**Importance Of Environmental Factors Influencing Dengue: A Strategic Approach in Managing Dengue Transmission in Outpatient Clinical Settings in Kerala**

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| **Abstract**  Dengue fever is caused by the dengue virus, a Flaviviridae member, transmitted through *Aedes Egypti* mosquitos. Dengue virus causes dengue fever and can develop into dengue haemorrhagic fever and Dengue shock syndrome and can be fatal and life threatening. Kerala, a small state from the southern part of India is hyper endemic to all 4 serotypes of dengue virus (DEN-1, DEN-2, DEN-3, DEN-4) posing a major concern to tackle with the limited resources available in the health care system in Kerala. Our study was conducted at an outpatient clinical setting in Kerala based on the reported dengue positive cases from the clinical laboratory during the period January 2023-December 2023 and correlated with the climate factors including rainfall, temperature and humidity obtained from relevant meteorological sources to know the influence of climate factors over dengue transmission. Our study revealed a strong positive correlation between rainfall and dengue cases (***r = .722, p = .008***) significant at 0.01 level, a moderate correlation between humidity and dengue cases was observed (***r=.579, p=0.049***) showing that an increase in humidity increases the number of dengue cases. A negative correlation observed between temperature and dengue cases (***r = -.490, p = .106***). However, the relationship is not statistically significant, suggesting temperature alone may not be impact in dengue transmission. A statistical regression model summary revealed that rainfall, temperature, and humidity collectively accounting approximately ***60%*** of the variability in dengue cases (R Square: ***0.598***). The Adjusted R Square **of *0.448*** shows the model’s ability to generalize beyond the sample, while the Standard Error of the Estimate of ***25.696*** reflects the average deviation between predicted and actual dengue cases occurrences highlighting a strong relationship between the environmental factors and the incidence of dengue infection, suggesting that changes in weather can significantly influence dengue outbreaks. The study will help in better understanding of the influence of environmental factors such temperature, rainfall and humidity on dengue transmission, helping to develop strategic plans, improving predictions of dengue outbreaks.  **Keywords: Dengue, Humidity, Rainfall, Temperature** |

**Introduction**

Dengue fever is a global concern affecting millions of people worldwide transmitted by *Aedes Egypti* mosquitos1,2,3. Dengue infection can be severe and life threatening and can cause hematological, neurological and systemic manifestations 4,5.

Kerala is hyper endemic for all the 4 serotypes (DEN-1, DEN-2, DEN-3, DEN-4) of Dengue virus6. Although transmission of dengue virus is primarily by *Aedes Aegypti*, vertical transmission of dengue virus through *Aedes albopictus* mosquitoes has been reported in different regions of Kerala 7,8. Climate factors such as temperature, rainfall, and humidity have a significant influence on dengue transmission9.

Understanding the influence of climate factors in transmission of dengue infection is important in predicting

* Strengthening Community Involvement:
* Evaluating Climate Change Impact:
* Framing Public Health Involvement:
* Resource Allocation:
* Optimizing Vector management strategies:
* Policy Development:
* Early Warning Systems development:

In this paper we examined the influence of environmental factors such as temperature, humidity and rain fall influencing dengue transmission. Climate and meteorological data in Ernakulam district Kerala were obtained from relevant authoritive sources to support the analysis in the study. The study was conducted at an outpatient clinical setting based on the number of dengue positive cases reported from the laboratory during the period January 2023-December 2023 and was correlated with the climate factors to know the influence of climate factors over dengue transmission.

**Materials and methods**

Climate and meteorological data:

* Temperature
* Humidity
* Rainfall

The data were obtained from relevant sources reported in the district of Ernakulam, kerala10,11.

Dengue Positive cases were collected retrospectively from the clinical laboratory attached to the outpatient clinical setting, reported during the period January 2023-December 2023.

**Study Design:** Cross-sectional observational study.

**Results**

**Table 1:Environmental factors:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Relative Humidity, %** | | | | **Rainfall** | **Temperature, °C** | | | |
| **Minimum** | **Maximum** | **Average** | **Std.Dev** | **In mm** | **Minimum** | **Maximum** | **Average** | **Std.**  **Dev** |
| **January** | 45.5 | 93.4 | 75.4 | ± 12.2 | 22.00 | 22.3 | 31.5 | 26.6 | ± 2.4 |
| **February** | 38.8 | 91.4 | 71.4 | ± 13.7 | 27.00 | 22.2 | 32.8 | 27.4 | ± 2.9 |
| **March** | 43.6 | 92.4 | 76.6 | ± 12.1 | 66.00 | 24 | 33 | 28.2 | ± 2.5 |
| **April** | 55.8 | 93.3 | 81.2 | ± 8.9 | 177.00 | 25.1 | 33.2 | 28.6 | ± 2.2 |
| **May** | 63.2 | 98 | 85 | ± 6.9 | 337.00 | 25.2 | 31.8 | 27.7 | ± 1.8 |
| **June** | 76.9 | 98.1 | 90.3 | ± 3.7 | 568.00 | 24.1 | 30.1 | 26.3 | ± 1.3 |
| **July** | 72.8 | 96.1 | 90.1 | ± 4.3 | 514.00 | 23.9 | 29.6 | 25.8 | ± 1.3 |
| **August** | 73.2 | 97.6 | 89.7 | ± 4.5 | 379.00 | 23.6 | 28.9 | 25.4 | ± 1.3 |
| **September** | 61.4 | 96 | 82.3 | ± 8.1 | 264.00 | 24 | 31.1 | 26.6 | ± 1.8 |
| **October** | 56.9 | 97.8 | 85.1 | ± 8.0 | 303.00 | 23.5 | 31.3 | 26.8 | ± 1.9 |
| **November** | 59.2 | 95.1 | 83.4 | ± 8.7 | 169.00 | 24.1 | 31.4 | 27 | ± 1.8 |
| **December** | 55.5 | 94.2 | 80.6 | ± 9.6 | 56.00 | 23.6 | 31.3 | 27 | ± 2.0 |

**Table 2:Dengue reported cases in the laboratory during period January-December 2023:**

|  |  |
| --- | --- |
| **MONTH** | **REPORTED POSITIVE CASES** |
| **January** | **6** |
| **February** | **10** |
| **March** | **27** |
| **April** | **9** |
| **May** | **6** |
| **June** | **78** |
| **July** | **115** |
| **August** | **25** |
| **September** | **19** |
| **October** | **5** |
| **November** | **7** |
| **December** | **8** |

**Statistical analysis**

Statistical analysis was done using SPSS version 29. In this study, a correlation analysis was conducted to know the correlation between environmental factors including temperature, humidity and rainfall on the incidence of dengue transmission.

**Table 3: Correlation analysis between environmental factors on the incidence of dengue transmission**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | | | | |
|  | | **Humidity** | **Dengue Pos** | **Temp** | **Rainfall** |
| **Humidity** | **Pearson Correlation** | **1** | **.579\*** | **-.578\*** | **.921\*\*** |
| **Sig. (2-tailed)** |  | **.049** | **.049** | **<.001** |
| **N** | **12** | **12** | **12** | **12** |
| **Dengue pos** | **Pearson Correlation** | **.579\*** | **1** | **-.490** | **.722\*\*** |
| **Sig. (2-tailed)** | **.049** |  | **.106** | **.008** |
| **N** | **12** | **12** | **12** | **12** |
| **Temp** | **Pearson Correlation** | **-.578\*** | **-.490** | **1** | **-.548** |
| **Sig. (2-tailed)** | **.049** | **.106** |  | **.065** |
| **N** | **12** | **12** | **12** | **12** |
| **Rainfall** | **Pearson Correlation** | **.921\*\*** | **.722\*\*** | **-.548** | **1** |
| **Sig. (2-tailed)** | **<.001** | **.008** | **.065** |  |
| **N** | **12** | **12** | **12** | **12** |
| **\*. Correlation is significant at the 0.05 level (2-tailed).** | | | | | |
| **\*\*. Correlation is significant at the 0.01 level (2-tailed).** | | | | | |

A statistical regression analysis was performed, and the model summary reveals that rainfall, temperature, and humidity collectively accounting approximately 60% of the variability in dengue cases (R Square: 0.598). The Adjusted R Square of 0.448 shows the model’s ability to generalize beyond the sample, while the Standard Error of the Estimate of 25.696 reflects the average deviation between predicted and actual dengue cases occurrences underscoring a strong relationship between the environmental factors and the incidence of dengue infection, suggesting that changes in weather can significantly influence dengue outbreaks.

**Humidity**

According to our study, a moderate correlation between humidity and dengue cases was observed (r=.579, p=0.049) which indicates that an increase in humidity increases the number of dengue cases.

**Temperature**

Although there was a negative correlation observed between temperature and dengue cases (r = -.490, p = .106) indicating that the relationship is not statistically significant, suggesting temperature alone may not be affected alone in dengue transmission.

**Rainfall**

A strong positive correlation was found between rainfall and dengue cases (r = .722, p = .008) significant at 0.01 level, indicating a strong positive relationship between rainfall and dengue transmission.

**Discussion**

Our study confirms the significant influence of environmental factors, including rainfall, humidity and temperature, impacts dengue transmission in Kerala. Rainfall showed a significant positive correlation between rainfall and dengue transmission. A similar study by Satya et al. 2019 showed a positive correlation between rainfall and dengue cases12.The study done at East Delhi by Vishnampettai, G et al.2016 also concluded the significant impact of rainfall on dengue cases9.A study by Anita, Chakravarti et al.2005 identified a significant correlation between humidity and dengue cases13. Humidity plays an important role in the transmission of dengue according to the study done at Surat, Gujarat by Viral, R et al 202014.The correlation between temperature and dengue transmission was statistically insignificant in our study even though a negative correlation was observed a result that contrast with other studies. Satya et al. 2019 exhibited a positive correlation between temperature and dengue cases12. Erin, A et al. 2017 also concluded that temperature has a significant influence on dengue transmission15. Dengue transmission is profoundly affected by environmental factors such as temperature, humidity, and rainfall which affects the availability and density of mosquito vector. Higher temperatures may cause an increase in the number of infected mosquitos as higher temperatures reduce the extrinsic incubation period of the virus promoting its transmission16.

Our predictive model summary showed that change in environmental factors have approximately 60% of the variation in dengue cases indicating powerful impact between dengue transmission and environmental factors. This predictive modelling will help in understanding the influence of environmental factors on dengue transmission, improving predictions and helps in strategic planning in anticipating for dengue outbreaks.

**Why environmental factors are crucial in managing dengue transmission**

For planning strategic approaches in controlling dengue transmission, it is very important to understand how environmental factors such as rainfall, temperature and humidity, effects on dengue infection. Our study will help in better understanding on the impact of environmental factors on dengue outbreaks and help to formulate strategic plans in controlling outbreaks.

**Limitations of the study**

The meteorological data at the district level may not precisely reflect the characteristics of the specific study regions.

**Conclusion**

Dengue infection is still a major concern worldwide. The prevalence of all serotype of dengue virus in Kerala, India is a major concern and challenging in preventing morbidity and mortality associated with dengue infection. Climate shifts in Kerala will affect the transmission of dengue Virus.Enviornmental factors, including temperature, rainfall and humidity, have a strong impact on dengue transmission. In our study we have found that rainfall had a strong positive correlation with dengue cases, increased humidity tends to increase dengue cases, whereas temperature alone doesn’t show an impact alone on dengue transmission even though a negative correlation observed. This study will help in better understanding of the influence of environmental factors, including temperature, rainfall and humidity, on dengue transmission, helping health care workers in developing strategic plans, improving predictions of dengue outbreaks.

**Disclaimer**

We hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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