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Epidemiological Trends of Dengue Fever Across Administrative Regions of Guyana, 2020–2022: A Cross-Sectional Analysis of Confirmed Case Data

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Abstract

Dengue fever remains a significant public health burden in Guyana, a low to middle-income country in the Caribbean South American region with a climate highly conducive to Aedes aegypti transmission. This study analyzed confirmed dengue fever case records from Guyana's ten administrative regions for 2020, 2021, and 2022, derived from the Ministry of Health national disease notification system. A total of 9,772 dengue fever cases were recorded over the three-year study period: 1,719 in 2020, 4,384 in 2021, and 3,669 in 2022. The sharpest burden was concentrated in regions 1, 6, and 2, which together accounted for more than 60% of cumulative cases. Adults aged 25–44 years constituted the largest affected age group across all years, accounting for 30.2%-34.1% of annual cases. A marginal female predominance was observed in 2021 and 2022, with females comprising 52.8% and 53.3% of cases, respectively. Region 1 recorded the highest single-year count (1,372 in 2021), while Regions 3 and 5 reported no cases across all years. These findings underscore persistent geographic heterogeneity in dengue transmission, the disproportionate burden in economically active age groups, and the urgent need to strengthen region-specific surveillance and implement integrated vector management strategies in Guyana.

Keywords: *Age Distribution, Dengue Fever, Epidemiology, Guyana, Regional Surveillance, Vector-Borne Disease.*

Introduction

Dengue fever is one of the fastest spreading mosquito-borne viral diseases worldwide, with an estimated 100–400 million infections annually across more than 100 endemic countries [1]. The disease, caused by any of four serotypes of dengue virus (DENV 1–4) and transmitted primarily by Aedes aegypti mosquitoes, poses a particularly severe threat in tropical and subtropical regions where warm temperatures and high rainfall create optimal conditions for vector breeding and virus replication [2]. The Pan American Health Organization (PAHO) has reported a rising dengue burden across the Americas, with the Caribbean subregion consistently recording surges linked to seasonal rainfall patterns and the El Niño Southern Oscillation (ENSO) [3].

Guyana, a low to middle-income country situated on the northeastern Atlantic coast of South America with a population of approximately 786,000, occupies a unique epidemiological position. The country shares its tropical climate and vector ecology with the wider Caribbean and South American dengue belt, yet its national surveillance infrastructure

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and region-disaggregated disease data remain understudied in the peer-reviewed literature [4]. Guyana is divided into ten administrative regions, each with distinct ecological, demographic, and healthcare delivery characteristics that influence disease patterns. Understanding how the dengue case burden is distributed across these regions is critical for targeted resource allocation and public health response planning.

Existing evidence from the Caribbean indicates pronounced intranational heterogeneity in dengue transmission, driven by urban density, water storage practices, vector control capacity, and proximity to international travel corridors [5]. In Guyana, the coastal belt, particularly Regions 1, 2, and 6, hosts most of the population in dense urban and peri-urban settlements, while the interior regions (3, 7, 8, and 9) are sparsely populated and predominantly forested. This ecological gradient is expected to produce differential dengue risk, yet no peer-reviewed analysis has characterized this distribution using confirmed case data across multiple years.

The COVID-19 pandemic (2020–2022) further complicated dengue surveillance, as health system resources were diverted, clinical consultations declined, and testing rates were affected [6]. This context makes interpretation of dengue case counts during the study period particularly nuanced. A recent analysis by Baksh et al. [7] demonstrated significant lagged associations between temperature, rainfall, and dengue incidence in Guyana, yet the study was limited in its regional disaggregation and multi-year scope. The present study addresses this gap by providing a systematic, region-stratified epidemiological analysis of confirmed dengue fever cases across all 10 Guyanese administrative regions over 3 consecutive years (2020–2022).

Objectives

The primary objective of this study was to characterize the epidemiological trends of confirmed dengue fever cases in Guyana between 2020 and 2022, stratified by administrative region, year, sex, and age group. Secondary objectives included identifying regions of disproportionate burden, describing demographic risk profiles, and generating evidence to inform targeted public health interventions.

Materials and Methods

Study Design

This study employed a retrospective cross-sectional design using routinely collected, secondary national disease notification data from the Guyana Ministry of Health (MoH). Data spanned three calendar years: 2020, 2021, and 2022.

Data Sources

Confirmed dengue fever case data were obtained from the national communicable disease notification system maintained by the MoH Epidemiology Unit. Data were structured at the regional level (Regions 1–10) and included information on disease type (dengue fever versus dengue haemorrhagic fever/shock syndrome), sex (male, female), and age group (<1, 1–4, 5–14, 15–24, 25–44, 45–64, and 65+ years). Hydrometeorology data covering monthly rainfall (mm), daytime temperature (°C), and night-time temperature (°C) for regions 5, 6, and 9 were obtained from the Guyana Hydrometeorological Service for 2020–2022 to provide climatic context for case trends.

Case Definition

Dengue fever cases included in this analysis were confirmed cases only, as classified by the MoH Epidemiology Unit using WHO diagnostic criteria, including clinical presentation consistent with dengue fever alongside positive laboratory results (NS1 antigen, IgM, IgG, or RT-PCR) [8]. Dengue hemorrhagic fever and dengue shock syndrome were recorded separately and are reported as supplementary findings.

Data Management and Analysis

Regional case counts were extracted from the MoH structured datasets for each year and aggregated by age-sex stratum and region. Total case counts by year were computed by summing male and female counts across all age strata at the national level. Regional proportional contributions were calculated as a percentage of the national annual total. Age-sex distribution was expressed as absolute counts and percentages. Descriptive statistics, including means and ranges, were computed for meteorological variables. All analyses were performed using Python (version 3.11) with the pandas, numpy, and openpyxl libraries, as well as Microsoft Excel. Ethical approval was not required as the study used anonymized aggregate secondary data from the national surveillance system.

Ethical Considerations

The study used anonymized, de-identified aggregate data from the national communicable disease surveillance system. No individual patient identifiers were accessed or reported. An institutional review board exemption was obtained from Texila American University due to the data's retrospective, secondary, and aggregate nature.

Results

National Case Counts and Annual Trends

A total of 9,772 confirmed dengue fever cases were reported across Guyana's ten administrative regions over the three-year study period (Table 1). Annual case counts were 1,719 in 2020, 4,384 in 2021, and 3,669 in 2022, representing a 155% increase from 2020 to 2021 and a subsequent 16.3% decline in 2022 relative to the 2021 peak. The year 2021 thus constituted the peak transmission year within the observation window.

Table 1. National Annual Confirmed Dengue Fever Case Counts, Guyana, 2020–2022

Year	Total Cases	Male (%)	Female (%)
2020	1,719	875 (50.9%)	844 (49.1%)
2021	4,384	2,070 (47.2%)	2,314 (52.8%)
2022	3,669	1,713 (46.7%)	1,956 (53.3%)
Total	**9,772**	**4,658 (47.7%)**	**5,114 (52.3%)**

Source: *Guyana Ministry of Health, National Communicable Disease Notification System, 2020–2022.*

Sex Distribution

Male cases slightly exceeded female cases in 2020 (50.9% vs 49.1%). However, females comprised the majority in 2021 (52.8%) and 2022 (53.3%), consistent with patterns observed in other tropical settings where females may face higher household vector exposure [9]. Over the three-year period, females accounted for 52.3% of all national cases (Table 1) [see Table 1].

Age Group Distribution

Adults aged 25–44 years consistently represented the largest affected group, comprising 34.1% of cases in 2020, 30.2% in 2021, and 31.2% in 2022 (Table 2). The 45–64 year old group was the second largest across all three years, accounting for approximately 20–21% of cases each year. Children under 5 years (groups <1 and 1–4 combined) accounted for 4.8%-9.5% of annual cases, with the highest proportion in 2021. The elderly (65+) made up 6.5–8.7% of cases across years. The 15–24-year-old group remained the third largest annually, ranging from 18.1% to 21.2% [see Table 2].

Table 2. Confirmed Dengue Fever Cases by Age Group, Guyana, 2020–2022

Age Group	2020 (n)	2020 (%)	2021 (n)	2021 (%)	2022 (n)
<1	19	1.1%	95	2.2%	75
1–4	64	3.7%	318	7.3%	275
5–14	221	12.9%	463	10.6%	455
15–24	365	21.2%	875	20.0%	663
25–44	587	34.1%	1,324	30.2%	1,144
45–64	352	20.5%	926	21.1%	769
65+	111	6.5%	383	8.7%	288
Total	**1,719**	**100%**	**4,384**	**100%**	**3,669**

Source: *Guyana Ministry of Health, National Communicable Disease Notification System, 2020–2022.*

Regional Distribution of Cases

Pronounced geographic heterogeneity was observed across all three years (Table 3). Region 1 (Barima-Waini) was the highest-burden region in 2020 (477 cases; 27.8% of national total) and 2021 (1,372 cases; 31.3%), though it declined to 749 cases (20.4%) in 2022. Region 6 (East Berbice-Corentyne) recorded the second-highest cumulative burden: 214 cases (12.4%) in 2020, rising sharply to 979 (22.3%) in 2021, and remaining elevated at 884 (24.1%) in 2022. Region 2 (Pomeroon-Supenaam) consistently ranked third, with 272 (2020), 565 (2021), and 518 (2022) cases, respectively. Collectively, Regions 1, 2, and 6 accounted for 56.1% of cases in 2020, 67.4% in 2021, and 58.7% in 2022 [see Table 3].

Region 8 (Potaro-Siparuni) displayed a striking upward trajectory from 86 cases (5.0%) in 2020 to 570 cases (15.5%) in 2022, representing a 563% increase over the study period. Similarly, Region 9 (Upper Takutu-Upper Essequibo) increased from 56 cases (3.3%) in 2020 to 498 cases (13.6%) in 2022, a nearly nine-fold increase. By contrast, Region 10 (Upper Demerara-Berbice) declined markedly from 566 cases in 2021 to 149 in 2022 [see Table 3].

Regions 3 (Essequibo Islands-West Demerara) and 5 (Mahaica-Berbice) recorded the lowest case burdens. Region 3 reported only 7, 16, and 6 cases in 2020, 2021, and 2022, respectively. Region 5 recorded zero confirmed dengue cases over the entire three-year period, though this likely reflects limitations of the surveillance system rather than the true absence of disease [see Table 3].

Table 3. Confirmed Dengue Fever Cases by Administrative Region, Guyana, 2020–2022

Region	2020 (n)	2020 (%)	2021 (n)	2021 (%)	2022 (n)	2022 (%)
Region 1	477	27.8	1,372	31.3	749	20.4
Region 2	272	15.8	565	12.9	518	14.1
Region 3	7	0.4	16	0.4	6	0.2
Region 4	145	8.4	68	1.6	151	4.1
Region 5	0	0.0	0	0.0	0	0.0
Region 6	214	12.4	979	22.3	884	24.1
Region 7	215	12.5	282	6.4	144	3.9
Region 8	86	5.0	248	5.7	570	15.5
Region 9	56	3.3	288	6.6	498	13.6

Region 10	247	14.4	566	12.9	149	4.1
National	**1,719**	**100**	**4,384**	**100**	**3,669**	**100**

Source: *Guyana Ministry of Health, National Communicable Disease Notification System, 2020–2022.*

Dengue Hemorrhagic Fever

Dengue hemorrhagic fever/shock syndrome (DHF/DSS) was reported in small numbers: 2 cases in 2020, 4 cases in 2021, and 42 cases in 2022 (Table 5). The 2022 surge in DHF/DSS (predominantly in regions 6, 8, and 9) warrants further clinical and serological investigation, as it may signal secondary heterotypic infection or cocirculation of multiple serotypes [10].

Climatic Context

Available hydrometeorological data from regions 5, 6, and 9 provided contextual insight into rainfall and temperature patterns during the study period (Table 4). Annual cumulative rainfall was substantially higher in 2021 (Region 5: 3,055.7 mm; Region 6: 3,348.6 mm; Region 9: 2,747.9 mm) compared to 2020 (Region 5: 2,045.1 mm; Region 6: 2,068.4 mm; Region 9: 1,881.4 mm), temporally coinciding with the sharp case increase in 2021. Mean daytime temperatures remained relatively stable across the three years (30.6–31.9°C), while Region 9 recorded consistently higher daytime temperatures despite comparatively lower rainfall [see Table 4].

Table 4. Annual Hydrometeorological Parameters for Regions 5, 6, and 9, Guyana, 2020–2022

Region/ Variable	2020 Rain (mm)	2020 Day T (°C)	2020 Night T (°C)	2021 Rain (mm)	2021 Day T (°C)	2021 Night T (°C)	2022 Rain (mm)	2022 Day T (°C)
Region 5	2,045.1	31.9	23.1	3,055.7	30.9	23.3	2,786.7	30.6
Region 6	2,068.4	31.3	22.8	3,348.6	31.1	22.7	3,134.5	31.1
Region 9	1,881.4	31.9	23.3	2,747.9	31.9	23.2	2,813.6	31.9

Source: *Guyana Hydrometeorological Service, 2020–2022. Rain = Annual cumulative rainfall; Day T = Mean annual daytime temperature; Night T = Mean annual night-time temperature.*

Table 5. Confirmed Dengue Fever Cases by Age Group and Year, with Sex Disaggregation, Guyana, 2020–2022

Age Group	2020 M	2020 F	2020 T	2020 %	2021 M	2021 F	2021 T	2021 %	2022 M	2022 F	2022 T	2022 %
<1	10	9	19	1.1	54	41	95	2.2	37	38	75	2.0
1–4	31	33	64	3.7	175	143	318	7.3	111	164	275	7.5
5–14	123	98	221	12.9	231	232	463	10.6	239	216	455	12.4
15–24	170	195	365	21.2	403	472	875	20.0	294	369	663	18.1
25–44	310	277	587	34.1	587	737	1,324	30.2	521	623	1,144	31.2
45–64	177	175	352	20.5	438	488	926	21.1	382	387	769	21.0
65+	54	57	111	6.5	182	201	383	8.7	129	159	288	7.8
Total	**875**	**844**	**1,719**	**100**	**2,070**	**2,314**	**4,384**	**100**	**1,713**	**1,956**	**3,669**	**100**

M = Male; F = Female; T = Total. Source: Guyana Ministry of Health, National Communicable Disease Notification System, 2020–2022.

Discussion

This investigation constitutes the first systematic, multi-year, region-stratified characterization of confirmed dengue fever burden across all ten administrative regions of Guyana for the period 2020 to 2022. Cumulatively, 9,772 cases were documented over the three-year window, with a peak annual burden of 4,384 cases in 2021, positioning Guyana among Caribbean and South American nations that have experienced notable dengue escalation, consistent with PAHO regional surveillance trends [3]. The 155% interannual rise from 2020 to 2021 is consistent with hemisphere-wide amplification patterns attributable to the resumption of post-pandemic health-seeking behavior, altered vector population dynamics, and elevated hydrometeorological drivers that support Aedes aegypti proliferation. Boston and Kurup [16] previously estimated that climate variables, including temperature and rainfall, exert a measurable influence on dengue transmission in Georgetown, Guyana, providing foundational support for the climatic drivers documented in the present multi-regional analysis.

The spatial concentration of cases within the coastal corridor, particularly Regions 1, 2, and 6, is attributable to the confluence of ecological conditions and demographic density that define Guyana's Atlantic littoral zone. Region 1 (Barima-Waini), though comparatively sparse in population, persistently ranked as the highest-burden region, an observation that may reflect both heightened forest-edge transmission dynamics and structural limitations in remote health facility reporting capacity. Analogous coastal-interior risk gradients have been characterized across Amazonian South America and Caribbean Island systems [11]. The influence of ambient temperature and precipitation on dengue incidence is well established in other tropical settings; Colón-González et al. [17] demonstrated in Mexico that seasonal shifts in temperature and humidity significantly modulate dengue transmission risk, a mechanism directly applicable to Guyana's comparable climate profile. Distributed lag modeling approaches, as formalized by Gasparrini et al. [18], offer robust methodological frameworks that future Guyanese dengue surveillance analyses could adopt to quantify delayed hydrometeorological effects on case counts with greater statistical precision.

The rapid ascent of interior regions 8 and 9 to high-burden status by 2022 represents a significant epidemiological transition warranting dedicated prospective monitoring. Plausible contributing mechanisms include intensified population mobility associated with artisanal gold mining operations, the inadvertent creation of stagnant water reservoirs in excavated terrain that serve as larval breeding habitats, and incremental expansion of diagnostic capacity and passive case detection following pandemic-related service disruptions. Hii et al. [19] demonstrated that integrating temperature and rainfall data into forecasting models substantially improves the predictive accuracy of dengue incidence projections—a method that could be operationalized for these emerging interior burden zones in Guyana. Tun-Lin et al. [20] further established that Aedes aegypti larval development rates and survival are directly temperature-dependent, implying that the consistently high daytime temperatures recorded in region 9 (31.9°C across all study years) may confer particular entomological suitability for accelerated vector population turnover. The World Meteorological Organization [24] has documented increasing global mean temperatures and intensified precipitation variability as characteristic features of the current climate trajectory, further contextualizing the hydrometeorological drivers observed in this dataset. Baksh et al. [7] confirmed significant lagged relationships between rainfall and dengue incidence within Guyana's coastal belt, and the substantially elevated 2021 rainfall totals across all three monitored regions corroborate the case surge pattern documented in this analysis.

The demographic structure of dengue cases observed in Guyana is consistent with patterns reported in other tropical nations. The disproportionate case burden in the 25–44-year age stratum is mirrored in findings from Brazil [12] and Colombia [13], where occupationally active adults sustain elevated exposure risk through outdoor work environments and bear primary household responsibilities for vector source reduction. Lee et al. [21] demonstrated in Colombia that early warning systems incorporating climate and non-climate predictors can successfully identify high-risk populations and geographic clusters prior to outbreak peaks, an approach that Guyana's Ministry of Health could feasibly adapt given the consistent age and regional risk profiles identified here. Ramachandran et al. [22] further showed in a 19-year retrospective analysis from India that empirical models combining temperature, rainfall, and relative humidity can reliably predict dengue incidence, underscoring the potential utility of integrating Guyana's available hydrometeorological data into operational predictive frameworks. The marginal female predominance documented in 2021 and 2022 aligns with evidence from multiple endemic settings and plausibly reflects differential domestic exposure patterns or disparities in healthcare-seeking behavior [9]. The sustained representation of the 15–24-year cohort at approximately 20% of annual cases across all three years highlights school-age and young adult populations as priority targets for community-based health education and vector source reduction initiatives.

The consistent reporting of zero confirmed dengue cases from region 5 (Mahaica-Berbice) over a three-year period is epidemiologically inconsistent with the region's ecological setting and its geographic proximity to high-burden neighboring regions. This pattern most plausibly reflects structural surveillance deficiencies, inadequate diagnostic laboratory infrastructure, fragmented case notification pathways, or suboptimal clinician compliance with mandatory disease reporting rather than an authentic absence of dengue transmission [14]. Walker et al. [23] documented the re-emergence of dengue in a regional Australian setting where routine surveillance had previously underestimated viral circulation, reinforcing the principle that reporting gaps can substantially obscure the true epidemiological footprint of dengue in areas with limited diagnostic coverage. Urgently addressing the underlying surveillance infrastructure deficits in region 5 is therefore a prerequisite for generating reliable national incidence estimates and ensuring equitable resource allocation across all administrative regions.

The marked escalation in DHF/DSS cases during 2022 (42 cases versus 2–4 in the two preceding years) constitutes a clinically consequential shift in disease severity that merits systematic virological investigation. The immunological mechanism of antibody-dependent enhancement, by which prior exposure to one dengue serotype amplifies disease severity upon heterotypic secondary infection, underlies the elevated DHF/DSS risk in populations with documented multi-serotype circulation [15]. The geographic clustering of severe cases in regions 6, 8, and 9 in 2022 may reflect serotype heterogeneity across Guyana's interior regions, where communities may lack pre-existing cross-reactive immunity to newly introduced serotypes. Spatial Bayesian modeling approaches, such as those formalized by Besag et al. [25], could provide rigorous analytical frameworks for future studies aiming to map serotype-specific dengue risk at the sub-regional level and to disentangle the relative contributions of population immunity gradients and environmental drivers to observe patterns of severe disease.

Several limitations are acknowledged. The dataset covers only confirmed cases, likely representing a fraction of the true dengue incidence given known under-reporting and under-testing in low-resource surveillance systems. Testing rates, case definitions, and reporting completeness may have varied across regions and over time, particularly during the COVID-19 pandemic period. Hydrometeorology data were available for only three regions (5, 6, and 9), limiting the scope of climatic contextualization. Population denominators for incidence rate computation were not available at the regional level with sufficient precision to enable reliable incidence rate calculations. Despite these limitations, this analysis provides the most comprehensive multi-year regional description of dengue cases in Guyana to date.

Conclusion

Dengue fever poses a growing, geographically heterogeneous public health burden across Guyana's 10 administrative regions. The 2021 case peaked, geographic concentration in coastal regions, emergence of interior regions as new high-burden areas in 2022, and pronounced adult demographic risk collectively demand a regionalized, evidence-driven response strategy. Priority actions should include strengthening diagnostic and reporting capacity in low-reporting regions, deploying targeted integrated vector management in high-burden and emergent regions, initiating prospective serotype surveillance, and developing early warning systems that integrate hydrometeorological data for timely dengue outbreak prediction and response. The data generated by this study establishes a baseline epidemiological profile essential for designing and evaluating dengue prevention programs in Guyana.

Conflict of Interest

The author declares no conflict of interest in the conduct and reporting of this research.

Ethical Approval

This study used anonymized, de-identified aggregate secondary data from Guyana's national communicable disease notification system. No individual patient data or identifiers were accessed. An institutional review board exemption was granted by Texila American University.

Author Contributions

Allison Peters: Conceptualization, data curation, formal analysis, writing – original draft, writing – review and editing.

Abiodun Olaiya Paul: Methodology, supervision, writing-review, editing, and validation.

Nayan Persaud: Resources, investigation, validation.

Dr. Keisha A. Nelson: Resources, data curation, investigation.

Komalchand Dhiram: Resources, hydrometeorological data curation.

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Data Availability

The aggregate data supporting the findings of this study were obtained from the Guyana Ministry of Health National Communicable Disease Notification System and the Guyana Hydrometeorological Service. Data may be made available upon reasonable request to the corresponding author, subject to MoH data governance policies.

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