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EFFECT OF CLIMATIC CHANGES ON REPORTED DENGUE CASES IN SRI LANKA: A RETROSPECTIVE STUDY FROM YEAR 2020 TO 2024

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Dengue fever remains a significant public health challenge in Sri Lanka, with rising incidence and expanding geographic distribution in recent years. This study investigates the spatial and temporal variations of dengue cases in relation to mortality patterns and their potential associations with climatic factors from 2020 to 2024. District-level data on dengue cases and deaths were obtained from national surveillance systems, alongside rainfall and temperature data from 21 districts. Statistical analyses, including Chi-square tests and linear-by-linear association models, were employed to assess relationships between dengue outcomes and climatic variables using SPSS version 25. The analysis also considered disruptions in disease surveillance during the COVID-19 pandemic. Colombo and Gampaha consistently reported the highest burdens, peaking in 2023 with 18,911 and 16,127 cases, respectively. Mortality reached its maximum in 2022 (72 deaths), followed by 62 in 2023 and 23 in 2024. A significant decline in cases was observed in 2020, with a 79% reduction in Colombo compared to 2019 ($p < 0.001$), which coincided with the implementation of COVID-19 restrictions. Dengue cases and deaths were strongly correlated in all years (2021: $r = 0.756$, $p < 0.01$; 2022: $r = 0.808$, $p < 0.01$; 2023: $r = 0.878$, $p < 0.01$; 2024: $r = 0.718$, $p < 0.01$). Rainfall was not significantly associated with dengue cases overall ($p = 0.236$), but in 2024 showed a significant positive trend with both cases ($p = 0.019$) and deaths ($p = 0.012$). Temperature showed no significant association with cases or deaths in any year (all $p > 0.05$). In conclusion, dengue transmission in Sri Lanka shows strong spatial variation, with urban districts most affected. Although rainfall had a significant impact in 2024, overall climate factors showed limited predictive value for 2020–2024. Integrating epidemiological and climate surveillance is advised to enhance climate-sensitive dengue preparedness.

Keywords: climate change, dengue fever, Sri Lanka, public health, vector-borne diseases.

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INTRODUCTION

Dengue fever, a mosquito-borne viral disease caused by four different serotypes (DENV-1 to DENV-4), remains a major public health concern in Sri Lanka. The primary vectors, *Aedes aegypti* and *Aedes albopictus* mosquitoes, facilitate transmission, with climatic conditions having a significant impact on their breeding and survival (Martina et al., 2009; WHO, 2024). Sri Lanka has experienced recurrent dengue epidemics over the years, with distinct seasonal patterns linked to temperature, rainfall, and humidity variations (Ebi and Nealon, 2016; Morin et al., 2013). These climate factors have a direct impact on mosquito life cycles, viral replication rates, and, ultimately, disease transmission dynamics (Sirisena & Noordeen, 2014). Climate change has exacerbated dengue epidemiology in recent years, altering weather patterns, potentially expanding *Aedes* mosquitoes' geographic range, and extending transmission seasons (Naish et al., 2014; Bhatia et al., 2022). Understanding these changes is critical for designing adaptive public health strategies such as early warning systems, targeted vector control, and climate-resilient policy planning. However, few studies have examined the relationship between recent climatic trends and dengue incidence in various regions of Sri Lanka.

This study examines dengue transmission in Sri Lanka from 2020 to 2024, focusing on climate-driven trends and regional vulnerabilities. The findings will contribute to evidence-based interventions for mitigating dengue risks under uncertain climate conditions.

METHODOLOGY

This retrospective ecological study used epidemiological and climate data to examine the relationship between dengue incidence and climatic factors in all districts of Sri Lanka between January 2020 and December 2024. Dengue case data, including monthly confirmed cases by district, were obtained from the Epidemiology Unit of the Ministry of Health in Sri Lanka, with permission granted by the Dengue Control Unit. Climate variables such as monthly mean temperature, total rainfall, and relative humidity were obtained from the Department of Meteorology in Sri Lanka and supplemented with satellite-derived datasets as needed to ensure completeness and accuracy. The data were analysed using the statistical software SPSS (version 25), and graphs were created with Microsoft PowerPoint LTSC Professional Plus 2021. The Chi-square test was used to determine statistical significance across various climatic conditions, and Pearson correlation analysis was used to investigate the relationships between dengue cases, temperature, and precipitation. These statistical methods assisted in identifying potential associations between climatic factors and dengue incidence trends over the study period.

RESULTS AND DISCUSSION

RESULTS

Dengue cases in Sri Lanka (2020-2024)

From 2020 to 2024, Colombo consistently recorded the highest number of dengue cases, reaching a peak of 18,911 in 2023. Particularly in urbanised districts, Gampaha and Kurunegala also reported high case counts during the years 2022 and 2023. In contrast, rural districts such as Mullaitivu, Vavuniya, and Kilinochchi consistently reported the lowest numbers. Nationally, dengue cases rose sharply from 34,411 in 2020 to a peak of 89,799 in 2023, before declining slightly to 78,352 in 2024. These trends highlight a clear link between higher population density in urban areas and increased dengue transmission (Figure 1).

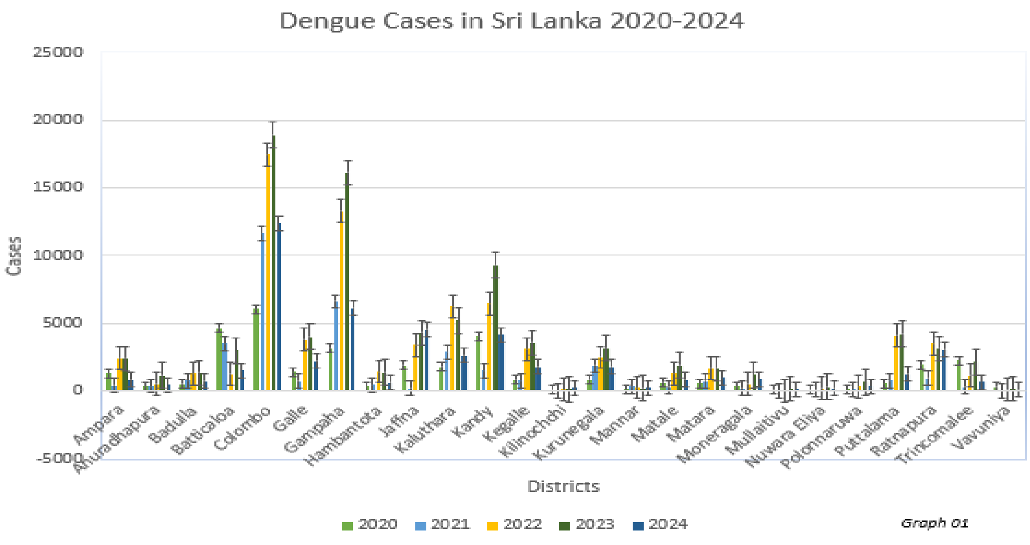

Figure 2 - Dengue cases in Sri Lanka by District (2020-2024)

Dengue mortality in Sri Lanka (2021-2024)

From 2021 to 2024, dengue-related deaths in Sri Lanka varied by district, with Colombo and Gampaha consistently reporting the highest rates. The highest number of deaths occurred in 2022 (72), followed by 2023 (62), with deaths falling to 28 in 2021 and 23 in 2024. In 2022 and 2023, Colombo had the most deaths, while in 2024, Colombo, Gampaha, and Matara all three districts had the most deaths. Several districts consistently reported no deaths, indicating regional differences in disease severity and healthcare response (Figure 2).

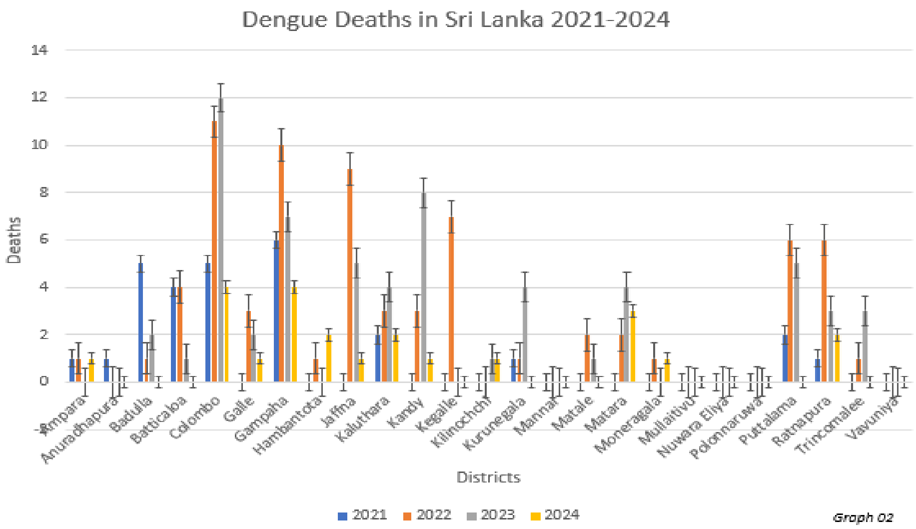

Figure 3-Dengue Mortality in Sri Lanka in each District (2021-2024)

Association of dengue incidence with climatic factors

From 2022 to 2024, dengue cases and related mortalities in Sri Lanka showed significant regional variation, yet no strong or consistent statistical associations with climate factors such as temperature ($p = 0.358$) or rainfall ($p = 0.236$). In 2024, dengue cases ranged from 113 to 12,382 per district (mean ± SD = 2,067.86 ± 2,871.43), with deaths averaging 0.95 and peaking at 4. The rainfall levels ranged from 56.17 - 327.52 mm, and the mean temperature was 31.94 °C.

In 2023, case counts ranged from 171 to 18,911 (mean = 3,761.00; SD = 5,042.14), with deaths ranging from 0 to 12 (mean = 2.67) and no significant associations with temperature or rainfall were observed ($p > 0.2$). Similarly, in 2022, cases ranged from 34 to 17,456 (mean = 3,136.67; standard deviation = 4,445.14), with an average of 2.86 deaths per district. Mean temperature was 30.74 °C, and rainfall averaged 177.99 mm – neither showed a statistically significant relationship with dengue outcomes. Overall, while a slight trend suggests rainfall may influence dengue incidence, no strong or consistent statistical associations were established over the three years.

District-wise Comparison of Dengue Cases in Sri Lanka (2020-2024)

From 2020 to 2024, dengue cases in Sri Lanka varied widely across districts. Colombo (6,084; 11,666; 17,456; 18,911; 12,382) and Gampaha (3,155; 6,628; 13,317; 16,127; 6,132). Several districts, including Kandy, Kalutara, Galle, and Jaffna, also witnessed significant increases in 2022 and 2023. Batticaloa had a high case count (4,614) in 2020, which decreased in 2022 but again increased in 2023. In contrast, Kilinochchi, Mullaitivu, and Nuwara Eliya consistently reported low case numbers. Major districts peaked in 2022 or 2023, with an overall decrease in cases noted in 2024 (Figure 3).

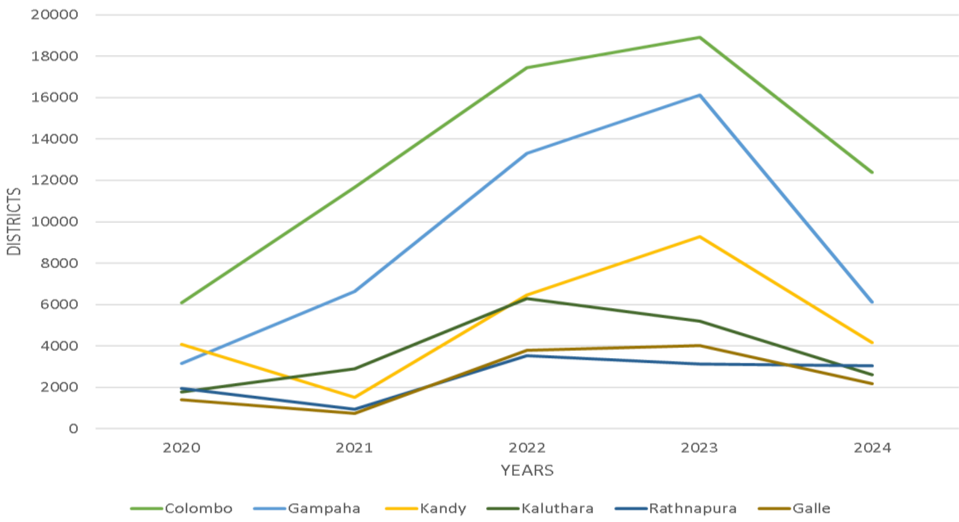

Figure 4- Major District-wise Comparison of Dengue Cases in Sri Lanka (2020-2024)

DISCUSSION

This study highlights distinct patterns in disease transmission and mortality across districts. As shown in Graph 01 and Table 01, Colombo consistently recorded the highest dengue burden, with cases peaking at 18,911 in 2023 (figure 02) before declining to 12,382 in 2024. Gampaha exhibited a similar pattern, while Mullaitivu maintained the lowest case numbers throughout the study period. Notably, dengue transmission patterns during 2020 and 2021 deviated significantly from typical epidemiological trends, coinciding with the COVID-19 pandemic. In 2020, Colombo reported only 6,084 dengue cases—a 79% reduction compared to 28,939 cases in 2019. This substantial decline is consistent with findings by Surendran et al. (2022), who documented a 74% nationwide decrease in dengue incidence during periods of pandemic-related mobility restrictions.

The analysis of climatic factors produced nuanced results. While rainfall was not significantly correlated with dengue cases in 2024 ($p = 0.236$), linear-by-linear association tests indicated a slight upward trend in both cases ($p = 0.019$) and deaths (0.012) with increasing rainfall. These results are consistent with Faruk (2022), who identified precipitation as a contributing factor to dengue transmission, particularly in Sri Lanka's wet zones. Temperature showed no statistically significant association with dengue outcomes in any of the study years.

Several limitations affected the scope and interpretation of this analysis. During the pandemic years, surveillance systems were compromised as health services prioritised COVID–19 response efforts. As noted by Surendran et al. (2020), this led to underreporting of dengue cases and incomplete mortality records, particularly in 2020-2021. Additionally, budget constraints limited the collection of complete meteorological data, restricting climate analysis to the years 2022 to 2024. District-level analysis was further hindered by delays in accessing detailed data from relevant government institutions. Climate data for Kilinochchi, Kegalle, Kalutara, and Matale districts were unavailable, limiting climate analysis to 21 areas. The study's findings carry important implications for post-pandemic public health strategies. Integrated vector management approaches that incorporate environmental monitoring, targeted vector control, and public education are essential, especially in high-burden urban areas like Colombo. Despite their low statistical significance, rainfall trends may still serve as useful early warning indicators during periods of regular dengue transmission.

Future research should aim to rebuild strong surveillance systems to close data gaps created during the pandemic. Longitudinal studies incorporating complete climate datasets, as well as analysis of socioeconomic factors influencing dengue risk, would enhance understanding of transmission dynamics. Additionally, the development of cost-effective meteorological data collection tools and investigations into the role of urbanisation in outbreak patterns could substantially strengthen dengue prediction and control efforts in Sri Lanka's evolving public health landscape.

CONCLUSIONS/RECOMMENDATIONS

This study provides a comprehensive overview of dengue trends in Sri Lanka from 2020 to 2024, highlighting significant spatial and temporal variations in disease incidence and mortality. Urban districts such as Colombo and Gampaha consistently experienced the highest burdens, with peaks in 2022 and 2023, followed by a decline in 2024. The COVID–19 pandemic significantly disrupted routine surveillance, contributing to underreporting in 2020 and 2021. While rainfall showed a slight positive trend with dengue cases and deaths in 2024, overall, climate variables, particularly temperature, did not exhibit strong or consistent statistical associations with dengue outcomes. These findings highlight the complex interplay between environmental, epidemiological, and systemic factors in dengue transmission. Strengthening real-time surveillance systems, especially in high-burden urban areas, integrating rainfall data into early warning models, improving access to climate and health data, and investing in low–cost monitoring tools are essential next steps. Future research should adopt an interdisciplinary approach, incorporating socioeconomic and urbanization factors to enhance predictive models and guide targeted, evidence-based vector control strategies in Sri Lanka's post–pandemic public health landscape.

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