Methods

Dengue Data

The number of reported dengue-related data, including total new cases, total new deaths, total cases per thousand, and total deaths per thousand have been extracted from the WHO situation reports/Weekly bulletin and Ministry of Health website from January 2000 to December 2023 of eight South Asian countries (Afghanistan (2021-2023) (<https://www.emro.who.int/afg/information-resources/infectious-disease-outbreak-situation-reports.html>) (<https://moph.gov.af/en/>) (<https://ghdx.healthdata.org/organizations/national-disease-surveillance-response-ndsr-afghanistan>) , Bangladesh (https://old.dghs.gov.bd/index.php/bd/home/5200-daily-dengue-status-report), Bhutan (https://www.moh.gov.bt/assessing-dengue-outbreak/) (https://www.rcdc.gov.bt/web/), India (https://ncvbdc.mohfw.gov.in/), Maldives, Nepal (https://edcd.gov.np/), Pakistan (https://www.nih.org.pk/health-data-center), and Srilanka (<https://www.dengue.health.gov.lk/web/index.php/en/>) (<https://www.epid.gov.lk/web/index.php?option=com_content&view=article&id=171&Itemid=487&lang=en>)). All reports in the Ministry of Health used the WHO case definition (https://www.who.int/docs/default-source/outbreak-toolkit/updates-documents\_july-5/dengue-outbreak-data-collection-toolbox---inis-3-july-1.pdf?sfvrsn=ec3ffcf3\_2). We collected Dengue serotypes from different published paper over the period 2000–2023 from all south Asian countries (Afghanistan (, Bangladesh (<https://tropmedhealth.biomedcentral.com/articles/10.1186/s41182-023-00528-6>) (<https://www.ijidonline.com/article/S1201-9712(23)00711-7/pdf>) (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9594905/>), Bhutan (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9594905/>) (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2866390/>) (<https://journals.plos.org/plosntds/article/file?id=10.1371/journal.pntd.0008165&type=printable>), India (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9594905/>) (https://www.sciencedirect.com/science/article/pii/S2405673117300612?via%3Dihub), Maldives, Nepal (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9594905/>) (<https://www.mdpi.com/1999-4915/15/2/507#:~:text=4.-,Discussion,2%20remained%20a%20minor%20serotype>) (<https://www.nature.com/articles/s41598-023-35928-5>), Pakistan (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9594905/>) (https://www.scielo.br/j/bjb/a/vmvbFKXcP5zbfhrr6TkwjQz/# ) (https://journals.lww.com/jvbd/fulltext/2022/59020/an\_overview\_of\_dengue\_viral\_infection\_circulating.1.aspx#:~:text=in%20these%20areas.-,CONCLUSION,%2F1994%20is%20DENV%2D2.), and Srilanka (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2662655/#:~:text=Circulating%20Dengue%20Serotypes&text=DENV%2D2%20and%20DENV%2D3,was%20not%20identified%20in%20samples) (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9594905/>) (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8618005/>) (<https://www.idhjournal.com.au/article/S2468-0451(18)30021-X/fulltext>) (https://www.ijidonline.com/article/S1201-9712(13)00342-1/pdf)

**Case-fatality ratio (CFR)**

We computed dengue's Case Fatality Rate (CFR) as the percentage of dengue-attributed deaths among confirmed cases, using the formula: CFR = (dengue-attributed deaths / confirmed cases) x 100.

**Time series model to predict the trend**

A time-series model (i.e., auto-regressive integrated moving average (ARIMA)), was used to identify the trend of south-Asian dengue CFR from 2000-2023. The details of the ARIMA model are discussed in an earlier article on COVID-19 (Hasan et al. 2021).

**Empirical evaluation**

We utilized the autoregressive integrated moving average (ARIMA) model for forecasting. The specifics of the ARIMA model are detailed in a previous article on dengue (<https://academic.oup.com/jme/article/61/2/345/7585384>). Additionally, we employed a Mann–Kendall (M–K) trend analysis to identify potential upward or downward trends (<https://doi.org/10.1623/hysj.49.1.21.53996>). The null hypothesis assumes no monotonic trend, while the alternative hypothesis suggests the presence of a trend, which may be positive, negative, or non-null. Furthermore, we conducted Sen’s slope test to evaluate variations in annual dengue cases and deaths. A positive slope indicates an upward trend, while a negative slope indicates a downward trend over a given period (<https://doi.org/10.1080/01621459.1968.10480934>).

**Statistical analysis**

We analyzed summary statistics, including the mean, standard deviation (SD), and interquartile range (IQR) with 1st and 3rd quartile dengue cases and deaths across South Asian countries. Our observations revealed dynamic shifts in dengue cases, deaths, and CFR trends over time. To forecast future trends, we employed time-series models. All statistical analyses were performed using R version 3.5.2.2.

**Results**

**Table 1: Comparison of dengue cases, deaths, and CFR between the SA Countries**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Cases/100000** | | **Deaths** | | **CFR (%)** | |
| **SA Countries** | **Mean (SD)** | **IQR (1st-3rd)** | **Mean (SD)** | **IQR (1st-3rd)** | **Mean (SD)** | **IQR (1st-3rd)** |
| **Afghanistan** | 0.45 (1.16) | 0.00 (0.00-0.00) | 0.04 (0.20) | 0.00 (0.00-0.00) | 0.01 (0.01) | 0.00 (0.00-0.00) |
| **Bangladesh** | 15.08 (41.32) | 4.32 (0.75-5.06) | 106.42 (346.88) | 45.75 (1.75-47.50) | 0.46 (0.58) | 0.32 (0.14-0.46) |
| **Bhutan** | 64.42 (121.81) | 75.62 (0.00-75.62) | 0.33 (1.27) | 0.00 (0.00-0.00) | 0.02 (0.09) | 0.00 (0.00-0.00) |
| **India** | 5.10 (5.30) | 7.09 (1.19-8.28) | 155.08 (94.29) | 132.75 (83.50-216.20) | 0.67 (0.57) | 0.91 (0.18-1.09) |
| **Maldives** | 290.47 (448.71) | 466.14 (0.00-466.1) | 0.38 (1.35) | 0.00 (0.00-0.00) | 0.02 (0.07) | 0.00 (0.00-0.00) |
| **Nepal** | 19.25 (51.93) | 3.25 (0.03-3.29) | 5.29 (18.12) | 1.50 (0.00-1.50) | 0.09 (0.19) | 0.05 (0.00-0.05) |
| **Pakistan** | 7.98 (10.61) | 8.65 (0.80-9.45) | 32.04 (78.94) | 17.25 (0.00-17.25) | 0.35 (0.77) | 0.19 (0.00-0.19) |
| **Sri Lanka** | 194.37 (201.48) | 186.14 (53.43-239.57) | 106.17 (102.38) | 67.25 (44.75-112.00) | 0.46 (0.36) | 0.45 (0.17-0.62) |
| **Total** | 74.64 (204.51) | 25.74 (0.01-25.75) | 50.72 (144.99) | 48.75 (0.00-48.75) | 0.26 (0.48) | 0.30 (0.00-0.30) |

Figure 1:



Figure 2



Figure 3:

