**Methods:**

We considered national level average CFR between 2000-2024 for each country as the outcome variable, while predictor variables included PM2.5 (average of 5 years), total annual rainfall (average of the 5 years), mean annual temperature (national average of 5 years), Urban population % in the year 2024, population density (per square kilometers) in 2024, Prevalence of diabetes & hypertension in 2023, and amount of per capita GDP ($) in 2024. These data were gathered from the World Bank, other United Nations sources, and ‘Our World in Data’ (NASA, 2022; OWID, 2024b, 2024a; The World Bank, 2018b, 2018a; WHO, 2020, 2023).

We used a time series count generalized linear mixed model (GLMM) with Poisson distribution to identify independent predictors of dengue cases and deaths, while reporting the incidence rate ratio (IRR) and 95% Confidence Interval (CI)8.

**Results:** In the GLMM analysis, countries with higher PM2.5 levels exhibited a significantly greater risk of fatal outcomes (Incidence Rate Ratio [IRR]: 1.94, 95% CI: 1.60–2.37), suggesting that each percentage increase in PM2.5 is associated with a 94% increase in dengue fatality risk compared to countries with lower PM2.5 levels. On the other hand, countries with higher GDPs experienced a lower risk of fatal outcomes (IRR: 0.65, 95% CI: 0.55–0.78), indicating a 35% reduction in dengue fatality rates in wealthier countries for an increase of GDP by one unit ($1).

Table 1: Factors associated with the Case fatality rate (CFR) of Dengue in endemic countries using Generalized linear mixed model

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **IRR** | **95% CI** | **P-value** |
| PM2.5 | 1.94 | 1.60 - 2.37 | <0.001 \*\*\* |
| Total Rainfall | 0.86 | 0.70 - 1.06 | 0.171 |
| Average Temperature | 1.13 | 0.92 - 1.38 | 0.236 |
| Urban Population (%) | 1.15 | 0.90 - 1.46 | 0.258 |
| Population Density | 0.97 | 0.81 - 1.18 | 0.792 |
| Diabetes (%) | 1.06 | 0.89 - 1.27 | 0.505 |
| Hypertension (%) | 1.03 | 0.84 - 1.27 | 0.744 |
| GDP ($) | 0.65 | 0.55 - 0.78 | <0.001 \*\*\* |
|  |  |  |  |
| **AIC** | 244.66 | **RMSE** | 0.73 |
| **BIC** | 275.92 | **R2 (%)** | 46.50 |

*Note. RR = relative risk; CI = confidence interval.*

*\*p < 0.1. \*\*p < .05. \*\*\*p < .01.*

**References:**

1 The World Bank. Population density (people per sq. km of land area). The World Bank. 2018. https://data.worldbank.org/indicator/EN.POP.DNST (accessed June 2, 2020).

2 The World Bank. Population ages 65 and above, total. World Bank Data. 2018. https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS (accessed June 2, 2020).

3 OWID. Urbanization - Our World in Data. 2024. https://ourworldindata.org/urbanization (accessed Jan 4, 2025).

4 WHO. Global health services data, obesity and overweight. 2020.

5 OWID. Diabetes prevalence, 2021. 2024. https://ourworldindata.org/grapher/diabetes-prevalence (accessed Jan 4, 2025).

6 WHO. Global report on hypertension: the race against a silent killer. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO. *https://www.who.int/publications/i/item/9789240081062* 2023; : 1–291.

7 NASA. POWER | Data Access Viewer. 2022. https://power.larc.nasa.gov/data-access-viewer/ (accessed Jan 30, 2022).

8 Hasan MN, Khalil I, Chowdhury MAB, *et al.* Two decades of endemic dengue in Bangladesh (2000–2022): trends, seasonality, and impact of temperature and rainfall patterns on transmission dynamics. *J Med Entomol* 2024; published online Jan 22. DOI:10.1093/jme/tjae001.