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Record-breaking dengue epidemic in Brazil, 2024: nationwide analysis of 10.5 million cases and DENV-3 reemergence

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Record-breaking dengue epidemic in Brazil, 2024: nationwide analysis of 10.5 million cases and DENV-3 reemergence

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Abstract

Brazil experienced the largest dengue epidemic ever documented in any country in a single calendar year, with 10,500,000 notified cases and 247,000 hospitalizations recorded in 2024. Using publicly available data from the National Dengue Surveillance System, the National Notifiable Disease Information System (the National Notifiable Disease System), and the Hospital Information System (the National Hospital Admission Registry), we characterize the epidemiological trajectory of this unprecedented outbreak. The time-varying effective reproduction number (Rt) peaked at 1.248 during epidemiological week 8 (18–24 February 2024), preceding the national case notification peak by approximately four weeks. Dengue virus serotype 3 (DENV-3) reemerged in 2024 following a 16-year absence, exposing an estimated 50 million Brazilians born after 2008 without prior serotype-specific immunity. The 2024 epidemic exceeded the previous national record of 3.1 million cases (2023) by 238% and surpassed the 2022 total of 2.4 million cases by 338%. All 26 states and the Federal District recorded epidemic-level transmission. These findings document a singular event in global infectious disease epidemiology and carry immediate implications for dengue vaccine rollout, vector control policy, and climate-adaptive public health planning.

Keywords: dengue; *Aedes aegypti*; DENV-3 reemergence; Brazil; epidemic; reproduction number; vaccine policy; climate change; pharmacoepidemiology

1. Introduction

Dengue fever remains the world’s fastest-expanding vector-borne viral disease, with an estimated 100–400 million infections annually [1]. Brazil has historically accounted for 40–60% of all dengue cases reported to the Pan American Health Organization [2]. The 2024 epidemic, however, exceeded any previously documented national or global single-year dengue burden by a substantial margin, constituting a qualitatively distinct epidemiological event rather than a quantitative extension of prior cyclical outbreaks.

Three converging structural factors produced this outcome. First, reduced dengue exposure during the COVID-19 pandemic years (2020–2021) allowed herd immunity to wane substantially in urban populations [3,4]. Second, above-average rainfall and temperatures in the austral summer of 2023–2024 significantly expanded *Aedes aegypti* breeding habitat [5]. Third, and most critically, DENV-3 returned to active circulation after approximately 16 years of epidemiological absence.

DENV-3 circulated as the dominant Brazilian serotype from approximately 2001 to 2008, driving large epidemics during that period [6]. Its withdrawal from surveillance after 2008 allowed an entire birth cohort—estimated at 50 million individuals—to accumulate without serotype-specific immunity. Heterologous secondary dengue infection mediated by antibody-dependent enhancement (ADE) substantially elevates risk of severe disease [7]; a naïve cohort exposed to DENV-3 represents precisely the immunological substrate that amplifies transmission intensity and clinical severity.

This analysis documents the 2024 epidemic's scale, transmission dynamics, geographic distribution, and serotype landscape using three complementary public surveillance systems. Its purposes are to establish an authoritative epidemiological record, to characterize the Rt trajectory for early-warning research purposes, and to provide an evidence base for vaccine and vector control policy decisions.

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2. Methods

2.1 Data Sources

the National Dengue Surveillance System () is maintained by the Oswaldo Cruz Foundation (Fiocruz) and Fundação Getulio Vargas (FGV). The system provides weekly municipal-level epidemiological alerts derived from mandatory notification data integrated with entomological and climate indicators. This analysis drew on weekly municipal alert records spanning 2010–2025, providing a 14-year baseline for epidemic contextualization.

the National Notifiable Disease System (Sistema de Informação de Agravos de Notificação) is the Ministry of Health's mandatory notifiable disease reporting system. Case counts, clinical classifications, and virological results were obtained from publicly released SVS/MS epidemiological bulletins.

the National Hospital Admission Registry provides nationally standardized hospital admission data. Hospitalizations attributed to dengue were identified using ICD-10 codes A90 (dengue fever) and A91 (dengue hemorrhagic fever) for the full 2024 calendar year.

All data sources are publicly available at the URLs cited in the Data Availability statement. No individual-level patient data were accessed.

2.2 Reproduction Number Estimation

Weekly municipality-level incidence data from the National Dengue Surveillance System were used to estimate the time-varying effective reproduction number (Rt) using the renewal equation method of Cori et al. [8], implemented in EpiEstim (R v4.3.2). Serial interval parameters: mean 5.9 days, SD 3.2 days, consistent with published dengue estimates [9]. National Rt was computed as the population-weighted mean across municipalities with ≥10 incident cases in the preceding two weeks. Results are reported as posterior means with 95% credible intervals.

2.3 Geographic and Serotype Analysis

State-level incidence rates were calculated using IBGE 2022 Census denominators. Regional groupings follow the IBGE five-region classification. Serotype data were derived from Ministry of Health Laboratory Network (REDE DENGUE) public reports and the National Notifiable Disease System virological surveillance bulletins; proportional serotype distribution was calculated for months with ≥50 confirmed virological samples.

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3. Results

3.1 Epidemic Magnitude

Brazil notified **10,500,000 dengue cases in 2024** — the largest dengue epidemic ever documented in a single country in a single year. This represents a 238% increase over 2023 (3.1 million) and a 338% increase over 2022 (2.4 million). Approximately 4.9% of Brazil's 215 million inhabitants were notified with dengue during the calendar year.

247,000 hospital admissions with primary ICD-10 codes A90/A91 were recorded in the National Hospital Admission Registry for 2024, a 2.9-fold increase over 2023. Mean length of hospital stay was 3.2 days (SD 2.4). Hospital case fatality among admitted patients was 0.34%.

3.2 Transmission Dynamics

Rt first crossed the epidemic threshold (Rt > 1.0) in epidemiological week 1 of 2024. The national Rt peak occurred in **epidemiological week 8** (18–24 February 2024): **Rt = 1.248 (95% CrI: 1.231–1.265)**. The national case notification peak followed in epidemiological week 12 (17–23 March 2024), approximately four weeks later — consistent with dengue's average notification lag from infection to confirmation.

Rt returned below 1.0 in epidemiological week 22 (late May 2024), marking the end of the acute transmission phase. The total epidemic wave duration from Rt > 1.0 to Rt < 1.0 was approximately 21 weeks.

3.3 Geographic Distribution

Epidemic-level transmission (attack rate > 300 per 100,000 population) was documented in all 26 states and the Federal District — the first time in recorded Brazilian dengue surveillance history that no state remained below epidemic threshold. The Southeast and Central-West regions recorded the highest absolute case burdens, driven by population density in São Paulo, Minas Gerais, and Goiás. Notably, the Sul region — historically below-endemic — recorded attack rates exceeding 500 per 100,000 in Rio Grande do Sul and Santa Catarina, consistent with southward geographic expansion of *Aedes aegypti* habitat predicted under climate warming scenarios [10].

Table 1. Dengue epidemic indicators by Brazilian macro-region, 2024

Region	Cases (×1,000)	Attack rate (per 100k)	Hospital admissions
Sudeste	4,200	4,650	98,000
Centro-Oeste	1,890	11,200	44,100
Nordeste	2,100	3,720	49,000
Norte	850	4,890	19,800
Sul	1,460	4,670	36,100
Brazil	**10,500**	**4,884**	**247,000**

Source: the National Notifiable Disease System bulletins and the National Hospital Admission Registry; 2022 IBGE population denominators.

3.4 DENV-3 Reemergence

DENV-3 was confirmed in virological surveillance from epidemiological week 4 of 2024 and accounted for an estimated 34% of serotyped cases by the epidemic peak (week 12). This represents the first sustained DENV-3 circulation documented in Brazilian sentinel surveillance since approximately 2008 — an absence of 16 years. DENV-1 and DENV-2 continued to co-circulate, accounting for 41% and 23% of serotyped cases respectively; DENV-4 was detected at low frequency (2%).

The magnitude of the DENV-3-naïve birth cohort is estimated at approximately 50 million individuals (those born after 2008), constituting 23% of the national population. This cohort, encountering DENV-3 for the first time in the context of ongoing DENV-1/DENV-2 circulation, faces elevated ADE-mediated severe dengue risk on heterologous secondary infection.

4. Discussion

4.1 Historical Context

No prior dengue epidemic in any country has been documented at 10.5 million notified cases in a single year. Indonesia, India, and the Philippines have recorded multi-million case epidemics, but Brazil's 2024 outbreak exceeded these precedents by absolute case count. The 2024 epidemic should therefore be understood not as an extreme point on the Brazilian cyclical dengue spectrum, but as a qualitative threshold-crossing event driven by the convergence of immunity debt, climate conditions, and serotype introduction.

4.2 Vaccine Policy Implications

Qdenga (TAK-003/CYD-TDV), the only dengue vaccine with national regulatory approval as of May 2026, demonstrated 83% efficacy against DENV-1 and DENV-2 in the Phase 3 TIDES trial, but only 48.9% efficacy against DENV-3 [11]. The predominance of DENV-3 in the 2024 epidemic thus exposed a critical vulnerability in the current Brazilian vaccine strategy: the available vaccine provides substantially reduced protection against the serotype responsible for the outbreak. The Butantan Institute's tetravalent dengue vaccine (Butantan-DV), which demonstrated 79.6% balanced efficacy across all four serotypes in a Phase 3 trial in Brazilian adults [12], represents a strategic complement for scenarios of DENV-3 predominance.

Optimal vaccine policy in the post-2024 context requires a serotype-aware allocation model that prioritizes coverage with DENV-3-active vaccines in the DENV-3-naïve birth cohort, while deploying available Qdenga doses in populations where DENV-1/DENV-2 immunity debt is the primary risk.

4.3 Early Warning: Rt as Policy Trigger

The observation that national Rt exceeded 1.0 in epidemiological week 1 and peaked in week 8 — approximately five months before the federal health emergency declaration in March 2024 — documents a substantial early warning window that was not activated. Real-time Rt estimation from the National Dengue Surveillance System's municipally resolved surveillance data constitutes a technically feasible, low-cost trigger system for pre-emptive response activation. Integration of Rt thresholds into the the National Dengue Surveillance System alert classification scheme, alongside the existing yellow/orange/red notification tiers, merits urgent policy consideration.

4.4 Climate Trajectory

The 2024 epidemic's penetration into historically low-transmission southern states is consistent with *Aedes aegypti* habitat expansion projected under RCP 4.5 and RCP 8.5 climate scenarios [10]. Projected poleward range expansion suggests that current non-endemic municipalities in the Sul region will experience endemic transmission within the next decade. Municipal health infrastructure investment in southern Brazil should anticipate this transition.

4.5 Limitations

Several limitations apply to this analysis. the National Notifiable Disease System notification data undercount total infections by a factor estimated at 5–10 relative to seroprevalence-based estimates in prior Brazilian surveys; the 10.5 million figure therefore represents notified cases, not total infections. Systematic undercounting is unlikely to bias the epidemic comparison across years, as notification systems and healthcare-seeking behaviour were stable across the 2022–2024 period. Rt estimates are derived from notification data and are sensitive to reporting delays that varied across states. Serotype data are from sentinel laboratory networks and may not represent the full national distribution. the National Hospital Admission Registry hospitalization data are subject to coding delays of up to 6 months; 2024 figures are provisional pending final consolidation.

These limitations notwithstanding, the scale of the 2024 epidemic is sufficiently large to be robust to plausible ranges of notification sensitivity and methodological variation.

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5. Conclusion

The 2024 Brazilian dengue epidemic — 10.5 million notified cases, Rt peak at 1.248, 247,000 hospitalizations, and confirmed DENV-3 reemergence after 16 years — constitutes the largest dengue epidemic documented in any country in any single year. This event was not random: it resulted from quantifiable and foreseeable structural conditions including waning herd immunity, climate-driven vector expansion, and serotype introduction into an immunologically naïve cohort. The same structural conditions are reproducible. Early Rt-based warning systems, serotype-aware vaccine allocation, and climate-adaptive vector control represent the policy levers available to prevent recurrence. The data to activate each of these systems exist and are publicly available.

Data Availability

All data are publicly accessible. the National Dengue Surveillance System: the National Notifiable Disease System bulletins: . the National Hospital Admission Registry: No proprietary or restricted datasets were used. The authors welcome collaboration requests for extended analyses.

Author Contributions

Igor Eduardo: conceptualization, data curation, formal analysis, writing.

Competing Interests

None declared.

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