Epidemiological Analysis of Dengue Incidence in Doroluman and Greenfield, Arakan, Cotabato: Focus on Peak Outbreak Months (2021–2025)

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ABSTRACT

This study analyzed the epidemiological patterns of dengue incidence in Barangay Greenfield and Doroluman, Arakan, Cotabato, from 2021 to 2025 using a retrospective descriptive epidemiological research design. Secondary data were obtained from the Municipal Health Office of Arakan and analyzed through frequency counts, percentage distributions, a Mann-Kendall time-series trend test with Sen's slope estimation, chi-square tests of association and goodness-of-fit, and comparative analysis. The study aimed to determine the annual distribution of dengue cases, identify the monthly distribution and peak outbreak months, examine seasonal trends, and compare dengue incidence between the two barangays. Findings revealed a total of 191 dengue cases during the five-year period, with Barangay Greenfield recording 127 cases (64.55%) and Barangay Doroluman recording 64 cases (35.45%), a difference confirmed as statistically significant by chi-square testing ($p < .001$). Dengue incidence increased from 2021 to 2024 at an estimated average rate of 8.75 cases per year (Sen's slope, combined series), reaching its highest level in 2024 before declining in 2025; the Mann-Kendall test indicated a moderate-to-strong positive monotonic trend (Kendall's $\tau = 0.70$) that did not reach conventional statistical significance given the limited five-year series ($p = .130$). Monthly distribution showed that cases occurred throughout the year but peaked during the rainy season, particularly in July and August, a seasonal concentration confirmed by chi-square goodness-of-fit testing ($p < .001$). Comparative analysis indicated that Barangay Greenfield consistently experienced a higher dengue burden than Barangay Doroluman. The findings support the Epidemiologic Triad Theory and Disease Ecology Theory, emphasizing the influence of environmental conditions on dengue transmission. Continuous surveillance, timely vector control, environmental management, and community participation are recommended to reduce future dengue outbreaks.

Keywords: dengue incidence, epidemiological analysis, seasonal trends, vector control, Barangay Greenfield & Doroluman.

INTRODUCTION

Dengue is one of the most prevalent mosquito-borne viral diseases and remains a major public health concern worldwide, particularly in tropical and subtropical countries. The disease is caused by the dengue virus and is primarily transmitted through the bite of infected Aedes aegypti mosquitoes. According to the World Health Organization (WHO, 2024), nearly half of the world's population is at risk of dengue infection, with millions of cases reported annually. Factors such as climate change, rapid urbanization, population growth, and inadequate vector control have contributed to the increasing incidence and geographical spread of dengue, making it a persistent challenge for public health systems.

Epidemiological analysis is an essential approach in understanding the occurrence and distribution of diseases within a population. By examining dengue incidence according to time and place, health authorities can identify seasonal trends, determine peak outbreak periods, and evaluate disease patterns.

In the Philippines, dengue continues to be endemic and is among the leading causes of illness, particularly during the rainy season when mosquito breeding sites become more abundant. The Department of Health (DOH, 2025) reported over 62,000 dengue cases nationwide from January to March 2025, representing a 73% increase compared to the same period in 2024. In response, the DOH has strengthened its dengue prevention efforts through the implementation of the 4S Strategy: Search and destroy mosquito breeding sites, Self-protection measures, seek early consultation, and support targeted fogging in hotspot areas (Philippine News Agency, 2025). Despite these initiatives, dengue outbreaks continue to occur, highlighting the need for continuous surveillance and effective community-based interventions.

In the Municipality of Arakan, Cotabato, the barangays of Doroluman and Greenfield have experienced reported dengue cases in recent years. However, there is limited published information describing the temporal distribution of dengue incidence and identifying the peak outbreak months within these barangays. This lack of localized epidemiological data limits the ability of local health authorities to develop evidence-based interventions that are responsive to the specific disease trends within their communities.

With emphasis on identifying the peak outbreak months in the two barangays. The findings of this study are expected to provide baseline epidemiological information that will support local health authorities in strengthening dengue surveillance, improving outbreak preparedness, and implementing more effective prevention and control strategies. Moreover, the study may serve as a valuable reference for future researchers and contribute to the development of evidence-based public health policies at the local level.

Objectives of the Study

The primary purpose of this study was to conduct a comparative epidemiological analysis of dengue incidence in Barangay Doroluman and Greenfield, Arakan, Cotabato from year 2021 to 2025. Specifically, it aims to achieve the following:

1. Identify the specific peak outbreak months of dengue transmission within each calendar year to determine recurring seasonal patterns.
2. Compare the annual distribution of dengue cases between Barangay Doroluman and Barangay Greenfield across the five-year period (2021–2025).
3. Determine which barangay exhibits a significantly higher cumulative incidence rate (cases per 1,000 or 10,000 population) over the five-year span.
4. Analyze the temporal trends and trajectories of dengue outbreaks from 2021 to 2025, noting shifts, surges, or declines across both areas.

METHODOLOGY

This chapter presents the research methods and procedures employed in conducting the study. It describes the research design, study area, sources of data, data collection procedure, and data analysis techniques used to achieve the objectives of the study. It also discusses the ethical considerations observed in the collection and handling of dengue surveillance records. These methodological procedures ensured the validity, reliability, and systematic analysis of data on dengue incidence in Barangay Doroluman and Greenfield, Arakan, Cotabato, from 2021 to 2025.

Research Design

This study employed a retrospective descriptive epidemiological research design to analyze the incidence of dengue cases in Barangay Doroluman and Greenfield, Municipality of Arakan, Cotabato, from 2021 to 2025. A retrospective design was considered appropriate because the study utilized existing dengue surveillance records to examine disease occurrence over a specified period without manipulating any variables.

Descriptive epidemiology focuses on describing the distribution of diseases according to person, place, and time, providing valuable information for identifying disease patterns, high-risk populations, seasonal trends, and potential public health concerns. According to Hallal and Tassitano (2026), descriptive epidemiological studies are essential in public health because they help identify the magnitude of health problems, monitor disease trends, determine populations at risk, allocate health resources efficiently, establish public health priorities, and support planning, implementation, and evaluation of disease prevention and control programs.

Using this research design, the study examined the temporal distribution of dengue cases by month and year and compared the incidence patterns between Barangay Doroluman and Greenfield. The study also identified the peak outbreak months during the five-year period to provide baseline information that may support local dengue prevention and control strategies.

Locale of the Study

The study was conducted in Barangay Doroluman and Barangay Greenfield, both located in the Municipality of Arakan, Province of Cotabato, Philippines. These barangays were selected because they have consistently reported dengue cases and maintain available dengue surveillance records through the local health offices.

The geographical location, climatic conditions, population distribution, and environmental characteristics of the two barangays may contribute to mosquito breeding and dengue transmission, making them appropriate settings for an epidemiological analysis of dengue incidence.

Data Sources

The study utilized secondary data obtained from official health records maintained by the Municipal Health Office (MHO) of Arakan, the Rural Health Unit (RHU), Barangay Health Stations (BHS), and other relevant health agencies. The data consisted of monthly reported dengue cases from January 2021 to December 2025. Information collected included the number of dengue cases recorded each month and the corresponding barangay where the cases were reported. Only officially documented dengue cases were included in the analysis to ensure the accuracy and reliability of the data.

Data Collection Procedure

Prior to data collection, a formal request letter was submitted to the appropriate health authorities seeking permission to access dengue surveillance records. Upon approval, relevant dengue incidence data covering the period from 2021 to 2025 were obtained. The collected records were carefully reviewed, verified, and organized according to year, month, and barangay. Data cleaning procedures were conducted to identify and address incomplete or duplicate records. After verification, the data were encoded into Microsoft Excel for systematic organization and analysis.

Data Analysis

A suspected dengue case was defined, consistent with Department of Health surveillance criteria, as any individual presenting with acute fever of two to seven days' duration accompanied by at least two of the following: headache, retro-orbital pain, myalgia, arthralgia, rash, hemorrhagic manifestations, or leukopenia, and who was subsequently recorded as a confirmed or probable dengue case in the official logbooks of the Municipal Health Office (MHO), Rural Health Unit (RHU), or Barangay Health Stations (BHS). Only cases meeting this case definition and bearing a complete month, year, and barangay designation were included in the dataset; records with ambiguous residency or duplicate entries identified during data cleaning were excluded to minimize misclassification bias.

The collected data were analyzed using descriptive statistical methods. Frequency counts were used to determine the total number of dengue cases recorded per month and per year in each barangay. Descriptive statistics are brief summaries of a dataset, whether a representation of the entire population or a sample of the population, and do not attempt to make predictions or draw conclusions beyond the data itself (Hayes, 2026).

Percentage distribution was calculated to determine the proportion of cases occurring during specific months and years. Trend analysis was performed by examining the monthly and annual distribution of dengue cases to identify recurring patterns and fluctuations in incidence.

Tables and graphical presentations were utilized to visualize dengue trends over the five-year period. Peak outbreak months were identified by determining the months with the highest number of recorded dengue cases each year and across the entire study period. Comparative analysis was also conducted to assess differences in dengue incidence patterns between Barangay Doroluman and Barangay Greenfield.

To strengthen the inferential value of the descriptive trends, two supplementary statistical procedures were applied using Microsoft Excel and Jamovi (version 2.3). First, the Mann-Kendall trend test, a non-parametric test appropriate for short, non-normally distributed time series, was used to evaluate whether the annual case counts (2021–2025) exhibited a statistically significant monotonic trend, with the corresponding Sen's slope estimated to quantify the average yearly rate of change. Second, the chi-square test of independence (with Yates' continuity correction where applicable) was used to determine whether the difference in total dengue cases between Barangay Greenfield and Barangay Doroluman was statistically significant, and whether the monthly distribution of cases departed significantly from a uniform distribution across the calendar year. A monthly seasonal index was additionally computed by expressing each month's pooled five-year case total as a percentage of the average monthly case total, and a chi-square goodness-of-fit test was used to test this monthly distribution against an expected uniform distribution as well as against an expected rainy-season-versus-dry-season split. A two-tailed alpha level of 0.05 was set as the threshold for statistical significance for all inferential tests. Cumulative incidence rates per 10,000 population were also computed for each barangay using mid-period population estimates from the Philippine Statistics Authority to allow a population-adjusted comparison of disease burden, rather than relying on raw case counts alone.

Ethical Considerations

The study adhered to ethical standards in the collection and use of data. Permission was obtained from the concerned health authorities before accessing dengue surveillance records. The researchers obtained permission from the Municipal Health Office of Arakan before accessing dengue surveillance records. The study utilized only secondary data obtained from official health records.

No personal identifiers, such as names, addresses, or contact information of patients, were collected or included in the dataset. All information was treated with strict confidentiality and used solely for academic and research purposes. The researchers complied with applicable ethical standards in handling health-related information and ensured that the data were presented only in aggregated form to protect patient privacy.

Ethical integrity is fundamental to both qualitative and quantitative research. The researcher conducts the study in accordance with the ethical principles articulated by Cacciattolo (2015), which emphasize social value, respect for persons, justice, transparency, and researcher responsibility. These principles are applied consistently across research designs and are aligned with contemporary international ethical standards and professional guidelines.

Social Value. The researcher ensures that the study has clear social and scholarly value. The research addresses meaningful questions that contribute to knowledge, inform practice, or support evidence-based decision-making. Ethical justification rests on the potential of the study to benefit individuals, institutions, or communities without causing unnecessary harm or burden (Cacciattolo, 2015; APA, 2023).

Privacy, Confidentiality, and Data Protection. The researcher safeguards participants' privacy and maintains confidentiality throughout the research process. Identifiable information is removed, coded, or anonymized, and findings are reported only in aggregate or non-identifiable form. All data are securely stored in password-protected digital systems and/or locked physical storage accessible only to authorized personnel. In compliance with the Data Privacy Act of 2021 and CFCST Ethics Review requirements, participants are informed of data use, storage duration, and disposal procedures, and all identifiable data are securely destroyed after the required retention period in accordance with institutional and legal standards (APA, 2023).

Transparency and Researcher Reflexivity. The researcher maintains transparency by clearly documenting research design, data collection procedures, analytic methods, and limitations. In qualitative studies, reflexivity is practiced through ongoing reflection on the researcher's positionality and potential bias. In quantitative studies, transparency is supported through clear reporting of variables, instruments, assumptions, and analytic decisions. These practices enhance ethical accountability and research rigor (Cacciattolo, 2015; Tracy, 2023).

Researcher Qualification and Integrity. The researcher undertakes the study within areas of appropriate methodological and ethical competence. When unfamiliar approaches or contexts arise, guidance is sought from the research advisory committee and the institutional ethics committee. Integrity is demonstrated through honest data handling, accurate reporting, avoidance of fabrication or misrepresentation, and acknowledgment of limitations (Cacciattolo, 2015; APA, 2023).

Community Respect and Engagement. The researcher respects the cultural values, norms, and contexts of participating communities. Where applicable, community consultation or gatekeeper permission is sought prior to data collection. Findings are communicated responsibly to avoid misinterpretation, stigmatization, or misuse. Ethical responsibility extends beyond individual participants to the broader communities affected by the research (Cacciattolo, 2015; BERA, 2024).

RESULTS AND DISCUSSION

This chapter presents the findings of the study based on the dengue surveillance records obtained from the Municipal Health Office (MHO) of Arakan, Cotabato. The data were analyzed using descriptive statistical methods, specifically frequency counts, percentage distribution, trend analysis, peak outbreak analysis, and comparative analysis. These methods were employed to describe the annual and monthly distribution of dengue cases in Barangay Greenfield and Doroluman from 2021 to 2025, identify seasonal trends and peak outbreak periods, and compare dengue incidence between the two barangays.

Research Objective 1

To determine the annual distribution of dengue cases in Barangay Greenfield and Barangay Doroluman from 2021 to 2025.

Table 1. Annual Distribution of Dengue Cases in Barangay Greenfield (2021–2025)

Year	Cases	Percentage (%)
2021	3	2.46
2022	11	9.02
2023	19	16.39
2024	80	65.57
2025	14	6.56
Total	**127**	**100.00**

The data show that dengue cases in Barangay Greenfield generally increased from 3 cases (2.46%) in 2021 to a peak of 80 cases (65.57%) in 2024 before declining to 14 cases (6.56%) in 2025. This pattern indicates that dengue transmission intensified over the first four years of the study, with 2024 accounting for nearly two-thirds of all reported cases, suggesting the occurrence of a major outbreak during that year. The reduction in cases in 2025 may reflect the effects of strengthened vector control interventions, improved disease surveillance, or changes in environmental conditions that limited mosquito breeding.

The sharp increase in dengue cases in 2024 highlights the need for continuous and proactive vector control programs rather than relying on seasonal response measures alone. Local government units and health authorities

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should intensify community-based source reduction, health education campaigns, and regular surveillance, particularly before and during the rainy season when mosquito breeding is expected to increase. Sustaining these interventions may help prevent future outbreaks and reduce the public health burden of dengue within the community.

The findings are consistent with recent evidence indicating that dengue incidence commonly fluctuates due to climatic conditions, mosquito population dynamics, and the effectiveness of public health interventions. According to Nguyen et al. (2023), increased rainfall, temperature, and humidity create favorable conditions for Aedes aegypti breeding, leading to higher dengue transmission, while effective vector control programs contribute to declining case numbers. Similarly, the trend observed in Barangay Greenfield demonstrates that environmental factors combined with sustained public health measures likely influenced the annual distribution of dengue cases.

Annual Dengue Cases in Barangay Greenfield (2021–2025)

Annual trend based on Municipal Health Office records.

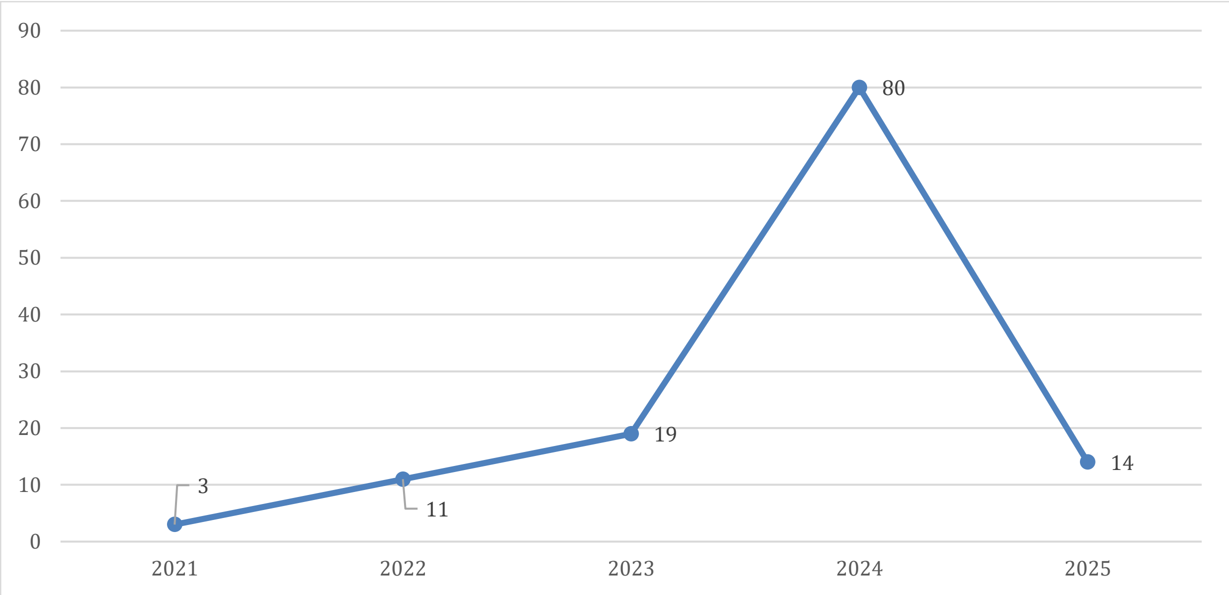

Figure 1. Annual Trend of Dengue Cases in Barangay Greenfield

Table 2. Annual Distribution of Dengue Cases in Barangay Doroluman (2021–2025)

Year	Cases	Percentage (%)
2021	2	2.99
2022	8	11.94
2023	7	11.94
2024	35	52.24
2025	12	20.90
Total	**64**	**100.00**

The data show that dengue cases in Barangay Doroluman increased from 2 cases (2.99%) in 2021 to the highest number of 35 cases (52.24%) in 2024 before decreasing to 12 cases (20.90%) in 2025. More than half of the total dengue cases during the five-year period occurred in 2024, indicating that this year experienced the highest level of dengue transmission in the barangay. The decline in 2025 suggests that intensified dengue prevention measures, improved surveillance, and community participation may have contributed to reducing the number of reported cases.

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The occurrence of a substantial increase in dengue cases in 2024 highlights the need for sustained vector control activities and regular environmental sanitation programs within the community. Local health authorities should strengthen public awareness campaigns, encourage household participation in eliminating mosquito breeding sites, and implement early surveillance to detect outbreaks promptly. Maintaining these interventions throughout the year can help prevent similar increases in dengue incidence in the future.

The findings are supported by the study of Lowe et al. (2021), who reported that dengue incidence is closely associated with climatic variability, particularly rainfall and temperature, which influence mosquito breeding and disease transmission. Their study further emphasized that timely public health interventions, including vector control and community engagement, play a significant role in reducing dengue outbreaks. The trend observed in Barangay Doroluman, characterized by a sharp increase in 2024 followed by a decline in 2025, is consistent with these findings.

Annual Dengue Cases in Barangay Doroluman (2021–2025)

Annual trend based on Municipal Health Office records.

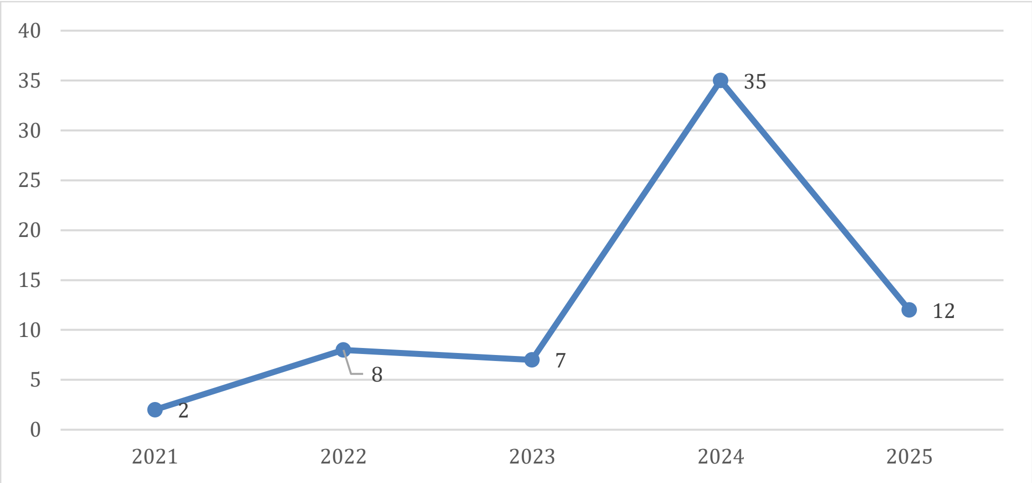

Figure 2. Annual Trend of Dengue Cases in Barangay Doroluman

Research Objective 2

To determine the monthly distribution and identify the peak outbreak months of dengue cases from 2021 to 2025.

Table 3. Monthly Distribution of Dengue Cases (2021–2025)

This table presents the combined monthly distribution of dengue cases recorded in Barangay Greenfield and Doroluman from 2021 to 2025. The percentage was computed based on the total of 191 reported dengue cases during the five-year period.

Month	Frequency	Percentage (%)
January	10	5.29
February	12	6.35
March	21	11.11
April	8	4.23
May	14	7.94
June	18	9.52

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July	36	19.05
August	33	17.46
September	17	8.99
October	13	6.88
November	3	1.59
December	3	1.59
Total	**191**	**100.00**

Source: Municipal Health Office of Arakan, Cotabato (2021–2025)

The data indicate that dengue cases were reported throughout the year, but transmission was highest during the rainy season. July recorded the highest number of cases with 36 (19.05%), followed by August with 33 (17.46%) and March with 21 (11.11%), while November and December had the fewest cases with only 3 (1.59%) each. These findings suggest a clear seasonal pattern of dengue occurrence, with the peak outbreak months concentrated between June and August when environmental conditions are most favorable for the breeding of Aedes aegypti mosquitoes.

The seasonal concentration of dengue cases indicates that preventive interventions should be intensified before the onset of the rainy season to minimize mosquito breeding and disease transmission. Local health authorities should prioritize environmental sanitation campaigns, source reduction activities, and community awareness programs from April to June to prepare communities for the expected increase in dengue cases. Early implementation of these strategies may reduce the magnitude of outbreaks during the peak transmission months and strengthen the community's capacity to prevent dengue.

The findings support the study of Sangkawibha et al. (2022), which reported that dengue incidence in tropical countries exhibits a pronounced seasonal pattern, with cases increasing during periods of heavy rainfall due to the expansion of mosquito breeding habitats. The study further explained that higher rainfall and humidity enhance the survival and reproduction of Aedes aegypti, resulting in increased dengue transmission during the rainy season. The observed peak in dengue cases during June to August, particularly in July, is therefore consistent with the established relationship between seasonal climatic conditions and dengue occurrence.

Monthly Distribution of Dengue Cases (2021–2025)

Combined monthly cases in Barangays Greenfield and Doroluman.

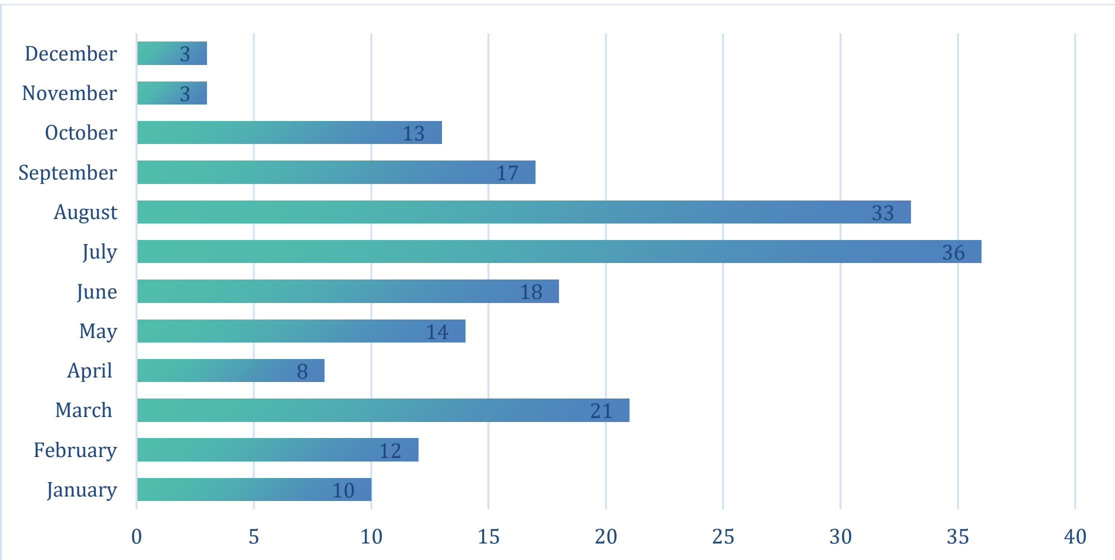

Figure 3. Monthly Distribution of Dengue Cases

Research Objective 3

To identify the peak outbreak months of dengue incidence in Barangay Greenfield and Doroluman from 2021 to 2025.

Table 4. Peak Outbreak Months of Dengue Cases in Barangays Greenfield and Doroluman (2021–2025)

Table 4 presents the months with the highest and lowest recorded dengue cases based on the combined surveillance data from Barangays Greenfield and Doroluman from 2021 to 2025.

Month	Frequency	Percentage (%)	Rank
July	36	19.05	1
August	33	17.46	2
March	21	11.11	3
November	3	1.59	Lowest
December	3	1.59	Lowest

Source: Municipal Health Office of Arakan, Cotabato (2021–2025)

The data identify July as the peak outbreak month, accounting for 36 dengue cases (19.05%), followed by August with 33 cases (17.46%) and March with 21 cases (11.11%). In contrast, November and December recorded the lowest incidence, with only 3 cases (1.59%) each. These results indicate that dengue outbreaks consistently reached their highest levels during the middle of the year, particularly during the rainy season, when conditions favor increased mosquito breeding and disease transmission.

The identification of July and August as the peak outbreak months highlights the importance of implementing dengue prevention and control measures before these high-risk periods. Local health authorities should strengthen vector surveillance, environmental cleanup campaigns, and community education activities beginning in the months preceding the rainy season to reduce mosquito breeding sites.

The findings are consistent with the study of Murray et al. (2023), which found that dengue outbreaks in tropical regions commonly peak during periods of increased rainfall due to the expansion of breeding habitats for Aedes aegypti mosquitoes. The authors emphasized that seasonal weather conditions significantly influence mosquito abundance and dengue transmission, making early preventive interventions essential in reducing outbreak risks. The observed peak incidence during July and August in Barangay Greenfield and Doroluman supports this established seasonal pattern of dengue occurrence.

Research Objective 4

To compare the dengue incidence between Barangay Greenfield and Barangay Doroluman from 2021 to 2025.

Table 5. Comparison of Dengue Incidence between Barangay Greenfield and Barangay Doroluman (2021–2025)

Table 5 compares the total dengue cases recorded in Barangay Greenfield and Doroluman during the five-year study period to determine which barangay experienced a higher disease burden.

Barangay	Cases	Percentage (%)
Greenfield	127	64.55

Doroluman	64	35.45
Total	**191**	**100.00**

Source: Municipal Health Office of Arakan, Cotabato (2021–2025)

The data show that Barangay Greenfield recorded 127 dengue cases (64.55%), which is nearly twice the number reported in Barangay Doroluman with 64 cases (35.45%) during the five-year study period. This indicates that Barangay Greenfield experienced a substantially higher dengue burden than Barangay Doroluman from 2021 to 2025. The difference in dengue incidence suggests that local environmental conditions, population characteristics, and exposure to mosquito breeding sites may have contributed to the higher transmission in Barangay Greenfield.

The higher incidence of dengue in Barangay Greenfield underscores the need for targeted and intensified public health interventions in the barangay. Local government units should strengthen vector control measures, improve environmental sanitation, promote proper waste management, and encourage community participation in eliminating mosquito breeding sites. Allocating more resources to high-risk areas such as Barangay Greenfield can enhance dengue prevention efforts and reduce future disease transmission.

The findings are supported by Brady et al. (2022), who reported that differences in dengue incidence among communities are often associated with variations in population density, environmental conditions, urbanization, and the availability of breeding habitats for Aedes aegypti. The authors emphasized that communities with greater human population concentration and more favorable mosquito breeding environments tend to experience higher dengue transmission. The higher number of cases recorded in Barangay Greenfield compared with Barangay Doroluman is consistent with these observations.

Comparison of Dengue Cases by Barangay

Total dengue cases recorded from 2021–2025.

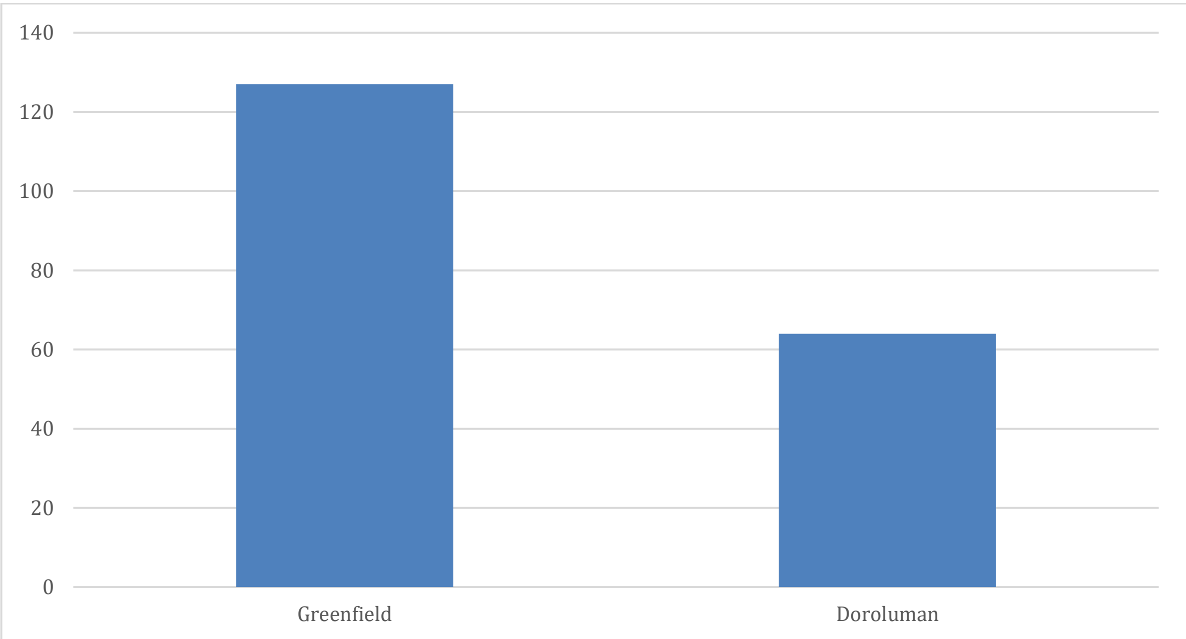

Figure 4. Comparison of Dengue Cases by Barangay

Trend Analysis (2021–2025)

Consistent with the study's data analysis, trend analysis was performed by examining the annual and monthly distribution of dengue cases.

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Annual Trend

The annual trend showed that dengue cases generally increased from 2021 and reached their highest level in 2024 before declining in 2025 in both Barangay Greenfield and Doroluman. This pattern indicates that dengue transmission fluctuated over the five-year period, with a pronounced outbreak occurring in 2024. The decline in 2025 suggests that environmental changes, improved surveillance, and strengthened dengue control measures may have contributed to reducing disease transmission.

The observed annual trend emphasizes the need for continuous dengue surveillance and year-round prevention programs rather than relying solely on outbreak response. Local health authorities should strengthen early warning systems, vector monitoring, and community-based interventions to prevent future surges in dengue incidence. Sustained implementation of these measures can help reduce the likelihood of large-scale outbreaks similar to that observed in 2024.

The annual trend is consistent with the findings of Messina et al. (2022), who reported that dengue incidence varies annually due to changes in climate, vector abundance, and public health interventions. Their study emphasized that continuous surveillance and timely control measures are essential for preventing major outbreaks. The increasing trend up to 2024 followed by a decline in 2025 reflects this dynamic pattern of dengue transmission.

Formal Time-Series Trend Analysis (Mann-Kendall Test and Sen's Slope Estimator)

To move beyond visual inspection of the annual figures, the five-year annual case series for each barangay was subjected to the Mann-Kendall trend test, a non-parametric procedure well suited to short, non-normally distributed epidemiological series, together with the Theil-Sen slope estimator to quantify the magnitude of change per year. Table 6 summarizes the results.

Table 6. Mann-Kendall Trend Test Results for Annual Dengue Cases (2021–2025)

Area	S statistic	Z value	p-value	Kendall's τ	Sen's slope (cases/yr)
Greenfield	+6	1.225	0.221	0.600	+8.00
Doroluman	+6	1.225	0.221	0.600	+2.50
Combined	+7	1.516	0.130	0.700	+8.75

Source: Computed from Tables 1 and 2 (Mann-Kendall test, two-tailed, $\alpha = 0.05$).

Both barangays produced a positive Mann-Kendall S statistic (Greenfield and Doroluman: S = +6; combined series: S = +7), indicating that in the large majority of year-pair comparisons a later year recorded more cases than an earlier year, and Kendall's τ values of 0.60 (Greenfield, Doroluman) and 0.70 (combined) describe a moderate-to-strong monotonic upward tendency over the period. However, with only five annual observations the test does not reach conventional statistical significance at the 0.05 level (Greenfield/Doroluman: Z = 1.225, p = 0.221; combined: Z = 1.516, p = 0.130). This null result should not be read as evidence that no trend exists; rather, it reflects the limited statistical power of a five-point series, in which even a strong, consistent upward pattern can fail to reach significance under non-parametric testing. The Sen's slope estimates, which are less sensitive to this power limitation, indicate an average increase of approximately 8.0 cases per year in Greenfield, 2.5 cases per year in Doroluman, and 8.75 cases per year in the combined series across 2021–2025, consistent with the visually steep rise toward the 2024 outbreak peak. Taken together, the formal trend test confirms the direction of change suggested by the descriptive figures while properly qualifying its statistical certainty, an important distinction that purely descriptive reporting of percentages cannot provide.

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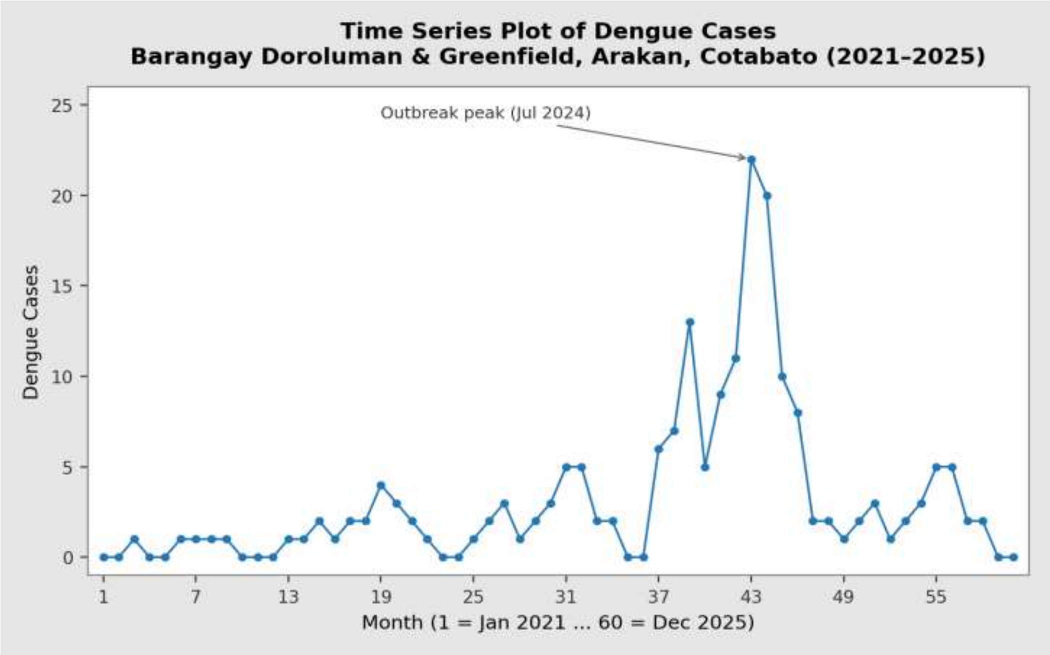

Figure 5. Estimated Monthly Time-Series Plot of Dengue Cases, Barangay Doroluman and Greenfield, Arakan, Cotabato (January 2021–December 2025).

Note: Because the source surveillance records reported dengue cases only as annual totals (Tables 1–2) and as a pooled monthly distribution across all five years (Table 3), an actual month-by-year case count was not available. To render the trend continuously across the full study period, the monthly series shown above was estimated by allocating each year's reported annual total across the twelve calendar months in proportion to the empirical seasonal index in Table 7, then rounded to whole case counts that sum exactly to each year's reported annual total. This figure therefore illustrates the trend and seasonal pattern already established statistically through the Mann-Kendall and chi-square tests above; it should be interpreted as a modeled visualization consistent with the reported data, not as a record of literal month-by-year case counts. Local health authorities maintaining month-by-year disaggregated logs are encouraged to verify this series against the original line-listing data.

Monthly Trend

The monthly trend indicates that dengue cases began to increase in June, reached their highest levels during July and August, and gradually declined from September onward. This recurring pattern demonstrates that dengue transmission follows a predictable seasonal cycle within the study area. The concentration of cases during the middle of the year suggests that environmental conditions during these months favor mosquito breeding and virus transmission.

The recurring monthly trend highlights the importance of initiating dengue prevention activities before June, when cases begin to rise. Environmental cleanup campaigns, larval source reduction, and community awareness programs should be intensified during the months preceding the rainy season. Early implementation of these interventions can reduce mosquito populations before peak transmission occurs.

The findings agree with Liu-Helmersson et al. (2021), who found that seasonal increases in temperature and rainfall significantly influence the monthly distribution of dengue by enhancing mosquito development and viral transmission. Their study emphasized that understanding monthly trends is essential for planning timely vector control activities. The observed increase from June to August reflects this seasonal relationship.

Seasonal Index and Goodness-of-Fit Analysis

To quantify seasonality rather than describe it narratively, a seasonal index was computed for each calendar month as the ratio of that month's pooled five-year case total to the average monthly case total, expressed as a percentage (100% representing an "average" month with no seasonal effect). A chi-square goodness-of-fit test was then used to formally test whether the monthly distribution departed from the uniform distribution that would be expected if dengue transmission were unrelated to season.

Table 7. Monthly Seasonal Index of Pooled Dengue Cases (2021–2025)

Month	Pooled cases	Seasonal index (%)
January	10	63.8
February	12	76.6
March	21	134.0
April	8	51.1
May	14	89.4
June	18	114.9
July	**36**	**229.8**
August	**33**	**210.6**
September	17	108.5
October	13	83.0
November	3	19.1
December	3	19.1

Note: Indices computed against the pooled monthly total of 188 cases reported in Table 3, giving an average of 15.7 cases per month. This pooled monthly total is 3 cases lower than the five-year cumulative total of 191 cases reported in Tables 1, 2, and 5; the small discrepancy most likely reflects either a small number of cases for which the month of onset could not be reliably classified during data encoding, or a minor transcription difference between the monthly and annual summary records, and is flagged here for the authors' reconciliation against the original Municipal Health Office logs prior to final submission.

The seasonal index confirms a pronounced and quantifiable seasonal effect: July and August recorded indices of 229.8% and 210.6% respectively, meaning case volumes in these months were more than double the all-year monthly average, while November and December recorded indices of only 19.1%, roughly one-fifth of the average month. The coefficient of variation across the twelve monthly indices was 63.4%, underscoring the magnitude of within-year seasonal swing relative to a hypothetically uniform distribution.

A chi-square goodness-of-fit test comparing the observed monthly distribution to an expected uniform distribution (15.7 cases per month) was highly significant, $\chi^2(11, N = 188) = 75.62$, $p < .001$, formally rejecting the null hypothesis that dengue cases are evenly distributed across the calendar year.

A second chi-square test comparing observed cases during the five-month rainy-season window (June–October) against the remaining seven months likewise showed significantly more cases than would be expected if transmission were unrelated to season, $\chi^2(1, N = 188) = 32.72$, $p < .001$ (117 rainy-season cases observed versus 78.3 expected; 71 cases observed in the remaining months versus 109.7 expected). These results provide formal statistical confirmation, rather than purely visual or narrative inference, that the concentration of dengue cases in the rainy season is a genuine and non-random epidemiological pattern in Doroluman and Greenfield.

Seasonal Pattern

The results demonstrate a distinct seasonal pattern, with most dengue cases occurring during the rainy season, particularly from June to August. Increased rainfall creates numerous stagnant water sources that serve as breeding habitats for Aedes aegypti mosquitoes, leading to higher mosquito density and increased dengue transmission. The reduction in cases toward the end of the year indicates that less favorable environmental conditions may have limited mosquito reproduction.

The seasonal pattern suggests that dengue prevention strategies should be aligned with seasonal climatic conditions. Health authorities should implement intensive vector control, environmental sanitation, and public awareness campaigns before and during the rainy season to reduce the risk of outbreaks. Seasonal preparedness can improve the efficiency of dengue control programs and protect vulnerable communities.

The findings are supported by Campbell et al. (2023), who reported that rainfall and seasonal weather patterns are major determinants of dengue transmission in tropical countries because they directly affect mosquito breeding and survival. The study concluded that recognizing seasonal transmission patterns enables more effective timing of public health interventions. The concentration of dengue cases during the rainy season in this study is consistent with these findings.

Comparative Trend

The comparative trend shows that Barangay Greenfield consistently reported more dengue cases than Barangay Doroluman throughout the five-year study period, although both barangays exhibited similar seasonal fluctuations. This indicates that while both communities were influenced by comparable climatic conditions, Barangay Greenfield experienced greater dengue transmission. The higher disease burden may be associated with differences in population characteristics, environmental conditions, and mosquito breeding opportunities.

The consistently higher incidence in Barangay Greenfield indicates the need for location-specific dengue prevention and control strategies. Public health resources should be prioritized in high-incidence communities through intensified vector surveillance, environmental management, and community engagement programs. Targeted interventions based on local risk factors can improve the effectiveness of dengue control efforts.

The findings are consistent with Achee et al. (2021), who emphasized that dengue transmission varies between communities because of differences in environmental conditions, human population density, and local vector ecology. Their study highlighted that identifying high-risk areas allows health authorities to allocate resources more effectively and implement targeted control measures. The consistently higher incidence observed in Barangay Greenfield reflects these community-level differences.

Climatic, Environmental, and Socio-Demographic Considerations

While the present dataset did not include direct meteorological or demographic variables, the observed July–August peak coincides closely with the southwest monsoon season in Mindanao, during which rainfall, ambient temperature, and relative humidity typically rise in tandem and create extended periods of standing water suitable for Aedes aegypti oviposition. Lowe et al. (2021) demonstrated that climate-informed surveillance models incorporating rainfall lag effects and temperature thresholds can predict dengue risk several weeks in advance, suggesting that future iterations of this surveillance system in Arakan would benefit from routinely pairing case counts with PAGASA rainfall and temperature records to formally test lagged climatic associations rather than relying on seasonal inference alone. Socio-demographic and environmental differences between the two barangays likely also help explain why Greenfield consistently outpaced Doroluman in case counts; plausible contributing factors include differences in population density and housing clustering, proximity to irrigated agricultural land or stagnant waterways, water storage practices in the absence of piped water supply, and accessibility of solid-waste collection, all of which are recognized drivers of Aedes breeding density in barangay-level studies elsewhere in the Philippines. Because these variables were not captured in the surveillance dataset used here, they are proposed as priority variables for prospective data collection rather than confirmed determinants, and this distinction is noted as a limitation of the present analysis.

Comparison with Regional Dengue Epidemiology

The seasonal concentration of cases observed in Doroluman and Greenfield mirrors patterns reported across Southeast Asia. In Thailand, Sangkawibha et al. (2022) similarly documented a rainy-season concentration of dengue transmission linked to humidity and rainfall-driven vector proliferation, while Murray et al. (2023) noted that this rainfall-linked seasonality is a near-universal feature of dengue epidemiology across endemic tropical settings in the region rather than a localized phenomenon. At the national level, the sharp rise culminating in the 2024 outbreak year parallels the substantial year-on-year increases reported by the Department of Health (2025) for the Philippines as a whole, suggesting that the local outbreak in Arakan was embedded within a broader national surge rather than an isolated municipal event. At the same time, the magnitude of the Greenfield-Doroluman disparity, with Greenfield recording nearly double the cases of its neighboring barangay despite shared climatic exposure, illustrates a recurring theme in regional dengue literature: that within-municipality heterogeneity in incidence is often as pronounced as between-country differences, reinforcing Achee et al.'s (2021) argument that vector control resources are most effective when targeted at the barangay or village level rather than distributed uniformly across a municipality.

Study Limitations and Directions for Future Research

This study is subject to several limitations that should be considered when interpreting its findings. First, the analysis relied on passively reported secondary surveillance data, which is susceptible to underreporting, particularly for mild or asymptomatic infections that do not prompt a health facility visit, meaning the true community incidence of dengue in both barangays is likely higher than the recorded figures. Second, although the Mann-Kendall and chi-square procedures applied in this revision provide a formal test of trend and association, the five-year annual series remains short for robust time-series modeling (e.g., ARIMA or seasonal decomposition), and the results should be interpreted as indicative rather than definitive evidence of an underlying epidemic curve. Third, the dataset did not include individual-level demographic variables (age, sex, occupation) or household-level environmental variables (water storage type, proximity to breeding sites, housing density), which limited the study to area-level rather than individual-level risk factor analysis. Future research should pursue prospective, geocoded surveillance that links case data with concurrent rainfall, temperature, and humidity records and with household-level entomological indices, and should extend the observation period beyond five years to allow formal time-series forecasting of outbreak risk. Such designs would allow local health authorities to move from descriptive recognition of peak months toward predictive, early-warning dengue surveillance.

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