**Global Landmark: 2023 Marks the Worst Year for Dengue Cases with Millions Infected and Thousands of Deaths Reported**

**Najmul Haider 1\*, Mohammad Nayeem Hasan 2, Joshua Onyango 3, Md Asaduzzaman 4**

1School of Life Sciences, Faculty of Natural Sciences, Keele University, Keele, Staffordshire, United Kingdom, ST5 5BG (NH: [n.haider@keele.ac.uk](mailto:n.haider@keele.ac.uk))

2Department of Statistics, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh (MNH: [nayeem5847@gmail.com](mailto:nayeem5847@gmail.com))

3The Harper and Keele Veterinary School, Keele University, Keele, Staffordshire, United Kingdom, ST5 5BG (j.o.onyango@hkvets.ac.uk)

4Department of Engineering, Staffordshire University, Stoke-on-Trent ST4 2DE, UK (MA: [md.asaduzzaman@staffs.ac.uk](mailto:md.asaduzzaman@staffs.ac.uk))

**Correspondence:** [n.haider@keele.ac.uk](mailto:n.haider@keele.ac.uk)

**Abstract**

**Objectives:** In 2023, the world experienced one of the worst dengue viruses (DENV) outbreak on record. This study aimed to identify global regions and continents with a high burden of Dengue in 2023.

**Design:** We collected data on the number of DENV cases and deaths reported by various countries to the WHO and WHO regional offices to identify regions with a high burden. We estimated cases per million population and case-fatality ratio among the confirmed cases reported by each country.

**Results:** Overall, 6.5 million cases and >6800 deaths attributed to DENV were recorded, marking a historic milestone. Two distinct hotspots of dengue virus circulation emerged: the South American and the South and Southeast Asian regions. South America reported 3,924,992, the highest number of cases and 1,946 deaths, resulting in a case fatality ratio (CFR) of 0.05. In Asia, 1,622,405 cases and 3,637 deaths were reported, with a CFR of 0.22. We observed a statistically significant difference in the number of cases and deaths per million across different continents (P-value < 0.001). However, there was no significant difference reported on CFR did across the continents (P-value = 0.123).

**Conclusions:** The increased cases and mortality highlight the urgent need for a comprehensive global approach aimed at DENV infection control. The approaches should include vaccine development, vector control, public health initiatives, and improved clinical management.

**The article:**

Dengue fever, a mosquito-borne illness, is caused by four distinct serotypes of the dengue virus within the Flaviviridae family. Transmission to humans occurs through the bites of *Aedes aegypti (L.)* and *Aedes albopictus* (Skuse) mosquitoes. Currently, Dengue Virus (DENV) is endemic in over 125 countries, with reported cases to the World Health Organization (WHO) escalating annually. While the majority of infections (>80%) exhibit no or mild symptoms leading to lifelong immunity against the specific serotype, reinfection with different serotypes, termed as secondary dengue infection which poses a significant risk of severe dengue, culminating in fatal outcomes [1].

We collected data from countries where WHO aids in outbreak confirmation, offers technical support for dengue management, and helps improve reporting systems to accurately capture disease burden [1]. The WHO recommends several serologic tests for diagnosing dengue infections, including: Hemagglutination-inhibition (HI), Complement fixation (CF), Neutralization test (NT), and IgM-capture enzyme-linked immunosorbent assay (MAC-ELISA). In some countries, the use nonstructural protein 1 (NS1) antigen test for DENV has been reported. The details of the laboratory test are discussed elsewhere [2]. Dengue cases and deaths from multiple sources: including WHO’s global dengue surveillance dashboard [3], WHO Eastern Mediterranean Region, WHO European Region [4], WHO Region of Africa, WHO Region of the Americas, WHO South-East Asia Region [5], and WHO Western Pacific Region. We used the national data to accumulate cases by country, continent, and globally. We estimated the cases per million population by countries and continents. A one-way analysis of variance (ANOVA) was employed to determine whether dengue variables differed significantly across geographic regions. The case-fatality rate of dengue was estimated by dividing the number of deaths by the number of confirmed cases reported by each country.

Globally, a total of 6.43 million cases and 6,892 deaths were recorded in 2023 with 56,672 cases and 28.45 deaths per million population [3]. Continent-wise, the highest number of cases were reported from South America (3,924992 cases) with the highest number of deaths in Asia (3,637 deaths). The highest number of cases and deaths per million population was reported in North America, with 258,252.27 cases and 90.30 deaths, respectively **(Table 1)**. One-way ANOVA analysis revealed a statistically significant difference in case incidence and death rates per million across continents (P-value < 0.001), indicating a substantial influence of geographic location on these variations. However, when analyzing the case fatality rate (CFR) with the same method, the results indicated that CFR does not significantly differ across continents (P-value = 0.123).

Two distinct hotspots of dengue virus circulation emerged: the South American and the South and Southeast Asian regions **(Table 1)**. The top five countries with cases of DENV infections in 2023 were Brazil (3,088,723), Vietnam (369,000), Bangladesh (321,179), Mexico (277,963), and Peru (274,227). Brazil reported the highest number of cases (3,088,723) while Bangladesh reported the highest number of deaths (1,705) [3,6]. Additionally, three European countries reported locally transmitted dengue cases in 2023: Italy (82 cases), France (43 cases), and Spain (3 cases), while the United States documented a record of 156 locally transmitted cases of DENV [7] (**Fig S1 and Table S2**).

In the first half of 2024, laboratory-confirmed dengue cases surged to nearly 4.7 million, with over 5,366 deaths reported globally [3]. As we come of from summer and rainy season, countries in the Northern Hemisphere are bracing for another potentially record-breaking year of DENV, eliciting both anticipation and surprise among observers.

WHO described several drivers for the largest-ever DENV outbreak in 2023 [1]. The impacts of the 2023 El Niño phenomenon and climate change, resulting in rising temperatures, heavy rainfall, and high humidity; fragile health systems strained by the COVID-19 pandemic; and political and financial instabilities in countries experiencing complex humanitarian crises and significant population movements [1]. The changes in rainfall seasonality and the introduction of heterogeneous serotypes contributed to the largest-ever outbreak in Bangladesh [8]. Brazil reported the highest-ever number of DENV cases in 2023 reported by any other country in the world which was probably linked to climate change and co-circulation of all four serotypes in the country [1].

Dengue is a major global health issue, impacting millions of individuals each year presenting significant public health challenges. The incidence of dengue is increasingly being reported in rural areas, broadening its geographical and demographic reach. Dengue infection can vary from mild to severe dengue fever, with fatality rates potentially exceeding 1% [9]. The case fatality ratio (CFR) of primary DENV infection is generally low with an estimated value of 0.01-0.1%, but the CFR could reach up to 1-4% for secondary or tertiary DENV infection [9]. Prior to 2023, the highest historical dengue caseload occurred in 2019, with over 3.18 million cases, 28,208 severe cases, and 1,823 deaths (CFR 0.06%) [4]. In 2023, within the South-East Asia Region, Bangladesh observed a rise in deaths from 281 (CFR 0.45%) to 1705 (CFR 0.52%), while Thailand's death toll increased from 34 (CFR 0.07%) to 147 (CFR 0.11%). Other countries reported CFRs ranging from 0.04% in Nepal to 0.72% in Indonesia. In the Western Pacific Region, the Philippines reported 167,355 cases and 575 deaths (CFR 0.34%), while Viet Nam reported 149,557 cases and 36 deaths (CFR 0.02%) [4]. Dengue case fatality rates are negatively associated with average income per capita. Additionally, primary health care units are linked to lower case fatality rates. A positive association was found between dengue mortality and the Gini index. Overall, investigations into the spatial distribution of dengue fever incidence indicate that these factors are geographically associated [10]. The direct costs of dengue, including hospitalization, outpatient visits, and supportive care are substantial. The indirect costs such as loss of productivity, long-term disability, and economic losses due to disease outbreaks are also very high. Furthermore, the disease places a heavy burden on healthcare systems, resulting in significant economic and social strain.

There were discrepancies between our collected data (6.43 million cases and 6,892 deaths), while the WHO’s reported totals (6.5 million cases and over 7,300 dengue-related deaths) on their official webpage [1]. We searched the data on WHO’s Global Dengue Surveillance dashboard [3] and found no inconsistencies with our findings. However, the differences could have been attributed to variations in case definitions used by different countries. The reported number of cases is likely a significant underestimation of the actual number, as many cases are asymptomatic and do not seek hospital or clinic testing [1]. A study in India found the actual number of cases to be 282 times higher than the reported cases[11]. In Africa, there are fewer reports on dengue and other arboviruses, possibly due to the high burden of malaria, which exhausts most resources [12]. Nevertheless, the findings show that the number of cases and deaths is significant and concerning. The generalizability of global dengue findings to regions with distinct epidemiological profiles can be limited due to variations in climate, vector species, population immunity, and health infrastructure. While global studies provide valuable insights, local factors such as mosquito abundance, behaviour, urbanization patterns, and public health responses can significantly influence disease transmission. Therefore, findings from one region may not fully apply to another, highlighting the need for region-specific research and tailored public health interventions to address the unique epidemiological context of each area [13].

Dengue and other *Aedes*-borne diseases are a critical global health challenge, that demands coordinated efforts from multiple sectors. The adaptability of mosquitoes to various breeding sites, including urban environments, and their resistance to insecticides continue to hinder vector control efforts. And while the development of dengue vaccines, such as Dengvaxia and TAK-003 marks significant progress, there are still concerns regarding their efficacy and safety across different age groups and serotypes. Therefore, vaccination strategies must be carefully tailored to specific epidemiological contexts. To control the ongoing trend of dengue cases, it is essential to enhance epidemiological surveillance, community engagement and education, environmental management, rapid response to outbreaks, international collaboration and sustained investment in public health infrastructure including vaccine development and delivery [14].

**Table 1: Number of dengue cases and deaths per million (/M) population by continents in 2023**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Continent** | **Cases** | **Deaths** | **Cases/M** | **P-value** | **Deaths/M** | **P-value** | **CFR (%)** | **P-value** |
| Africa | 194032 | 832 | 9088.38 | <0.001 | 33.63 | <0.001 | 0.43 | 0.123 |
| Antarctica | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Asia | 1622405 | 3637 | 34416.06 | 36.03 | 0.22 |
| Europe | 128 | 0 | 2.12 | 0.00 | 0.00 |
| North America | 692109 | 477 | 258252.27 | 90.30 | 0.07 |
| Oceania | 1032 | 0 | 69.41 | 0.00 | 0.00 |
| South America | 3924992 | 1946 | 94877.55 | 39.18 | 0.05 |
| Total/ average | **6434698** | **6892** | **56,672.26** |  | **28.45** |  | **0.11** |  |

**Acknowledgments**

We acknowledge the WHO and the regional office of WHO for sharing dengue cases and death data on a portal accessible by the public.

**Financial Support**

There was no funding for this study.

**Conflicts of interest**

The authors declare no conflict of interest.

**Ethics statement**

There are no identifiable individual-level data, and ethical approval is not required.

**Author´s Contributions**

Conceptualization: NH, Data curation: MNH, writing original draft: NH, Supervision: MA, Writing, review, and editing: NH, MNH, JO, MA

**References:**

[1] WHO. Dengue and severe dengue: Global burden. WHO 2024:1–2.

[2] Technical note Algorithm for laboratory confirmation of dengue cases - PAHO/WHO | Pan American Health Organization n.d. https://www.paho.org/en/documents/technical-note-algorithm-laboratory-confirmation-dengue-cases (accessed September 5, 2024).

[3] WHO. Global dengue surveillance: https://worldhealthorg.shinyapps.io/dengue\_global/. WHO 2024.

[4] Dengue- Global situation n.d. https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON498 (accessed May 25, 2024).

[5] SEAR Epidemiological Bulletins n.d. https://www.who.int/southeastasia/outbreaks-and-emergencies/health-emergency-information-risk-assessment/sear-epi-bulletins (accessed May 24, 2024).

[6] Mohammad Nayeem Hasan, Mahbubur Rahman, Meraj Uddin, Shah Ali Akbar Ashrafi, Kazi Mizanur Rahman, Kishor Kumar Paul, et al. Shifting Geographical Transmission Patterns: Characterizing the 2023 Fatal Dengue Outbreak in Bangladesh. MedRxiv 2024;2024.

[7] European CDC. Dengue worldwide overview. ECDC 2023:1–10.

[8] Haider N, Asaduzzaman M, Hassan MN, Rahman M, Sharif AR, Ashrafi SAA, et al. Bangladesh’s 2023 Dengue outbreak – age/gender-related disparity in morbidity and mortality and geographic variability of epidemic burdens. International Journal of Infectious Diseases 2023. https://doi.org/10.1016/j.ijid.2023.08.026.

[9] Soo K-M, Khalid B, Ching S-M, Chee H-Y. Meta-Analysis of Dengue Severity during Infection by Different Dengue Virus Serotypes in Primary and Secondary Infections. PLoS One 2016;11:e0154760. https://doi.org/10.1371/journal.pone.0154760.

[10] Paixão ES, Costa M da CN, Rodrigues LC, Rasella D, Cardim LL, Brasileiro AC, et al. Trends and factors associated with dengue mortality and fatality in Brazil. Rev Soc Bras Med Trop 2015;48:399–405. https://doi.org/10.1590/0037-8682-0145-2015.

[11] Naik BR, Tyagi BK, Xue R-D. Mosquito-borne diseases in India over the past 50 years and their Global Public Health Implications: A Systematic Review. J Am Mosq Control Assoc 2023;39:258–77. https://doi.org/10.2987/23-7131.

[12] Braack L, Wulandhari SA, Chanda E, Fouque F, Merle CS, Nwangwu U, et al. Developing African arbovirus networks and capacity strengthening in arbovirus surveillance and response: findings from a virtual workshop. Parasit Vectors 2023;16:129. https://doi.org/10.1186/s13071-023-05748-7.

[13] Gwee XWS, Chua PEY, Pang J. Global dengue importation: a systematic review. BMC Infect Dis 2021;21:1–10. https://doi.org/10.1186/S12879-021-06740-1/FIGURES/6.

[14] WHO. Disease Outbreak News: Dengue - Global situation. WHO 2024.

**Appendix Fig S1 and Table S1**



**Fig S1: Number of dengue cases and deaths per million population by country in 2023. Source of the data: WHO global monitoring of dengue** [3]

**Table S1: Worldwide dengue cases and deaths in 2023. Sources: ECDC, WHO Africa and WHO** [3]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Country** | **WHO Region** | **Continents** | **Cases** | **Deaths** | **Cases/Million** | **Deaths/Million** |
| Afghanistan | WHO Eastern Mediterranean Region | Asia | 1700 | 1 | 40.25 | 0.02 |
| Oman | WHO Eastern Mediterranean Region | Asia | 2016 | 0 | 434.07 | 0.00 |
| Pakistan | WHO Eastern Mediterranean Region | Asia | 24352 | 0 | 101.26 | 0.00 |
| Saudi Arabia | WHO Eastern Mediterranean Region | Asia | 2259 | 0 | 61.14 | 0.00 |
| Somalia | WHO Eastern Mediterranean Region | Africa | 755 | 1 | 41.61 | 0.06 |
| Sudan | WHO Eastern Mediterranean Region | Africa | 10412 | 66 | 216.43 | 1.37 |
| Yemen | WHO Eastern Mediterranean Region | Asia | 951 | 1 | 27.61 | 0.03 |
| France | WHO European Region | Europe | 43 | 0 | 0.66 | 0.00 |
| Italy | WHO European Region | Europe | 82 | 0 | 1.39 | 0.00 |
| Spain | WHO European Region | Europe | 3 | 0 | 0.06 | 0.00 |
| Benin | WHO Region of Africa | Africa | 6 | 1 | 0.44 | 0.07 |
| Burkina Faso | WHO Region of Africa | Africa | 146878 | 688 | 6316.93 | 29.59 |
| Cape Verde | WHO Region of Africa | Africa | 410 | 0 | 684.84 | 0.00 |
| Chad | WHO Region of Africa | Africa | 1342 | 1 | 73.42 | 0.05 |
| Ethiopia | WHO Region of Africa | Africa | 21469 | 17 | 169.68 | 0.13 |
| Ghana | WHO Region of Africa | Africa | 18 | 0 | 0.53 | 0.00 |
| Guinea | WHO Region of Africa | Africa | 1 | 0 | 0.07 | 0.00 |
| Ivory Coast | WHO Region of Africa | Africa | 3922 | 27 | 135.84 | 0.94 |
| Mali | WHO Region of Africa | Africa | 4427 | 29 | 190.05 | 1.24 |
| Mauritania | WHO Region of Africa | Africa | 3582 | 0 | 736.58 | 0.00 |
| Mauritius | WHO Region of Africa | Africa | 265 | 0 | 203.76 | 0.00 |
| Niger | WHO Region of Africa | Africa | 148 | 0 | 5.44 | 0.00 |
| Nigeria | WHO Region of Africa | Africa | 72 | 0 | 0.32 | 0.00 |
| Sao Tome and Principe | WHO Region of Africa | Africa | 69 | 0 | 297.60 | 0.00 |
| Senegal | WHO Region of Africa | Africa | 248 | 1 | 13.96 | 0.06 |
| Togo | WHO Region of Africa | Africa | 8 | 1 | 0.88 | 0.11 |
| Anguilla | WHO Region of the Americas | North America | 1 | 0 | 62.90 | 0.00 |
| Antigua | WHO Region of the Americas | North America | 254 | 0 | 2693.59 | 0.00 |
| Argentina | WHO Region of the Americas | South America | 146876 | 75 | 3208.73 | 1.64 |
| Aruba | WHO Region of the Americas | South America | 22 | 0 | 207.01 | 0.00 |
| Bahamas | WHO Region of the Americas | North America | 243 | 1 | 588.92 | 2.42 |
| Barbados | WHO Region of the Americas | North America | 771 | 0 | 2734.09 | 0.00 |
| Belize | WHO Region of the Americas | North America | 1688 | 0 | 4108.81 | 0.00 |
| Bermuda | WHO Region of the Americas | North America | 1 | 0 | 15.61 | 0.00 |
| Bolivia | WHO Region of the Americas | South America | 156774 | 88 | 12654.73 | 7.10 |
| Brazil | WHO Region of the Americas | South America | 3088723 | 1184 | 14271.73 | 5.47 |
| Cayman Islands | WHO Region of the Americas | North America | 42 | 0 | 605.97 | 0.00 |
| Colombia | WHO Region of the Americas | South America | 131784 | 90 | 2530.16 | 1.73 |
| Costa Rica | WHO Region of the Americas | North America | 30649 | 0 | 5880.27 | 0.00 |
| Dominica | WHO Region of the Americas | North America | 419 | 0 | 5736.58 | 0.00 |
| Dominican Republic | WHO Region of the Americas | North America | 27972 | 62 | 2468.20 | 5.47 |
| Ecuador | WHO Region of the Americas | South America | 27838 | 33 | 1530.36 | 1.81 |
| El Salvador | WHO Region of the Americas | North America | 5788 | 0 | 909.36 | 0.00 |
| French Guiana | WHO Region of the Americas | South America | 2684 | 0 | 8598.29 | 0.00 |
| Grenada | WHO Region of the Americas | North America | 628 | 1 | 4976.90 | 7.92 |
| Guadeloupe | WHO Region of the Americas | North America | 11751 | 7 | 29686.31 | 17.68 |
| Guatemala | WHO Region of the Americas | North America | 72358 | 119 | 3999.44 | 6.58 |
| Guyana | WHO Region of the Americas | South America | 27709 | 0 | 34047.48 | 0.00 |
| Honduras | WHO Region of the Americas | North America | 34050 | 49 | 3214.14 | 4.63 |
| Jamaica | WHO Region of the Americas | North America | 8180 | 6 | 2895.02 | 2.12 |
| Martinique | WHO Region of the Americas | North America | 13239 | 6 | 36075.44 | 16.35 |
| Mexico | WHO Region of the Americas | North America | 277963 | 203 | 2163.88 | 1.58 |
| Montserrat | WHO Region of the Americas | North America | 6 | 0 | 1367.99 | 0.00 |
| Nicaragua | WHO Region of the Americas | North America | 181096 | 4 | 25700.83 | 0.57 |
| Panama | WHO Region of the Americas | North America | 20924 | 18 | 4682.99 | 4.03 |
| Paraguay | WHO Region of the Americas | South America | 63216 | 24 | 9213.11 | 3.50 |
| Peru | WHO Region of the Americas | South America | 274227 | 441 | 7982.69 | 12.84 |
| Puerto Rico | WHO Region of the Americas | North America | 1242 | 0 | 380.94 | 0.00 |
| Saint Barthelemy | WHO Region of the Americas | North America | 737 | 0 | 67036.57 | 0.00 |
| Saint Kitts | WHO Region of the Americas | North America | 286 | 1 | 5988.90 | 20.94 |
| Saint Lucia | WHO Region of the Americas | North America | 60 | 0 | 332.87 | 0.00 |
| Saint Martin | WHO Region of the Americas | North America | 1272 | 0 | 39654.58 | 0.00 |
| Saint Vincent | WHO Region of the Americas | North America | 17 | 0 | 163.94 | 0.00 |
| Sint Maarten | WHO Region of the Americas | North America | 1 | 0 | 22.61 | 0.00 |
| Suriname | WHO Region of the Americas | South America | 282 | 3 | 452.48 | 4.81 |
| Trinidad | WHO Region of the Americas | North America | 126 | 0 | 82.09 | 0.00 |
| Turks and Caicos Islands | WHO Region of the Americas | North America | 182 | 0 | 3951.20 | 0.00 |
| Uruguay | WHO Region of the Americas | South America | 48 | 0 | 14.02 | 0.00 |
| USA | WHO Region of the Americas | North America | 156 | 0 | 0.46 | 0.00 |
| Venezuela | WHO Region of the Americas | South America | 4809 | 8 | 166.76 | 0.28 |
| Virgin Islands | WHO Region of the Americas | North America | 7 | 0 | 70.89 | 0.00 |
| Bangladesh | WHO South-East Asia Region | Asia | 321179 | 1705 | 1857.02 | 9.86 |
| India | WHO South-East Asia Region | Asia | 94198 | 91 | 65.94 | 0.06 |
| Maldives | WHO South-East Asia Region | Asia | 3417 | 0 | 6558.28 | 0.00 |
| Nepal | WHO South-East Asia Region | Asia | 51243 | 20 | 1658.53 | 0.65 |
| Sri Lanka | WHO South-East Asia Region | Asia | 89799 | 61 | 4101.61 | 2.79 |
| Thailand | WHO South-East Asia Region | Asia | 159219 | 179 | 2217.50 | 2.49 |
| Australia | WHO Western Pacific Region | Oceania | 1023 | 0 | 38.69 | 0.00 |
| Cambodia | WHO Western Pacific Region | Asia | 35390 | 99 | 2088.54 | 5.84 |
| China | WHO Western Pacific Region | Asia | 19627 | 1 | 13.77 | 0.00 |
| Indonesia | WHO Western Pacific Region | Asia | 83302 | 633 | 300.15 | 2.28 |
| Laos | WHO Western Pacific Region | Asia | 32109 | 20 | 4206.17 | 2.62 |
| Malaysia | WHO Western Pacific Region | Asia | 120418 | 96 | 3509.86 | 2.80 |
| Myanmar | WHO Western Pacific Region | Asia | 6685 | 30 | 122.49 | 0.55 |
| New Caledonia | WHO Western Pacific Region | Oceania | 9 | 0 | 30.72 | 0.00 |
| Philippines | WHO Western Pacific Region | Asia | 195603 | 657 | 1667.01 | 5.60 |
| Singapore | WHO Western Pacific Region | Asia | 9938 | 0 | 1652.28 | 0.00 |
| Vietnam | WHO Western Pacific Region | Asia | 369000 | 43 | 3732.59 | 0.43 |