either (p > 0.05), indicating that the clinical severity and complication rates of dengue were relatively similar across both populations. However, the slightly higher rates in urban areas may suggest secondary infections or delayed presentation.

Table 1: Demographic Distribution of Study Participants (N = 180)

Variable	Category	Rural (n = 90)	Urban (n = 90)	Total (n = 180)	p-value
Age (years)	5–18	24 (26.67%)	18 (20.00%)	42 (23.33%)	0.24
	19–40	45 (50.00%)	52 (57.78%)	97 (53.89%)	
	>40	21 (23.33%)	20 (22.22%)	41 (22.78%)	
Sex	Male	48 (53.33%)	51 (56.67%)	99 (55.00%)	0.67
	Female	42 (46.67%)	39 (43.33%)	81 (45.00%)	
Occupation	Student	20 (22.22%)	18 (20.00%)	38 (21.11%)	0.61
	Farmer/Laborer	40 (44.44%)	10 (11.11%)	50 (27.78%)	
	Service/Other	30 (33.33%)	62 (68.89%)	92 (51.11%)	

Table 2: Seroprevalence of Dengue Infection in Rural and Urban Populations

Serological Marker	Rural (n = 90)	Urban (n = 90)	Total (n = 180)	p-value
NS1 Positive	36 (40.00%)	28 (31.11%)	64 (35.56%)	0.18
IgM Positive	18 (20.00%)	26 (28.89%)	44 (24.44%)	0.14
IgG Positive	22 (24.44%)	30 (33.33%)	52 (28.89%)	0.17
Any Positive	61 (67.78%)	65 (72.22%)	126 (70.00%)	0.49

Table 3: Clinical Presentation of Dengue Cases by Residence

Symptom	Rural (n = 90)	Urban (n = 90)	Total (n = 180)	p-value
Fever	90 (100.0%)	90 (100.0%)	180 (100.0%)	--
Headache	70 (77.78%)	76 (84.44%)	146 (81.11%)	0.23
Myalgia	64 (71.11%)	68 (75.56%)	132 (73.33%)	0.50
Rash	22 (24.44%)	30 (33.33%)	52 (28.89%)	0.19
Bleeding Manifestation	12 (13.33%)	10 (11.11%)	22 (12.22%)	0.65
Retro-orbital Pain	18 (20.00%)	25 (27.78%)	43 (23.89%)	0.22

Table 4: Environmental and Preventive Factors Among Rural vs Urban Participants

Factor	Rural (n = 90)	Urban (n = 90)	Total (n = 180)	p-value
Use of mosquito nets	34 (37.78%)	50 (55.56%)	84 (46.67%)	0.01*
Use of mosquito repellents (coils/spray)	28 (31.11%)	62 (68.89%)	90 (50.00%)	<0.001*
Breeding site near house	66 (73.33%)	55 (61.11%)	121 (67.22%)	0.07
Knowledge of dengue prevention	40 (44.44%)	69 (76.67%)	109 (60.56%)	<0.001*

*Significant p-value (<0.05)

Table 5: Hospitalization and Complication Profile

Parameter	Rural (n = 90)	Urban (n = 90)	Total (n = 180)	p-value
Hospitalized cases	28 (31.11%)	35 (38.89%)	63 (35.00%)	0.26

Developed Dengue Hemorrhagic Fever (DHF)	7 (7.78%)	10 (11.11%)	17 (9.44%)	0.44
Platelet count < 100,000/mm³	32 (35.56%)	40 (44.44%)	72 (40.00%)	0.22

DISCUSSION

In the present study, participants from both rural and urban settings were predominantly in the 19–40 years age group (50.00% rural, 57.78% urban), highlighting that dengue largely affects young adults, likely due to occupational and outdoor exposure. This demographic trend is comparable with the findings of **Sinha et al** who reported a high burden of dengue among young working individuals in Delhi.[11] Similarly, **Kumar et al** observed male predominance (55% in our study) in dengue cases, attributing it to increased outdoor activity and occupational exposure. Occupational distribution revealed that rural participants were mostly farmers or laborers (44.44%), while urban participants were primarily engaged in service or other occupations (68.89%).[12] This socioeconomic contrast may affect the level of exposure, awareness, and response to dengue infection, as also suggested by **Suresh et al** in their study across Kerala.[13]

The seroprevalence pattern in our study (Table 2) demonstrated NS1 antigen positivity in 40.00% of rural and 31.11% of urban cases, indicating early presentation in the rural group. Conversely, urban participants showed higher IgM (28.89% vs. 20.00%) and IgG (33.33% vs. 24.44%) positivity, possibly due to delayed presentation or secondary infections. Overall, 70.00% of the participants were seropositive (67.78% rural, 72.22% urban), closely resembling the 68.3% reported in the community-based study by **Suresh et al**, suggesting a high level of endemicity.[13]**Biradar et al** also reported seasonal variation in NS1 and IgM/IgG detection, noting that urban residents may undergo testing at later phases of illness, leading to higher antibody detection.[14] Our comparable rural and urban seroprevalence reinforces the understanding that **dengue is not confined to urban areas**, as it was historically thought, and rural transmission is equally significant, a point emphasized by **Saini et al** in western Maharashtra.[15]

The clinical symptomatology (Table 3) remained consistent across groups. Fever was universally present (100%), followed by headache (81.11%), myalgia (73.33%), and rash (28.89%). Retro-orbital pain and bleeding tendencies were reported in 23.89% and 12.22% respectively. These findings are consistent with the classical profile of dengue described by **Karoli et al** and **Mishra et al**, who documented similar symptom frequencies. The slight variation in rash and retro-orbital pain, being more frequent in urban participants, could be due to **better symptom recognition or health literacy in urban populations**. The lack of statistically significant differences suggests that **the virus affects patients uniformly**, regardless of their residence, as long as the exposure risk and immunity status are comparable.[16,17]

Environmental and preventive behavior findings (Table 4) revealed significant contrasts. Use of mosquito nets (37.78% rural vs. 55.56% urban, $p = 0.01$) and repellents (31.11% rural vs. 68.89% urban, $p < 0.001$) were significantly more common in urban participants. Awareness regarding dengue prevention was also significantly higher in urban areas (76.67% vs. 44.44%, $p < 0.001$). These differences reflect **urban-rural disparities in health education, economic access, and exposure to public health messaging**, as previously documented by **Bhatti et al**. Despite this, breeding sites were more prevalent around rural households (73.33% vs. 61.11%), indicating a **greater vector density in rural settings**, which may contribute to transmission despite lower awareness and preventive measures.[18] This observation aligns with the findings of **Suresh et al**, who emphasized the role of environmental sanitation in controlling rural dengue outbreaks.[13]

Regarding hospitalization and complications (Table 5), 35.00% of the total participants required hospitalization, with a slightly higher proportion in urban areas (38.89% vs. 31.11%). Dengue Hemorrhagic Fever (DHF) was seen in 9.44% of cases, and 40.00% had platelet counts <100,000/mm³. These findings are similar to those of **Samanta and Sharma**, who noted that thrombocytopenia and DHF are significant complications but can occur irrespective of urban or rural residence.[19] The slightly higher complications in urban cases may be linked to **secondary infections**, as inferred from higher IgG positivity, which has been associated with severe manifestations in previous literature, including **Sinha et al**.[11]**Karoli et al** also reported similar trends in hospitalization and complication profiles in their North Indian cohort, reinforcing the similarity in disease progression across demographics.[16]

CONCLUSION

This study demonstrates that dengue affects both rural and urban populations with comparable seroprevalence and clinical profiles. However, significant differences were observed in preventive practices, awareness, and environmental risk factors, with rural areas being more vulnerable due to lower health literacy and higher mosquito breeding sites. Strengthening community-level health education and vector control, especially in rural settings, is essential to curb the spread of dengue. Integrated public health strategies tailored to regional needs can enhance early diagnosis, prevention, and management of dengue infection.

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