

THE EFFECT OF CLIMATE VARIATIONS (RAINFALL, TEMPERATURE, AND HUMIDITY) ON THE INCIDENCE OF DENGUE HEMORRHAGIC FEVER (DHF) IN WEST JAKARTA FROM 2023 TO 2025

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Abstrak

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Dengue hemorrhagic fever (DHF) remains a serious public health problem, particularly in tropical regions such as Indonesia. Climatic factors such as rainfall, air temperature, and humidity are known to influence the life cycle of the *Aedes aegypti* mosquito and the dynamics of dengue virus transmission; therefore, it is important to analyze their association with DHF incidence in West Jakarta. To analyze the influence of climatic variations—including rainfall, air temperature, and humidity—on the incidence of Dengue Hemorrhagic Fever (DHF) in West Jakarta. A quantitative study with a time-series ecological design, using all dengue fever case data and monthly climate data from West Jakarta for the period 2023–2025. The analysis employed Spearman's correlation test. The highest rainfall was recorded in January 2025 (527.3 mm) and the lowest in October 2023 (0 mm). The highest air temperature was 29.15°C (October 2024) and the lowest was 26.66°C (February 2023). Humidity ranged from 67–84%. The results of the Spearman correlation test showed no significant relationship between rainfall and dengue fever (DBD) cases ($p > 0.05$ for all years) or between air temperature and DBD cases ($p > 0.05$ for all years). Humidity showed a positive and significant relationship with dengue fever incidence in 2023 ($r = 0.580$; $p = 0.048$), but this relationship was not significant in 2024 ($r = 0.322$; $p = 0.308$) or 2025 ($r = 0.238$; $p = 0.457$).

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INTRODUCTION

Dengue hemorrhagic fever (DHF) is a vector-borne infectious disease that remains a serious public health problem in tropical and subtropical regions, including Indonesia. The disease is transmitted through the bite of the *Aedes aegypti* mosquito infected with the dengue virus. Global climate change is known to play a role in influencing the spread of vector-borne diseases, both directly through its impact on the vector's reproductive capacity and survival, and indirectly through changes in the interaction patterns between humans, vectors, and pathogens. This situation is exacerbated by globalization, increased international air travel, rapid urbanization, and weak vector control systems, resulting in *Aedes aegypti* expanding its global distribution range; nearly half of the world's population is now at risk of dengue transmission.

The three climatic factors most frequently studied in relation to the dynamics of dengue transmission are rainfall, temperature, and humidity. Rainfall contributes to the formation of standing water, which serves as a breeding ground for mosquitoes; air temperature affects the speed of the mosquito life cycle as well as the extrinsic incubation period of the dengue virus within the mosquito's body; and humidity is related to the survival and flight activity of adult mosquitoes. Theoretically, these three climate factors interact with one another to influence the intensity of dengue fever transmission in a given region.

West Jakarta is one of the administrative districts in the Special Capital Region of Jakarta with a relatively high incidence of dengue fever, with 2,969 cases recorded in 2025 according to the Special Capital Region of Jakarta's health profile. This high number of cases raises questions about the extent to which climate variability contributes to fluctuations in dengue fever incidence in this region, given that various studies in other regions of Indonesia have shown inconsistent results regarding the direction and strength of the relationship between climatic factors and dengue fever incidence. Therefore, this study aims to analyze the influence of climate variations—including rainfall, air temperature, and humidity—on dengue fever incidence in West Jakarta during the 2023–2025 period, while also identifying patterns in dengue fever incidence based on these climate variations.

LITERATURE REVIEW

1. Dengue Hemorrhagic Fever and *Aedes aegypti* Transmission

Dengue hemorrhagic fever (DHF) is a vector-borne infectious disease that remains an important public health problem in tropical and subtropical regions, including Indonesia. DHF is caused by dengue virus and is transmitted mainly through the bite of infected *Aedes aegypti* mosquitoes. The transmission process involves an interaction between humans, mosquitoes, and the virus. Therefore, changes in environmental conditions may influence mosquito survival, reproduction, and the transmission process. The increasing distribution of *Aedes aegypti* has also been associated with urbanization, population mobility, globalization, and weaknesses in vector control. These conditions make dengue transmission a continuing concern in densely populated urban areas.

Aedes aegypti is closely associated with human environments and can reproduce in containers holding water. The availability of breeding sites is therefore an important environmental component of dengue transmission. Rainfall can contribute to the formation and persistence of standing water, creating suitable habitats for mosquito larvae. However, the relationship between rainfall and mosquito abundance is not

necessarily linear. Very heavy rainfall may remove larvae from breeding containers or temporary habitats, whereas moderate rainfall may increase the availability of breeding sites. Consequently, the effect of rainfall on dengue incidence can differ among locations and periods.

Temperature also affects mosquito development and the dengue virus within the mosquito. Air temperature can influence the speed of the mosquito life cycle and the extrinsic incubation period of the virus. Within a suitable range, warmer conditions may accelerate mosquito development and viral replication. Nevertheless, temperature that becomes excessively high may negatively affect mosquito survival. Humidity is another environmental factor associated with adult mosquito survival and flight activity. Higher humidity can provide conditions that support mosquito persistence, although its influence may vary according to other environmental circumstances.

Dengue transmission is therefore influenced by multiple interacting factors rather than by a single climatic variable. Community behavior, population density, sanitation, mobility, vector density, and the implementation of mosquito control activities may modify the relationship between climate and DHF incidence. In urban areas such as West Jakarta, these non-climatic factors are particularly relevant because environmental conditions and human activities change continuously. Understanding dengue transmission requires consideration of both climatic and non-climatic determinants. This framework provides a basis for examining whether rainfall, temperature, and humidity are associated with fluctuations in DHF incidence during a specific period. Local surveillance is important for identifying changing patterns and guiding appropriate prevention efforts and communities.

2. Rainfall, Air Temperature, and Humidity as Climatic Factors

Climate variables, particularly rainfall, air temperature, and humidity, are frequently examined in dengue epidemiology because they can affect different stages of the mosquito and virus transmission cycle. Rainfall may influence the availability of aquatic habitats required for *Aedes aegypti* breeding. When rainwater accumulates in natural or artificial containers, the number of potential breeding sites may increase. However, the effect depends on the amount and timing of rainfall. Moderate rainfall may support mosquito breeding, while excessive rainfall can disturb or wash away immature mosquitoes. This explains why rainfall does not necessarily have a uniform relationship with dengue incidence across different years or geographical settings.

Air temperature is important because it affects both mosquito biology and viral development. Temperature can influence egg, larval, and pupal development and may also affect adult mosquito survival. In addition, temperature influences the extrinsic incubation period of dengue virus inside the mosquito. When temperature remains within a suitable range, viral development may occur more rapidly, potentially shortening the time before an infected mosquito can transmit the virus. However, temperature outside the mosquito's suitable range may reduce survival or reproductive success. Therefore, the relationship between temperature and dengue incidence may depend on the temperature range experienced in a particular location.

Relative humidity can also influence the persistence and activity of adult mosquitoes. Adequate humidity may support mosquito survival and flight activity, increasing opportunities for mosquitoes to encounter human hosts. However, the contribution of humidity to dengue transmission may differ according to temperature, rainfall, housing conditions, and other ecological characteristics. Climate variables may also interact rather

than operate independently. For example, rainfall can create breeding habitats, while temperature and humidity can affect the survival and development of mosquitoes within those habitats.

Previous findings presented in the study show that the associations between climatic variables and DHF incidence are not consistent. The study's discussion notes that rainfall may have different effects depending on intensity, while temperature variations may have limited explanatory value when temperatures remain within a suitable range for *Aedes aegypti* development. Humidity may show a stronger relationship during periods but not necessarily across consecutive years. These observations indicate that climate should be examined in relation to local environmental and epidemiological conditions. Consequently, assessing rainfall, temperature, and humidity together can describe climatic variation and its potential relationship with dengue incidence. Local climatic patterns may alter these relationships over time.

3. Relationship Between Climate Variation and Dengue Hemorrhagic Fever Incidence

The relationship between climatic variation and dengue hemorrhagic fever incidence is biologically plausible because rainfall, temperature, and humidity can influence mosquito ecology and virus transmission. Nevertheless, an observed association may vary according to location, season, population characteristics, vector density, and the effectiveness of dengue prevention programs. Climate therefore should not be interpreted as an isolated determinant of DHF incidence. Epidemiological analysis is needed to determine whether changes in climatic conditions correspond with changes in reported dengue cases during a defined observation period.

Rainfall may increase the number of mosquito breeding habitats when water accumulates in containers and other locations. However, rainfall can also reduce immature mosquito populations when water flow removes larvae. Consequently, the direction and strength of the relationship between rainfall and DHF may change between periods. The manuscript reports that rainfall in West Jakarta was not significantly related to DHF incidence during 2023, 2024, or 2025. The correlation coefficients were 0.301, -0.105, and 0.063, respectively, with p-values above 0.05. These results indicate that the observed monthly rainfall patterns did not demonstrate a statistically significant association with DHF cases in any of the three years.

Temperature showed a similar pattern. The manuscript reports no significant relationship between air temperature and DHF incidence during the three observation years. The correlation coefficients were -0.434 in 2023, 0.091 in 2024, and 0.070 in 2025, and all p-values exceeded 0.05. One possible explanation discussed in the manuscript is that temperature variation during the study period was relatively narrow, ranging from 26.66°C to 29.15°C. Such conditions may generally remain suitable for *Aedes aegypti* development, making temperature less useful for explaining monthly differences in dengue incidence.

Humidity produced a different result in 2023. A positive, moderately strong, and statistically significant relationship was identified, with $r = 0.580$ and $p = 0.048$. However, the association was not significant in 2024 or 2025, when r values were 0.322 and 0.238, respectively. The inconsistency suggests that humidity may contribute to dengue transmission under particular conditions but does not consistently explain annual fluctuations. Overall, the findings support an ecological perspective in which climatic conditions interact with non-climatic factors, including vector density, population

mobility, sanitation, community behavior, and mosquito control activities. Further research incorporating these factors may clarify the mechanisms underlying variations in DHF incidence in urban settings and communities.

RESEARCH METHOD

This study is quantitative in nature and employs a descriptive epidemiological approach using a time-series-based ecological study design. It aims to explore the patterns and trends of dengue fever cases over a specific time period and to identify their association with climatic variables (rainfall, temperature, and relative humidity). The study was conducted in West Jakarta from January 2023 to December 2025.

The study population included all dengue fever cases recorded by the West Jakarta City Health Department during the 2023–2025 period. No sampling was conducted because the ecological study design uses the entire population as the unit of analysis. The data used were secondary data, specifically monthly data on the number of dengue fever cases sourced from the Indonesian Ministry of Health (a compilation of reports from the Health Office and Community Health Centers), as well as monthly climate data (air temperature, humidity, and rainfall) obtained from the West Jakarta Climatological Station in the form of monthly averages derived from daily reports.

Data processing was conducted through the stages of data editing, entry, and tabulation, and the data were then analyzed using SPSS statistical software, version 24. Univariate analysis was used to describe the distribution of data for each variable (mean, standard deviation, minimum and maximum values). Prior to bivariate analysis, a normality test was performed using the Kolmogorov-Smirnov test; since the data were not normally distributed, the relationship between variables was analyzed using Spearman's rank correlation test to assess the strength and direction of the relationship between rainfall, temperature, and humidity and the incidence of dengue fever in each year of observation

RESULT AND DISCUSSION

1. Overview of Climate Variations in West Jakarta from 2023 to 2025

The average monthly rainfall in West Jakarta shows a seasonal pattern that fluctuates from year to year. In 2023, the highest rainfall occurred in February (332.1 mm) and dropped to a low of 0 mm in October. In 2024, the highest rainfall was recorded in December (344.7 mm), with the lowest at 8.1 mm in October. A different pattern emerged in 2025, with the highest peak during the study period occurring in January (527.3 mm) and the lowest at 130.8 mm in October.

Monthly average air temperatures exhibit a relatively consistent seasonal pattern each year, tending to rise starting in the middle of the year and peaking in October, then declining toward the end of the year. The highest temperature during the study period was recorded at 29.15°C in October 2024, while the lowest temperature was recorded at 26.66°C in February 2023. Humidity fluctuated with relatively small variations, ranging from 67–84% throughout the study period. The pattern tended to be similar each year, peaking early in the year, declining from mid-year through the end of the year, and then rising again toward the start of the following year. The highest humidity was recorded at 83.95% in March 2023, and the lowest at 67.94% in September 2023.

The highest number of dengue fever cases in West Jakarta in 2023 occurred in May (130 cases); in 2024, there was a sharp spike in April (799 cases); and in 2025, the highest

number of cases occurred in May (362 cases). The extremely high spike in cases in 2024 indicates the possibility of an Outbreak (KLB) of dengue fever that year.

2. Data Normality Test

The results of the Kolmogorov-Smirnov test indicate that the temperature variable is normally distributed (Sig. = 0.547), while the humidity (Sig. = 0.009) and rainfall (Sig. = 0.036) variables are not normally distributed. Since all data are non-normally distributed, the analysis of the relationship between variables in this study used Spearman's rank correlation test.

3. The Relationship Between Climate Variations and Dengue Fever Incidence in West Jakarta from 2023 to 2025

The results of the Spearman correlation test between the three climate variables and the incidence of dengue fever in each year of observation are presented in the following table.

Climate Variables	Year	Correlation Coefficient (r)	P-Value	Notes
Rainfall	2023	0.301	0.342	Not Significant
	2024	-0.105	0.746	Not Significant
	2025	0.063	0.846	Not Significant

**Table 1. Results of the Spearman Correlation Test Between Rainfall and Dengue Fever Incidence in West Jakarta from 2023 to 2025*

Climate Variables	Year	Correlation Coefficient (r)	P-Value	Notes
Temperature	2023	-0.434	0.159	Not Significant
	2024	0.091	0.778	Not Significant
	2025	0.070	0.829	Not Significant

**Table 2. Results of the Spearman Correlation Test Between Temperature and Dengue Fever Incidence in West Jakarta in –2025*

Climate Variables	Year	Correlation Coefficient (r)	P-Value	Notes
Humidity	2023	0.580	0.048	Significant
	2024	0.322	0.308	Not Significant
	2025	0.238	0.457	Not Significant

**Table 3. Results of the Spearman Correlation Test Between Humidity and Dengue Fever Incidence in West Jakarta from 2023 to 2025*

a. Relationship Between Rainfall and Dengue Fever Incidence

The results of the Spearman correlation test indicate that the relationship between rainfall and dengue fever incidence was not significant across all years of observation ($p > 0.05$), with a very weak to weak strength of association and a correlation direction that varied from year to year (positive in 2023 and 2025, negative in 2024). Descriptively, patterns of rainfall change do not always align with patterns of change in the number of dengue fever cases; for example, in 2024, the number of dengue fever cases rose sharply from March to May even though rainfall during that period actually tended to decrease. This finding is consistent with a number of studies showing that the effect of rainfall on

dengue fever incidence is not always linear, as excessively high rainfall can actually wash away mosquito larvae from their breeding sites, while moderate rainfall accompanied by standing water is more likely to increase the vector population.

b. The Relationship Between Temperature and Dengue Fever Incidence

The results of the Spearman correlation test showed no significant relationship between air temperature and the incidence of dengue fever throughout the observation period ($p > 0.05$). The direction of the relationship also varied, being negative in 2023 ($r = -0.434$) and positive in 2024 and 2025; however, all correlations were weak to very weak. Air temperature variations in West Jakarta during the study period were relatively small ($26.66\text{--}29.15^{\circ}\text{C}$) and fell within the optimal temperature range for the year-round development of *Aedes aegypti* mosquitoes; thus, temperature does not appear to be a distinguishing factor influencing the monthly fluctuations in the number of dengue fever cases.

c. The Relationship Between Humidity and Dengue Fever Incidence

The results of the Spearman correlation test showed a positive, moderately strong, and statistically significant relationship between humidity and the incidence of dengue fever in 2023 ($r = 0.580$; $p = 0.048$). This pattern is supported by descriptive data, which show that in early 2023, relative humidity was high and was followed by a high number of dengue fever cases, while a decrease in humidity from mid- to late-year was also followed by a decrease in the number of cases. However, this relationship was inconsistent in 2024 ($t = 0.322$; $p = 0.308$) and 2025 ($r = 0.238$; $p = 0.457$), with both results being statistically insignificant. Air humidity is known to play an important role in the survival of adult mosquitoes and their flight activity; however, this effect appears to be more pronounced under certain conditions and is not always consistent from year to year.

4. General Discussion

Overall, the results of this study indicate that climatic variations (rainfall, air temperature, and humidity) in West Jakarta during the 2023–2025 period have not shown a consistent association with dengue fever cases. Of these three variables, only humidity in 2023 showed a significant association with dengue fever cases, while the other variables did not show a statistically significant association in any given year. These findings suggest that fluctuations in dengue fever incidence in West Jakarta are likely influenced more by non-climatic factors, such as vector density, community behavior regarding mosquito breeding site elimination (PSN), population density and mobility, environmental sanitation conditions, and the effectiveness of dengue control programs in the region.

This study has limitations, including the use of secondary data, which may not fully guarantee the accuracy of case count calculations, as well as a scope of variables that focuses solely on climatic factors without accounting for other behavioral and environmental factors that also play a role in the transmission of dengue fever. Future research is recommended to include these non-climatic variables in order to provide a more comprehensive description of the factors associated with fluctuations in dengue fever incidence in tropical urban areas such as West Jakarta.

CONCLUSION

Rainfall, air temperature, and humidity in West Jakarta from 2023 to 2025 showed seasonal patterns that varied from year to year. The results of the Spearman correlation

test indicated that there was no significant relationship between rainfall or air temperature and the incidence of dengue fever during the entire observation period ($p > 0.05$). Humidity showed a positive and significant relationship with dengue fever incidence only in 2023 ($r = 0.580$; $p = 0.048$), but this relationship was not significant in 2024 and 2025.

Overall, climatic variations did not show a consistent association with dengue fever incidence in West Jakarta during the study period; therefore, non-climatic factors are suspected to play a greater role in the fluctuations in dengue fever cases. The Health Department and the West Jakarta local government are advised to strengthen dengue fever control strategies based on epidemiological data and community behavior, rather than relying solely on climatic indicators, and to consider air humidity as an early warning indicator during specific periods.

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