JURNAL RISET KESEHATAN
POLTEKKES DEPKES BANDUNG
Vol 17 No 2, Oktober 2025

e-ISSN: 2579-8103
p-ISSN:1979-8253

THE INFLUENCE OF CLIMATIC CONDITIONS ON THE DYNAMICS OF DENGUE HEMORRHAGIC FEVER: LITERATURE REVIEW

Pengaruh Kondisi Iklim terhadap Dinamika Demam Berdarah Dengue: Tinjauan Literatur

Rizky Febryan Samal[1*], Mateus Sakundarno Adi[1] , Nurjazuli Nurjazuli[1]
[1] Fakultas Kesehatan Masyarakat, Universitas Diponegoro, Semarang, Indonesia
*Email: rizkysamal40@gmail.com

ABSTRAK

Demam berdarah dengue merupakan masalah kesehatan global utama yang dipengaruhi oleh perubahan iklim dan faktor lingkungan seperti suhu, kelembaban, kecepatan angin, jumlah hari hujan, curah hujan dan paparan sinar matahari. Penelitian ini bertujuan menganalisis pengaruh kondisi iklim terhadap dinamika penularan demam berdarah dengue. Metode pencarian dalam penelitian ini terdapat sebanyak 20 studi dari wilayah tropis dan subtropis dipilih menggunakan metode PRISMA 2020 dengan desain studi Cross Sectional, Cohort, dan Ekologi. Penelitian ini bersumber dari basis data Google Scholar, Science Direct, PubMed dan Garuda. Hasilnya terdapat sebanyak 20.510 publikasi yang memenuhi kriteria pencarian. Setelah dilakukan skrining dengan batasan tahun, full text, dan relevansi abstrak, hanya 20 jurnal yang memenuhi kriteria inklusi penulisan artikel ini. Kriteria inklusi dari penelitian ini adalah artikel yang diterbitkan dalam rentang tahun 2019-2024, artikel terpublikasi resmi, artikel tersedia dalam teks lengkap dan dapat diakses dan artikel tidak terduplikasi. Studi ini menyimpulkan bahwa kondisi iklim berpengaruh dengan dinamika penularan demam berdarah dengue.

Kata kunci: *Aedes aegypti, faktor risiko, perubahan iklim, PRISMA*

ABSTRACT

Dengue hemorrhagic fever is a major global health problem influenced by climate change and environmental factors, such as temperature, humidity, wind speed, rainy days, rainfall and sun hours. This study aims to analyze how climate conditions influence the transmission dynamics of dengue hemorrhagic fever. Twenty studies from tropical and subtropical regions were selected for this study using the PRISMA 2020 method, with cross-sectional, cohort, and ecological study designs. These studies were sourced from Google Scholar, ScienceDirect, PubMed, and Garuda. A total of 20,510 publications met the search criteria. After screening for year, full text, and abstract relevance, only 20 journals met the inclusion criteria for this article. This study included articles published between 2019 and 2024 that were officially published and available in full text, as well as non-duplicated articles. The study concluded that climatic conditions affect the transmission dynamics of dengue hemorrhagic fever.

Keywords: *Aedes aegypti, risk factors, climate, PRISMA*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease transmitted by mosquitoes, primarily Aedes aegypti. The development and increase in the number of this vector are influenced by various environmental factors, including weather conditions. Factors such as temperature, humidity, and rainfall play a crucial role in determining the mosquito's reproductive rate, lifespan, and distribution area. Climate change, particularly increases in temperature and rainfall, has a direct impact on the increase in dengue fever incidence.[1]Increased rainfall creates stagnant water, ideal for mosquito breeding. High humidity also increases the lifespan of adult mosquitoes, thus increasing the risk of transmission. A study conducted in Delhi, India, showed

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

a correlation between rainfall and dengue fever incidence (ρ= 0.01).[2]Rainfall is significantly linked to dengue fever incidence because it creates an ideal habitat for the Aedes aegypti mosquito to lay eggs and breed in puddles formed after rain. Furthermore, rainfall increases ambient humidity, which prolongs the lifespan of adult mosquitoes and enhances their ability to transmit the dengue virus.[2]Dengue fever cases often peak during or after the rainy season, when moderate temperatures and high humidity favor the mosquito life cycle and viral replication. Research conducted in Delhi, India, showed that rainfall in the previous month (with a 1-2 month lag) was strongly associated with an increase in dengue cases in the following month, with a significant ρ value. This understanding is crucial for predicting dengue outbreaks and implementing preventive measures, such as vector control, early before a surge in cases occurs.[2]

Dengue hemorrhagic fever (DHF) has emerged as the most widespread and fastest-growing vector-borne disease in the world. In 2023, the number of dengue hemorrhagic fever (DHF) cases worldwide reached a record high, with more than 6.5 million cases reported. This included 7,300 dengue-related deaths in more than 80 countries. This increase in cases was influenced by several factors, including the El Niño phenomenon, climate change, and weak health systems in some countries.[1]

In the last three years (2022–2024), climate conditions in Indonesia have shown a significant trend of change, marked by an increase in the frequency and intensity of extreme weather phenomena. 2022 and most of 2023 were dominated by the La Nina phenomenon, which caused increased rainfall in various regions, triggering floods and landslides in several areas. However, from late 2023 to 2024, Indonesia began to experience the impacts of the El Nino phenomenon, which caused decreased rainfall and triggered drought, particularly in eastern Indonesia, such as East Nusa Tenggara (NTT) and parts of Kalimantan. According to the Meteorology, Climatology, and Geophysics Agency (BMKG), these climate conditions indicated anomalous sea surface temperatures and an increase in average air temperatures in line with global warming trends. Furthermore, the BMKG also noted that 2023 was one of the hottest years ever in Indonesia, reflecting the real impact of climate change on environmental stability and vital sectors such as agriculture and public health.[3]

Over the past five years, there has been a significant increase in the number of dengue cases. This increase is particularly pronounced in the Americas. Currently, 90 countries are known to have active dengue transmission in 2024, not all of which are reflected in formal reporting. As of April 30, 2024, more than 7.6 million dengue cases had been reported to the WHO, including 3.4 million confirmed cases, over 16,000 severe cases, and over 3,000 deaths.[4]

Over the past five years, the trend of dengue fever cases in Indonesia has shown a fluctuating pattern, with a tendency to increase, especially in 2022 and 2023. According to data from the Indonesian Ministry of Health, in 2022, more than 143,000 cases of dengue fever were recorded, with more than 1,200 deaths, an increase compared to 2021. This increase was influenced by tropical climate factors that support the breeding of the Aedes aegypti mosquito, as well as a lack of public awareness of environmental protection. In 2024, several provinces, such as West Java, East Java, and East Nusa Tenggara, were reported to have the highest number of cases. Rising global temperatures and extreme rainfall due to climate change also contributed to the surge in cases. This makes dengue

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

fever a public health problem that still requires serious attention in Indonesia.[5]

Based on research conducted in Depok, West Java, rainfall (ρ= 0.024), humidity (ρ= 0.036), and temperature (ρ= 0.007) were proven to have a strong correlation as predictors of dengue fever transmission (Depok)[6]Dengue fever is a serious problem facing the world today. Therefore, based on this background, researchers are interested in conducting a literature review to discuss and examine various sources of information regarding climate change and dengue fever incidence.

METHODS

The literature review was conducted using a reference search strategy using databases such as PubMed, Science Direct, Garuda and Google Scholar in November 2024. The research search process used the PICOS method (Population - Intervention - Comparison - Outcome Study Design). The PICOS terms used in this study are: (P) dengue fever in tropical and subtropical areas, (I) risk factors, (C) not dengue fever, (O) risk factors for dengue fever, (S) the study design is cross-sectional, case-control, ecological and cohort studies. Keywords were adjusted using the PICOS method to obtain relevant keywords, therefore the relevant keywords arerisk factors, climate change, aedes aegypti mosquito, PRISMA.

All titles and abstracts were screened using the following inclusion criteria: articles in English, published within the last five years (2019–2024), original research, full-text and open access, and relevant to the topic of climate change on dengue fever incidence. The methodological quality of each study was evaluated using standard tools such as the Joanna Briggs Institute critical appraisal tools to ensure data validity and reliability.

The selected articles were included in the data extraction and synthesis process, which is presented in a table based on the PICOS framework: (i) study title and location, (ii) investigator and year, (iii) design and methods, and (iv) results. After searching the database, 20 articles were obtained that met all criteria.

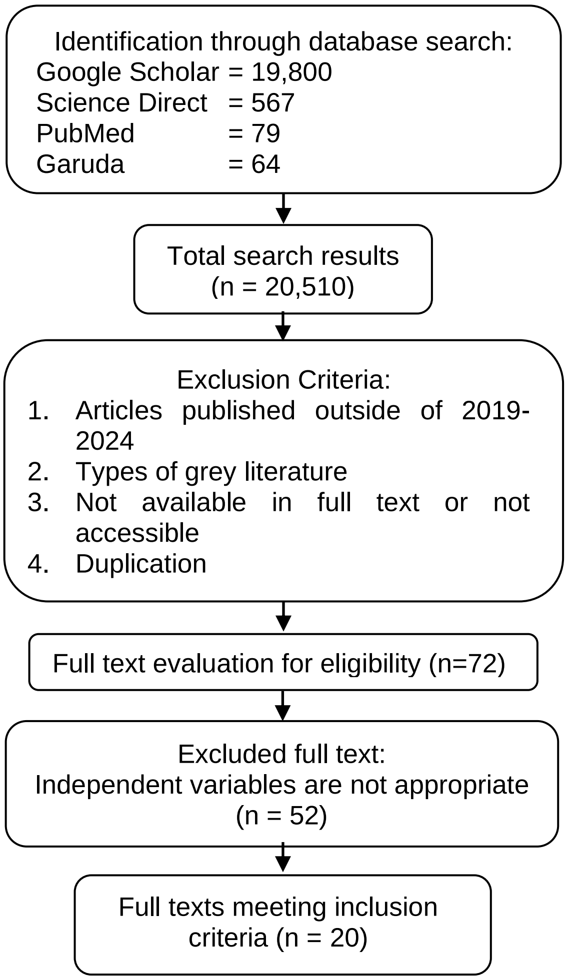

Figure 1. PRISMA Flowchart

Based on Figure 1, 20,510 studies were identified and included in the screening phase. After screening based on inclusion criteria, 72 studies were identified and obtained for full-text screening. As a result of full-text screening based on exclusion criteria, 52 studies were excluded. The primary reason for excluding these four studies was that they did not meet the inclusion criteria. Thus, 20 studies were used in the literature review.

RESULT

The results of a review of 20 articles included in the synthesis stage to examine the influence of climate

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

conditions on the dynamics of dengue fever spread. The studies included in this literature review were conducted in South Sumatra, Palembang, Sleman, Bengkulu, Yogyakarta, Manado, South Jakarta, Depok, Kendari, Denpasar, Bandung, Bogor, Thailand, Mexico, Myanmar, Sri Lanka, Bangladesh, Delhi, and Jayapura. Of the 20 articles found, there were 6 articles with a cross-sectional study design, 7 articles with a cohort study design, and 7 articles with an ecological study design. The following is Table 1. Characteristics of the 20 articles reviewed.

Table 1. Characteristics of the Studies Reviewed

No	Title, Researcher and Year	Design	Results	Climate Variables Studied
1.	*Impact Of Climate Variability And Incidence On Dengue Hemorrhagic Fever In Palembang City, South Sumatra, Indonesia*[7] Minarti, Chairil Anwar, Irfannuddin, Chandra Irsan, Ramzi Amin, and Ahmad Ghiffari (2021)	*Cross-sectional*	Type of analysis: Spearman's Rank Correlation Coefficient Research result: Variables that had a significant influence included rainfall (p = 0.005), number of rainy days (p = 0.020), temperature (p = 0.040), and humidity (p = 0.024). Variables that did not have a significant effect included wind speed (p = 0.492) and sun exposure (p = 0.865).	Rainfall, number of rainy days, temperature, humidity, wind speed and sun exposure.
2.	*Climate Variability (Temperature, Humidity, Rain Intensity And Wind Speed) And Dengue Hemorrhagic Fever Case Correlations in Depok City in 2009-2018*[6] BN Sugardo, MM Sintorini, and RA Kusumadewi (2021)	Ecology	Type of analysis: Spearman test and linear regression. Research result: Variables that have a significant influence include temperature (ρ= 0.023), humidity (ρ= 0.016) Variables that did not have a significant effect included rainfall (ρ= 0.190), wind speed (ρ= 0.432).	Temperature, humidity, rainfall and wind speed.
3.	*Correlational Study Of Climate Factor, Mobility And The Incidence of Dengue Hemorrhagic Fever in Kendari, Indonesia*[8] Andi Arsunan Arsin, Siti Nurul Ainun Istiqamah, Rezki Elisafitri, Muhammad Akbar Nurdin, Saifuddin Sirajuddin, Dwia Aries Tina Pulubuhu, Andi Nilawati Usman, Aisyah, and Ahmad Yani (2020)	Ecology	Types of analysis: Pearson correlation test and Spearman correlation test. Variables that have a significant influence include temperature (ρ= 0.048), humidity (ρ= 0.001), and population mobility (ρ= 0.045). Variables that did not have a significant effect included wind speed (ρ= 0.589).	Temperature, humidity, population mobility and wind speed.
4.	Hubungan Iklim dengan Peningkatan Kasus Demam Berdarah (DBD) di Kota Denpasar [9] Nana Putri Yanto (2022)	*Cross-sectional*	Type of analysis: path analysis. Variables that have a significant influence include humidity (p = 0.021) Variables that did not have a significant effect included temperature (0.150) and rainfall (0.277).	Humidity, temperature and rainfall.
5.	Hubungan Variabilitas Iklim dan Kejadian Demam Berdarah di Kota Manado [10] Febrian Fredrik Landu, Wulan PJ Kaunang, and Paul AT Kawatu (2021)	Ecology	Type of analysis: Pearson correlation test and simple linear regression. Variables that have a significant influence include rainfall (p = 0.040), humidity (0.016), temperature (0.000)	Rainfall, temperature and humidity

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

No	Title, Researcher and Year	Design	Results	Climate Variables Studied
			Variables that do not have a significant influence: none.	
6.	*Analysis of Temperature, Humidity, Rainfall, and Wind Velocity on Dengue Hemorrhagic Fever in Bandung Municipality*[11] Agung Sutriyawan, N. Kurniati, Novianti, U. Farida, L. Yusanti, SN Destriani, MKF Saputra (2024)	*Cross-sectional*	Type of analysis: Pearson correlation test and multiple linear regression Variables that have a significant influence include humidity (p = 0.018) and wind speed (p = 0.028). Variables that did not have a significant influence included temperature (p = 0.324) and rainfall (p = 0.383).	Humidity, wind speed, temperature and rainfall.
7.	*Coherence of dengue incidence and climate in the wet and dry zones of Sri Lanka*[12] RA Ranga Prabodanie, Sergei Schreider, Bernard Cazelles, Lewi Stone (2020)	*Cohort*	Type of analysis: 1. Wavelet analysis 2. Granger causality test 3. Negative binomial and linear regression Variables that have a significant influence include the number of rainy days (p= 0.000), humidity (p= 0.027), wind speed (p= 0.045), rainfall (p= 0.027). Variables that did not have a significant effect included temperature (p= 0.653).	Number of rainy days, humidity, wind speed, rainfall and temperature.
8.	*Analysis of temperature and humidity on dengue hemorrhagic fever in Manado Municipality*[13] Tyrsa CN Monintja, A. Arsin, R. Amiruddin, Muhammad Syafar (2021)	*Cross-sectional*	Type of analysis: 1. Descriptive analysis 2. Spearman rank correlation test Variables that have a significant influence include temperature (p= 0.000), humidity (p= 0.000). Variables that have no effect: none	Temperature and humidity.
9.	*The ecological determinants of severe dengue: A Bayesian inferential model*[14] Annan, Moeen Hamid Bukhari, Jesús Treviño, Zahra Shakeri Hossein Abad, Jailos Lubinda, Eduardo AB da Silva, Ubydul Haque (2023)	*Cohort*	Type of analysis: 1. Bayesian Poisson Regression Model 2. Conditional Autoregressive (CAR) Bayesian Modeling 3. Principal Component Analysis (PCA) for poverty index 4. Spatial Analysis (Moran's I, Hotspot Gi*) 5. The model is executed using MCMC (Markov Chain Monte Carlo) Variables that have a positive relationship include humidity, poverty index, regional altitude, and type of virus. Variables that have a negative relationship include temperature and rainfall.	Humidity, poverty index, altitude, virus type, temperature and rainfall.
10.	*Association of climate factors with dengue incidence in Bangladesh, Dhaka City: A calculated regression*	*Cohort*	Type of analysis: Negative binomial regression Variables that have a significant influence include temperature (p=	Temperature, humidity, wind speed, rainfall,

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

No	Title, Researcher and Year	Design	Results	Climate Variables Studied
	approach[15] Sorif Hossain, Md. Momin Islam, Md. Abid Hasan, Promit Barua Chowdhury, Imtiaj Ahmed Easty, Md. Kamruzzaman Tusar, Md. Bazlur Rashid, Kabirul Bashar (2023)		0.001), humidity, wind speed and rainfall (p= 0.000), The variable that had no effect was the hours of sunlight (p = 0.851)	and sunlight direction.
11.	*Dengue Hemorrhagic Fever (DHF): Vulnerability Model Based on Population and Climate Factors in Bengkulu City*[16] Dessy Triana, Martini Martini, Ari Suwondo, Muchlis Achsan Udji Sofro, Soeharyo Hadisaputro, Suhartono (2023)	*Cross-sectional*	Type of analysis: Structural Equation Modeling (SEM) Variables that have a significant influence include; Population factors: population density and sanitation (p= 0.018) Climate factors: temperature, humidity and rainfall (p= 0.000). Variables that have no effect; none	Population density, sanitation, temperature, humidity and rainfall.
12.	*The Relationship Between Climate Factors and Dengue Hemorrhagic Fever Incidence in Sleman, Yogyakarta*[17] Tri Wulandari Kesetyaningsih, Reza Arief Fauzan (2024)	*Cross-sectional*	Type of analysis: Spearman correlation analysis significantly related variables: Humidity (p = 0.000), rainfall (p = 0.000), number of rainy days (p = 0.000). Variables that are not significantly related: Average temperature (p= 0.407). Min-max temperature difference (p= 0.060).	Humidity, temperature, rainfall, number of rainy days, difference between minimum and maximum temperatures
13.	*Climate change and dengue risk in central region of Thailand*[18] Uma Langkulsen, Kamol Promsakha Na Sakolnakhon, Nigel James (2020)	*Cohort*	Analysis types: Gaussian Kriging interpolation (ArcGIS 10.1) and Factor Weighted Index (FWI). Significantly related variables: rainfall and average temperature Less dominant variables: relative humidity and wind speed.	Rainfall, average temperature, relative humidity and wind speed.
14.	*Dynamics of dengue hemorrhagic fever incidence and climate as potential factors in Palembang 2013 - 2019*[19] Krisna Delita, Nurhayati Damiri, Rico Januar Sitorus, Poeji Loekitowati Hariani, Fika Minata Wathan, Annisa Tassia H (2021)	Ecology	Type of analysis: correlation analysis Significantly related variables: number of rainy days (p= 0.004), wind speed (p= 0.04) and air temperature (p= 0.000) Variables that were not significantly related: rainfall (p= 0.880), rainfall index (p= 0.065), air humidity (p= 0.88), duration of sunlight (p= 0.425).	Rainfall, rainfall index, number of rainy days, air temperature, air humidity, duration of sunshine, wind speed.
15.	*Time-Series Analysis of Climate Change Effect on Increasing of Dengue Hemorrhagic Fever (DHF) Case with Geographic Information System Approach in Yogyakarta, Indonesia*[20] Marko Ferdian Salim, M. Syairaji (2020)	Ecology	Type of analysis: 1. Time-Series Analysis 2. Correlation Analysis and Multiple Linear Regression 3. Geographic Information System (GIS) Overlay Significantly related variables: air humidity (p= 0.000) Variables that were not significantly related: rainfall (p= 0.131) and air temperature (p= 0.079)	Rainfall, air temperature and air humidity.

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

No	Title, Researcher and Year	Design	Results	Climate Variables Studied
16.	*The effects of climate factors, population density, and vector density on the incidence of dengue hemorrhagic fever in South Jakarta Administrative City 2016-2020: an ecological study*[21] Yuri Shizcha Amelinda, Ririn Arminsih Wulandari, Al Asyary (2022)	Ecology	Type of analysis: Pearson and Spearman correlation analysis Significantly related variables: rainfall (p= 0.000), air temperature (p= 0.024), humidity (p= 0.001), population density (p= 0.014) and larva-free index (p= 0.001) Variables that are not significantly related: 2-month lag air temperature (p= 0.151)	Rainfall, humidity, temperature, population density and mosquito-free index.
17.	*Dengue in Myanmar: Spatiotemporal epidemiology, association with climate and short-term prediction* [22] Win Zaw, Zaw Lin, Juli Ko Ko, Chawarat Rotejanaprasert, Neriza Pantanilla, Steeve Ebener, Richard James Maude (2023)	*Cohort*	Type of analysis: 1. Spearman rank correlation 2. Distributed lag non-linear model 3. Auto regressive integrated moving average Significantly related variables: Minimum temperature and rainfall Variables that are not significantly related: humidity	Minimum temperature, rainfall and humidity
18.	*A retrospective study of environmental predictors of dengue in Delhi from 2015 to 2018 using the generalized linear model* [2] Poornima Suryanath Singh and Himanshu K. Chaturvedi (2022)	*Cohort*	Type of analysis: Spearman rank correlation and generalized linear model Significantly related variables: maximum temperature (p= 0.001), max-min temperature difference (p= 0.000), cumulative rainfall (p= 0.000), and relative humidity (p= 0.000)	Maximum temperature, max-min temperature difference, cumulative rainfall and relative humidity
19.	Studi Ekologi Hubungan Iklim dengan Kejadian Demam Berdarah (DBD) di Kabupaten Bogor 2013-2022 [23] Lulu Rakhmatsani, Dewi Susanna (2024)	Ecology	Type of analysis: time series ecological study and Spearman correlation test Significantly related variables: air humidity (p= 0.0001) and rainfall (p= 0.0001) Variables that were not significantly related: air temperature (p= 0.297)	Air humidity, rainfall and air temperature
20.	Perubahan Iklim Kasus DBD di Kabupaten Jayapura 2014-2021 [24] Samuel Sandy (2024)	*Cohort*	Type of analysis: Spearman analysis Significantly related variables: rainfall (p= 0.043) Variables that were not significantly related: population density (p= 0.494), humidity (p= 0.073), temperature (p= 0.0666) and wind speed (p= 0.515)	Population density, rainfall, humidity, temperature and wind speed.

DISCUSSION

This study has a global scope in examining the influence of climate conditions on dengue dynamics, with the advantage of identifying general patterns and trends in transmission across diverse climates. This study integrates previous research findings to uncover knowledge gaps and support the development of adaptive dengue control policies globally and locally.

The implication is that the results of this review provide a scientific basis for policymakers and health practitioners in formulating dengue control strategies that take climate factors into account. Furthermore, this study supports the development of more accurate outbreak

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

prediction models and health policies responsive to climate change.

The impact of climate change on dengue fever incidence is the impact of changes in global weather patterns, such as temperature, humidity, wind speed, number of rainy days, and sunlight exposure, which can exacerbate the spread of the disease. Based on standards set by the World Health Organization (WHO), the ideal temperature for mosquito breeding is between 25-28°C.C.[1]High temperatures accelerate the life cycle of the Aedes aegypti mosquito, the main vector of dengue fever, increasing the incubation rate of the virus and extending the disease transmission season.[1]

A relative humidity of 60–80% is optimal for the survival and activity of Aedes aegypti mosquitoes. At this level, mosquitoes are more active, bite more frequently, and their life cycle is faster, thus increasing the potential for dengue transmission. Conversely, low humidity causes mosquitoes to become dehydrated, less active, and reduces transmission efficiency.[25]

Wind speed significantly influences the activity and spread of Aedes aegypti mosquitoes. Excessively high wind speeds can inhibit mosquito flight and reduce host-seeking behavior. The ideal wind speed for mosquito activity is usually below 2 meters per second (m/s). At this speed, mosquitoes can still fly effectively, searching for blood sources and breeding sites. Wind speeds above 2 m/s tend to disrupt mosquito movement, thereby reducing the spread and transmission of the dengue virus.[26]

The number of rainy days significantly influences the Aedes aegypti mosquito population and the risk of dengue transmission. Rain provides ideal breeding grounds in the form of standing water, such as in flower pots, used cans, and other open containers that can hold water. An ideal number of rainy days (≥10-15 days per month) increases the availability of habitat for mosquitoes to lay eggs and breed.[27]

Light to moderate rainfall (0.1–35.0 mm) for 2–4 months creates more mosquito breeding grounds, while optimal humidity supports mosquito survival. Climate change can disrupt seasonal patterns and trigger extreme weather events such as heavy rains or droughts, which increase mosquito populations and the risk of transmission. Consequently, climate change contributes to the increase in dengue fever cases, particularly in tropical and subtropical regions prone to weather fluctuations.[6]

Sunlight exposure plays a crucial role in the life cycle of the Aedes aegypti mosquito. Adequate light intensity can increase the water temperature in egg-laying areas, accelerate the development of larvae into adults, and accelerate mosquito population growth, thereby increasing the risk of dengue transmission. However, excessive sunlight can also accelerate water evaporation and reduce mosquito habitat. Therefore, environmental management, particularly of stagnant water exposed to sunlight, is crucial in dengue prevention efforts.[27]

In addition to direct climate factors, the relationship between climate variability and dengue fever (DHF) incidence is also influenced by moderating and mediating factors that form a systematic mechanism of disease transmission. Moderating factors such as population density, community mobility, environmental conditions, and access to health services can strengthen or weaken the influence of climate on the spread of DHF.[28]For example, high temperatures and humidity tend to have a greater impact in densely populated areas with poor sanitation than in areas with good vector control systems. Meanwhile, mediating factors include biological and ecological mechanisms such as changes in the mosquito life cycle, the duration of the virus incubation period (EIP), reproductive rates, and the

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

frequency of mosquito-human contact. High temperatures, for example, can accelerate the EIP and increase the potential for virus transmission. Understanding the role of these moderating and mediating factors is crucial for developing climate-based predictive models and designing intervention strategies that adapt to global environmental and climate change.[28]

Temperature and Dengue Fever Incidence

High temperature (25-30°C)has a significant relationship with the incidence of dengue fever in several areas, namely Delhi, India (ρ= 0.01)[2], Manado (ρ= 0.000)[11], Bangladesh (ρ= 0.000)[15], Mexico (ρ= 0.001)[23], Thailand (ρ= <0.05)[18], Depok (ρ= 0.007)[6], Kendari (ρ= 0.048)[8], Bengkulu (ρ= 0.000)[16], Myanmar (r= 0.3)[22], Palembang (p= <0.05)[19], Manado (p= 0.05)[13], Bogor Regency (ρ= 0.05)[23], Jayapura (ρ= 0.001)[24], South Sumatra (r= 0.371)[7]and South Jakarta (r= 0.4)[21]. Air temperature is significantly related to the incidence of dengue hemorrhagic fever (DHF) because temperature affects the life cycle of the Aedes aegypti mosquito, the vector for dengue virus transmission.[19]High temperature (25-28°C) accelerate the development of larvae into adult mosquitoes and increase the mosquito's activity in seeking blood, which contributes to the transmission of the virus.[22]High temperatures also accelerate the replication of the dengue virus in the mosquito's body, shortening the incubation period and increasing the likelihood of transmission.[14]High temperatures are often accompanied by rainfall, which increases the amount of standing water where mosquitoes lay their eggs. Therefore, warmer air temperatures support an increase in mosquito populations and increase the risk of dengue fever transmission.

Humidity and Dengue Fever Incidence

High humidity (72-95%) has been shown to have a significant relationship with dengue fever incidence. This is supported by research conducted in several areas, including Delhi, India (ρ=0.01)[2], Manado (ρ= 0.000)[10], Bandung (ρ= 0.018)[11], Bangladesh (ρ= 0.000)[15], Mexico (ρ= 0.001)[23], Depok (ρ= 0.036)[6], Bengkulu (ρ= 0.000)[16], Manado (ρ= <0.05)[13], Denpasar (ρ= 0.021)[9], Palembang (ρ= 0.024)[7], South Jakarta (ρ= 0.001)[21], Sleman (ρ= 0.001)[17], Jayapura (ρ= 0.0001)[24], South Sumatra (r= 0.221)[7] and Yogyakarta (ρ= 0.000)[20]. High air humidity is closely related to the occurrence of dengue fever because high air humidity supports the survival and development of the Aedes aegypti mosquito and the dengue virus it carries.[20]The Aedes Aegypti mosquito prefers to breed in environments with high air humidity, especially in puddles after rain.[9] High humidity also affects the ability of adult mosquitoes to survive, as they require sufficient water in the environment to survive and reproduce.[17]In addition, high air humidity accelerates the process of water evaporation, which causes water to puddle more often and for longer periods, thus providing more places for mosquitoes to lay eggs.[18]

Wind Speed and Dengue Fever Incidence

Wind speed (4-8 km/h) has been shown to have a significant relationship with dengue fever incidence. Similar research has been conducted in several locations, including Bandung (ρ= 0.028).[11], Bangladesh (ρ= 0.000)[11], and Surabaya (ρ= 0.000), Jayapura (ρ= 0.0001)[24] and Mexico (ρ= 0.001)[23]. Wind speed is significantly related to dengue fever because wind affects the distribution of Aedes aegypti mosquitoes and the environmental conditions where mosquitoes breed.[15]Strong winds can reduce the amount of standing water around human settlements, which reduces

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

mosquito breeding grounds, but can also spread adult mosquitoes over a wider area, thereby increasing the area of disease transmission.[23]Furthermore, strong winds can worsen humidity conditions, which impacts mosquito and virus survival. On the other hand, little or no wind creates a more stable and humid environment, allowing mosquito populations to grow more rapidly. Therefore, moderate wind speeds tend to reduce mosquito densities.[11]

Number of Rainy Days and Dengue Fever Incidence

The number of consecutive rainy days in the previous 1-2 months has been shown to have a significant relationship with dengue fever incidence. This is supported by research conducted in Sleman (ρ = 0.001).[19]and South Sumatra (r= 0.295).[10]The number of rainy days is significantly related to dengue fever incidence because frequent rain creates more standing water—whether in drainage channels, open containers, or other places—which provides ideal habitat for Aedes aegypti. The more rainy days in a given period, the greater the opportunity for mosquito breeding grounds to form, which increases the population and the risk of dengue virus transmission.[9.19]

Rainfall and Dengue Fever Incidents

Rainfall starts from 2-4 months with light to moderate intensity (0.1-35.0 mm)[18]has a significant relationship with the incidence of dengue fever. This is supported by research conducted in Palembang (ρ= 0.005),[7]Manado (ρ= 0.000),[10]Sri Lanka (ρ= 0.027),[12]Bangladesh (ρ= 0.000),[15]and Bogor (ρ= 0.000).[23]The relationship between rainfall and dengue fever incidence is complex and depends on its intensity. Light to moderate rainfall (0.1–35.0 mm) is positively correlated with increased cases, as it effectively provides and maintains standing water, which serves as an ideal habitat for Aedes aegypti mosquitoes to lay eggs and breed. However, the opposite effect occurs with very heavy rainfall (>90 mm). High-intensity rainfall can actually negatively impact mosquito populations by potentially washing away or damaging eggs, larvae, and pupae from their breeding grounds. Therefore, it can be concluded that the increase in dengue fever cases is more influenced by rainfall with sufficient volume to create standing water, rather than excessive rainfall.

Sun Exposure and Dengue Fever Incidence

Sun exposure has been shown to be significantly associated with dengue fever incidence. This is supported by research conducted in Bangladesh (ρ= 0.000),[15] and Mexico (ρ= 0.001).[23] Sunlight exposure significantly influences the incidence of dengue fever. Although Aedes aegypti is more active at night, the environment affected by sunlight still affects the survival of mosquitoes and their larvae. Adequate sunlight can reduce stagnant water through evaporation, thereby reducing mosquito breeding sites. However, if stagnant water is protected from direct sunlight—such as under bushes or eaves—sunlight exposure can actually increase the micro-temperature, accelerate the mosquito life cycle, and shorten the incubation period of the dengue virus. Thus, the intensity and distribution of sunlight also influence the depth of stagnant water and the environmental temperature, ultimately increasing the risk of dengue transmission.[8.15]

CONCLUSION

Climate conditions play a significant role in the spread of dengue fever (DHF) through their influence on the dynamics of the Aedes aegypti mosquito, the disease vector. Based on 20 analyzed studies, an optimal temperature of 25–30°C accelerates the mosquito life cycle and the virus incubation period. High humidity (around 88%) increases the survival of adult mosquitoes, while wind

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

speeds of 4–8 km/h contribute positively to the increase in DHF cases.

A consecutive rainy day in the previous 1–2 months can trigger an increase in cases, while light to moderate rainfall (0.1–35 mm) in the last 2–4 months creates stagnant water as a breeding ground for mosquitoes. Shorter exposure to sunlight is also associated with increased transmission, as mosquitoes are more active in shaded or dark environments, increasing the frequency of bites. To reduce the risk of spread, mitigation measures such as vector control, early warning systems, and increasing public awareness of the impact of climate change on dengue are needed.

REFERENCES

1. World Health Organization. Dengue and Severe Dengue. Published 2024. https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue
2. Singh PS, Chaturvedi HK. A retrospective study of environmental predictors of dengue in Delhi from 2015 to 2018 using the generalized linear model. *Sci Rep*. 2022;12(1):1-10. doi:10.1038/s41598-022-12164-x
3. BMKG. Laporan Prakiraan Musim dan Analisis Iklim di Indonesia (2022-2024). Published 2024. https://www.bmkg.go.id/iklim/informasi-iklim.bmkg
4. World Health Organization. WHO EPI-WIN Webinar: dengue: current epidemiological situation and response. Published 2024. https://www.who.int/news-room/events/detail/2024/06/13/default-calendar/dengue--current-epidemiological-situation-and-response
5. Kemenkes RI. Waspada Penyakit di Musim Hujan. Published 2024. https://kemkes.go.id/id/waspada-penyakit-di-musim-hujan
6. Sugardo BN, Sintorini MM, Kusumadewi RA. Climate variability (temperature, humidity, rain intensity and wind speed) and dengue hemorrhagic fever case correlations in Depok City in 2009-2018. *IOP Conf Ser Earth Environ Sci*. 2021;737(1). doi:10.1088/1755-1315/737/1/012001
7. Minarti M, Anwar C, Irfannuddin I, Irsan C, Amin R, Ghiffari A. Impact of climate variability and incidence on dengue hemorrhagic fever in palembang city, south sumatra, indonesia. *Open Access Maced J Med Sci*. 2021;9:952-958. doi:10.3889/oamjms.2021.6853
8. Arsin AA, Istiqamah SNA, Elisafitri R, et al. Correlational study of climate factor, mobility and the incidence of Dengue Hemorrhagic Fever in Kendari, Indonesia. *Enferm Clin*. 2020;30:280-284. doi:10.1016/j.enfcli.2020.06.064
9. Yanto NP. Hubungan Iklim Terhadap Peningkatan Kasus Demam Berdarah Dengue (Dbd) Di Kota Denpasar. *J Kesehat Lingkung*. 2022;12(2):114-124.
10. Landu FF, Kaunang WPJ, Kawatu PAT. Hubungan Antara Variabilitas Iklim Dengan Kejadian Demem Berdarah Dengue di Kota Manado. *J Kesmas*. 2021;10(3):19-26. https://ejournal.unsrat.ac.id/index.php/kesmas/article/view/33632/31825
11. Sutriyawan A, Kurniati N, Novianti, et al. Analysis of Temperature, Humidity, Rainfall, and Wind Velocity on Dengue Hemorrhagic Fever in Bandung Municipality. *Russ J Infect Immun*. 2024;14(1):155-162. doi:10.15789/2220-7619-AOT-2110
12. Prabodanie RAR, Schreider S, Cazelles B, Stone L. Coherence of dengue incidence and climate in the wet and dry zones of Sri Lanka. *Sci Total Environ*. 2020;724:138269. doi:10.1016/j.scitotenv.2020.138269
13. Monintja TCN, Arsin AA, Amiruddin R, Syafar M. Analysis of temperature and humidity on dengue hemorrhagic fever in Manado Municipality. *Gac Sanit*. 2021;35:S330-S333. doi:10.1016/j.gaceta.2021.07.020
14. Annan E, Bukhari MH, Treviño J, et al. The ecological determinants of severe dengue: A Bayesian inferential model.

https://doi.org/10.34011/juriskesbdg.v17i2.2908

e-ISSN: 2579-8103
p-ISSN:1979-8253

Ecol Inform. 2023;74(August 2022). doi:10.1016/j.ecoinf.2023.101986
15. Hossain S, Islam MM, Hasan MA, et al. Association of climate factors with dengue incidence in Bangladesh, Dhaka City: A count regression approach. *Heliyon*. 2023;9(5):e16053. doi:10.1016/j.heliyon.2023.e16053
16. Triana D, Martini M, Suwondo A, Sofro MAU, Hadisaputro S, Suhartono S. Dengue Hemorrhagic Fever (DHF): Vulnerability Model Based on Population and Climate Factors in Bengkulu City. *J Heal Sci Med Res*. 2024;42(2). doi:10.31584/jhsmr.2023982
17. Kesetyaningsih TW, Fauzan RA. The Relationship Between Climate Factors and Dengue Hemorrhagic Fever Incidence in Sleman, Yogyakarta. *Proc 4th Int Conf Sustain Innov 2020–Health Sci Nurs (ICoSIHSN 2020)*. 2021;33(ICoSIHSN 2020). doi:10.2991/ahsr.k.210115.116
18. Langkulsen U, Promsakha Na Sakolnakhon K, James N. Climate change and dengue risk in central region of Thailand. *Int J Environ Health Res*. 2020;30(3):327-335. doi:10.1080/09603123.2019.1599100
19. Delita K, Damiri N, Sitorus RJ, Hariani PL, Wathan FM, Annisa Tassia H. Dynamics of dengue hemorrhagic fever incidence and climate as potential factors in Palembang 2013 - 2019. *IOP Conf Ser Earth Environ Sci*. 2021;819(1). doi:10.1088/1755-1315/819/1/012050
20. Salim MF, Syairaji M. Time-Series Analysis of Climate Change Effect on Increasing of Dengue Hemorrhagic Fever (DHF) Case with Geographic Information System Approach in Yogyakarta, Indonesia. *Int Proc 2Ed Int Sci Meet Heal Inf Manag*. 2020;5:248-256.
21. Amelinda YS, Wulandari RA, Asyary A. The effects of climate factors, population density, and vector density on the incidence of dengue hemorrhagic fever in South Jakarta Administrative City 2016-2020: an ecological study. *Acta Biomed*. 2022;93(6). doi:10.23750/abm.v93i6.13503
22. Zaw W, Lin Z, Ko JK, et al. Dengue in Myanmar: Spatiotemporal epidemiology, association with climate and short-term prediction. *PLoS Negl Trop Dis*. 2023;17(6 June):1-24. doi:10.1371/journal.pntd.0011331
23. Rakhmatsani L, Susanna D. Studi Ekologi Hubungan Iklim Terhadap Kejadian Demam Berdarah Dengue (DBD) di Kabupaten Bogor Tahun 2013-2022. *J Kesehat Lingkung Indones*. 2024;23(2):207-214. doi:10.14710/jkli.23.2.207-214
24. Sandy S. Perubahan Iklim Terhadap Kasus DBD di Kabupaten Jayapura Tahun 2014-2021. *J Kesehat Lingkung Indones*. 2024;23(2):182-190. doi:10.14710/jkli.23.2.182-190
25. Beno J, Silen A., Yanti M. National Guideline for Clinical Management of Dengue 2022. *Braz Dent J*. 2022;33(1):1-12.
26. Epidemiology and Disease Control Division (EDCD). National guidelines on intergrated vector management. 2020;(June):1-140. http://www.who.int/neglected_diseases/vector_ecology/ivm_concept/en/
27. Bermudi PMM, Kowalski F, Menzato MM, et al. Aedes aegypti breeding site in an underground rainwater reservoir: a warning. *Rev Saude Publica*. 2017;51:1-5. doi:10.11606/S1518-8787.2017051000087
28. Colon-Gonzalez, F. J., Fezzi, C., Lake, I. R., & Hunter PR. The effects of weather and climate change on dengue. *PLoS Negl Trop Dis*. 2017;11:11. https://doi.org/10.1371/journal.pntd.0006477

https://doi.org/10.34011/juriskesbdg.v17i2.2908