

Impact of Circular Economy on Dengue Fever Cases in Sondekoppa Village, Rural Bangalore



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Abstract

Dengue fever is a significant public health issue in India. The number of reported cases varies each year. According to the National Vector-Borne Disease Control Program (NVBDCP), the average yearly number of dengue cases in India between 2019 and 2024 is predicted to be 117,286. In Karnataka, the annual average is 10,561 instances throughout the same time period. Dengue fever has been a reportable disease in India since 1996; However, regional comparisons show that reported cases significantly underrepresent the true impact of the disease, a case study in Sondekoppa in rural Bangalore. It emphasizes the need for adjustments to accommodate underreporting. According to the World Health Organization Out-of-pocket healthcare costs in India reached 70.8% in 2010. This economic burden is compounded by the significant social impact of dengue in endemic areas. The World Bank reported a figure of 86.4%. The study analyzed dengue fever cases in Sondekoppa village for one month. They tested patterns based on age, gender, and stage of infection. Research from the Ranga Clinic reports a higher incidence in adult men. This may be due to work-related exposure. While cases in children are female dominated serologic results. It states that most cases are in the acute phase. This is evident in the presence of IgM antibodies. These findings highlight the urgent need for targeted public health interventions to effectively manage the dengue outbreak. The study also highlights that the burden of dengue fever is not has been reported and calls for strengthening surveillance systems in rural areas to better capture the true extent of these diseases.

Keywords: Dengue; Sondekoppa; NVBDCP; Economic burden; IgM

Introduction

Dengue fever is rapidly emerging as a global viral epidemic. Especially in the tropics and subtropics. The recent increase in dengue fever cases poses a significant public health risk. Nearly half of the world's population is at risk of infection. Dengue fever is endemic in India. Especially in large urban areas with frequent outbreaks in urban and rural areas such as Haryana, Maharashtra, Andhra Pradesh and Karnataka [1]. Dengue is an arboviral disease transmitted by the bite of infected female mosquitoes, mainly *Aedes aegypti* and, to a lesser extent by *Aedes albopictus* [2]. In India, the primary vectors responsible for transmitting the dengue virus are *Aedes aegypti* and *Aedes albopictus* mosquitoes. It is a viral disease that affects every part of the body and has spread globally. Although many diseases are undetectable, dengue fever can cause a wide variety of symptoms, from low fever to illnesses that are severe and potentially fatal. Some dengue viruses have four separate strains: DEN-1, DEN-2, DEN-3, and DEN-4 [3]. In 2013, a fifth serotype of the dengue virus was detected in Malaysia

[4]. Dengue cases have surged 30-fold over the past 50 years across 119 countries, with the WHO estimating 390 million infections annually and 3.9 billion people living in dengue-endemic regions [5]. The number of dengue fever cases worldwide increased from 23,283,274 cases in 1990 to 104,771,911 cases in 2017, a five-fold increase [23]. By 2020, India had 44,585 dengue cases and 56 deaths. This trend highlights the growing public health challenge, increase in dengue fever worldwide [6]. Approximately 75% of cases are reported from the Americas, South-East Asia, and the Western Pacific. Modelling suggests 96 million symptomatic infections globally, with Asia bearing 70% of the burden, and India alone contributing 34% of the total, The annual direct medical costs of dengue fever are \$548 million, with 67% of patients treated at outpatient facilities. And costs were only 18% compared to 33% of hospitalized patients, who accounted for a significant 82% of total costs. When including indirect non-medical costs the total economic impact will increase to \$1.11 billion. Equivalent to approximately \$0.88 per capita [7,8].

Dengue fever has not only seen an increase in the number and severity of the disease. But it also extends geographically. by moving from urban to rural areas. In India, this spread is linked to factors such as unplanned urbanization. environmental changes Interaction between pathogen and host and population immunity. Moreover, inadequate vector control also facilitates the spread of the virus. Effective prevention and control strategies focus on case identification, management, and vector control. The objective of this study was to assess the burden of dengue fever, disease patterns, and health-seeking behaviour among urban and rural populations as well as between the genders [6,9]. Between July and September 2024, Ranga Clinic in Karnataka reported ten dengue cases from Sondekoppa village to the Bengaluru Rural District Surveillance Office. Thick blood smears of the affected patients tested negative for malaria but confirmed the presence of dengue. From July 27 to September 5, 2024, an investigation was carried out to verify the outbreak, assess its epidemiological and entomological characteristics, and suggest effective vector control measures to contain the disease.

Materials and Methods

Study and Setting

The study area, Sondekoppa village, located in Bengaluru Rural District, Karnataka (13°00'N 77°22'E), has geographical coordinates of 13.0197831 latitude and 77.3834021 longitude. This study area includes around 881 houses and a population of approximately 4,045 residents. The district experiences an annual average temperature range between 22.0°C and 32.9°C, with an average yearly rainfall of 793 mm.

Data Collection

A retrospective review was undertaken on confirmed dengue fever patients at the Ranga clinic from July 31–August 31, 2024. Demographic and clinical laboratory data of individuals

participating in surveillance were acquired from blood or serum samples from probable dengue fever patients. Symptoms may include fever, rash, arthritis, and bleeding. Dengue fever is defined as a fever lasting 2-7 days with at least two symptoms, such as headache and ocular pain. Muscle aches, burns, and bleeding [10]. Alternatively, if there is just one confirmed case, IgM antibodies, dengue virus, NS1 antigen, or both must be evaluated using ELISA.

Laboratory Diagnosis

Under sterile conditions, 5 ml of blood is collected from a febrile patient and sent to Bilva Diagnostic Centre in Nelamangala, Bangalore, for a series of haematology and serology tests. Haematological tests include spectrophotometry using the Oxy-Hb method, [11] VCS technology, [12] and impedance analysis. Serological tests include the Widal Slide test, [13] as well as the NS1 dengue specific antigen test [14] and the ELISA antibody [15] and IgG and IgM tests [16].

Results

The serology lab data indicates that dengue cases occur consistently month-round, affecting individuals across all age groups and genders. Both male and female patients, from pediatric to adult populations, are susceptible to the disease. The distribution of cases does not show a seasonal trend, highlighting the constant presence of the virus. This underscores the need for continuous monitoring and preventive measures. The data shows a fluctuation in dengue cases throughout the month as shown in Table 1, with the highest incidence (45.45%) in the fourth week. The sharp rise in positive cases during the fourth week points to a potential dengue outbreak or seasonal transmission peak. Contributing factors may include environmental conditions like increased rainfall and mosquito breeding activity. The first week also experienced a notable number of cases (27.27%), followed by a decline in the second and third weeks, where cases dropped to 18.18% and 9.09%, respectively.

Table 1: Week-wise dengue distribution of percentage of positive cases.

Week	Number of cases	Positive cases (%)
1 st	3	27.27272727
2 nd	2	18.18181818
3 rd	1	9.090909091
4 th	5	45.45454545

The data presented in Table 2 indicated a clear gender disparity in dengue cases, with 63.64% of the patients being male, primarily adults. This may suggest that adult males are either more susceptible to dengue or face higher exposure to the virus. In contrast, among pediatric cases, females outnumber males, with three females compared to one male, which could point to higher vulnerability or diagnosis rates in young girls. Despite females comprising only 36.36% of total cases, their prevalence in the pediatric group is notable, while adult cases are predominantly

male. The data indicates a clear gender disparity in dengue cases, with 63.64% of the patients being male, primarily adults. This may suggest that adult males are either more susceptible to dengue or face higher exposure to the virus. In contrast, among pediatric cases, females outnumber males, with three females compared to one male, which could point to higher vulnerability or diagnosis rates in young girls. Despite females comprising only 36.36% of total cases, their prevalence in the pediatric group is notable, while adult cases are predominantly male.

Table 2: Dengue cases distribution among age and gender.

Gender	Positive cases		
	Pediatric age (<14 years)	Adult age (>14 years)	Total (%)
Male	1	6	63.63636
Female	3	1	36.36364
Total	4	7	100

The haematological analysis revealed distinct differences between pediatric and adult dengue patients (Table 3). Children exhibit higher rates of reduced haemoglobin and lower white blood cell counts, indicating more pronounced anemia and a greater tendency toward leukopenia, which are common in dengue infections. Both age groups show elevated neutrophil levels, suggesting an acute inflammatory response, though lymphopenia is only observed in adults, pointing to age-related variations in immune response. Low eosinophil counts in both groups align with the dengue-induced suppression of the immune system. Adults, however, demonstrate higher monocyte counts, indicating a potentially delayed or prolonged immune response. Thrombocytopenia is more severe in children, raising the risk of bleeding complications in this group, while haemoconcentration, evidenced by increased PCV, is more pronounced in adults, signalling more severe cases of dengue in this population.

The dengue virus rapid test results shown in Table 4 using ELISA indicate that the majority of patients (54.54%) are in the acute phase of infection, as evidenced by the presence of IgM antibodies, suggesting recent infections. A smaller group (18.18%) tested positive for NS1 antigen alone, indicating they are in the early phase of infection. No patients tested positive for IgG alone, implying the absence of past or late-phase infections. Additionally, 27.27% of patients showed co-detection of NS1 antigen with either IgM or IgG, which may suggest the transition from early to later stages of infection or co-detection of markers during different immune responses. The absence of IgG-only cases indicates no secondary infections or late-stage cases in this patient group. The overall data shows that most patients are in the early to acute phase of dengue infection, with the immune response just beginning to emerge in many of them. There is no evidence of late-stage or secondary infections within this sample group.

Table 3: Haematological data of positive Dengue cases with distinct differences between pediatric and adult groups.

Age	Haemoglobin (<14-18 gm/dl)	total count (<4000-11000 cells/cumm)	Neutrophils (>40-70%)	lymphocytes (<20-45%)	Eosinophils (<2-8%)	Monocytes (>1-6%)	Platelet count (<1.5-4.5 lakhs/cumm)	PCV (<33-45%)
Pediatric age group (<14 years)	4	1	2	0	0	1	1	1
adult age (>14 years)	1	2	2	2	1	3	4	4

Table 4: Distribution of Dengue Virus Markers Detected by ELISA in Patients.

Presence of antigen or antibody	Number of patients	Percentage (%)
NS1 Antigen	2	18.18181818
IgG	0	0
IgM	6	54.54545455
NS1 Antigen & IgG both	2	18.18181818
NS1 Antigen & IgM both	1	9.090909091

Discussion

In recent decades, dengue has become a significant public health concern across the Indian subcontinent and nearby regions [17]. This article describes a laboratory-confirmed outbreak of dengue fever in the village of Sondekoppa, which is transmitted by Aedes mosquitoes. Dengue fever is endemic to the region. The cases were observed throughout the month. However, there was a

notable increase in suspected and confirmed dengue fever cases beginning in the fourth week. In the present study, serological investigations revealed that dengue-suspected cases and positive results were significantly higher in adult males compared to females, which may be attributed to greater daytime exposure to dengue-transmitting mosquitoes during work or commuting [18]. In contrast, the infection rate was higher among females in the pediatric age group. The overall male-to-female ratio was

1.75:1, aligning with similar observations made by Adrejiya et al. and Kumar et al. [9], [19]. Haematological analysis reveals clear differences between adult and pediatric dengue patients. Children show more pronounced anemia and leukopenia. It has a higher rate of haemoglobin decline and a lower white blood cell count. Both age groups showed higher neutrophil levels. This indicates an acute inflammatory response. But only adults show lymphopenia. This indicates that there are age-related differences in the immune response. Eosinophil counts were low in both groups. This is consistent with the immune suppression caused by dengue fever. Adults have a higher number of monocytes. This may indicate a delayed or long-lasting immune response. Thrombocytopenia is more severe in children. by increasing the risk of bleeding complications While adults have higher blood concentrations. This can be seen from increased packed cell volume (PCV), which indicates more severe dengue fever in this population [20-22].

In this study, 54.54% of patients were in the acute phase of dengue fever infection. identified by IgM antibodies, while 18.18% were in the early stage. As shown by the presence of only NS1 antigen, in addition, 27.27% of patients showed co-localization of NS1 with IgM or IgG, indicating a change between stages of infection or co-infection. Overall, the data showed the predominance of acute dengue fever infection is evident in the early stages. And there was no evidence of late-stage infection in the sample group. The epidemic of dengue fever in Sondekoppa hamlet indicates a significant public health issue. This is combined with poorly managed ponds and lakes, which serve as breeding grounds for *Aedes* mosquitos. There is just one government hospital and two clinics. Mosquito bites are frequently a problem due to limited healthcare infrastructure. Economic burden. Dengue fever can be minimised by using a circular economy strategy that struggles to fulfil the demands of a labour-intensive population. Additionally, by encouraging sustainable practices and investing in local healthcare institutions. The relationship between environmental management, public health, and economic sustainability is critical in rural areas. Sondekoppa can better prepare for a dengue outbreak by improving its healthcare infrastructure and encouraging community participation. This ultimately leads to better health outcomes and economic recovery.

Conclusion

This study emphasises the crucial need of monitoring blood parameters in dengue-infected patients, finding that the fourth week of August had the highest number of suspected and confirmed cases, indicating peak transmission. The findings demonstrate a higher incidence of dengue in adults (>14 years) than in children, indicating increased susceptibility due to diminished herd immunity following a dearth of cases in prior years. The outbreak in Sondekoppa village highlights the public health issues caused by environmental variables, such as poorly managed ponds that serve as breeding grounds for *Aedes* mosquitos, which are exacerbated by limited healthcare facilities. Communities that

implement circular economy ideas and invest in local healthcare facilities can greatly minimise the economic impact of dengue. a circular economy framework prioritises public health and environmental management, enhancing resilience against dengue epidemics in rural regions like Sondekoppa. This improves health outcomes and quality of life for the residents.

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