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The Relationship Between Meteorological and Dengue Fever Prevalence at Tanjung Priok Health Center, North Jakarta (2018-1014): An Islamic Perspective

Zahwa Aisya Nabila Ajedo, Ambar Hardjanti*, Afrizal Tw
Universitas Yarsi, Indonesia
Email: ambar.hardjanti70@gmail.com*

ABSTRACT

Dengue Hemorrhagic Fever (DHF) is an infectious disease that remains a major public health problem in Indonesia, particularly in tropical regions such as North Jakarta. Meteorological factors, including air temperature, humidity, rainfall, and wind speed, play an important role in the spread of this disease because they affect the life cycle and activity of the Aedes aegypti mosquito vector. The high number of DHF cases in the Tanjung Priok area over the years is thought to be influenced by variations in these dynamic climatic factors. This study was an analytical observational study with a cross-sectional design using secondary data. Data on DHF cases were obtained from the annual reports of the Tanjung Priok Health Center, while meteorological data (air temperature, humidity, rainfall, and wind speed) were collected from NASA. Data analysis was performed using multiple linear regression tests to determine the relationship between meteorological factors and DHF prevalence. The results showed that the meteorological factor that had a significant effect on the prevalence of DHF was wind speed ($p = 0.046$). Meanwhile, air temperature ($p = 0.902$), humidity ($p = 0.562$), and rainfall ($p = 0.528$) did not show significant relationships. The increase in wind speed can extend the flying range of Aedes aegypti mosquitoes, thereby increasing the potential for DHF transmission in densely populated areas. This study concludes that there is a significant relationship between wind speed and the prevalence of DHF in the Tanjung Priok Health Center area, North Jakarta.

KEYWORDS Dengue Hemorrhagic Fever; Meteorology; Temperature; Humidity; Rainfall.

INTRODUCTION

Dengue hemorrhagic fever (DHF) is one of the most common and widely prevalent infectious diseases today. The disease is zoonotic in nature, occurring in both humans and animals, and can be transmitted from animals to humans. The transmission agent is the female Aedes aegypti mosquito that carries the dengue virus and bites humans during the day (A, Tomia and R, Tuharea, 2021; WHO, 2024).

Since its first discovery in Indonesia, the incidence of dengue fever has continued to increase (Isna Hikmawati & Huda, 2021; Fiqi Nurbaya et al., 2022; Hartono, 2019. Although the government has implemented various interventions to prevent and control dengue fever since the start of dengue control programs in 1970, these efforts have not slowed the rate of spread of this disease throughout the archipelago (P2P Ministry of Health of the Republic of Indonesia, 2021).

As of April 2024, more than 7.6 million cases of dengue fever have been reported to WHO, including 3.4 million confirmed cases, more than 16,000 severe cases, and more than 3,000 deaths. Although a large increase in dengue cases has been reported worldwide over the past five years, this increase is especially notable in the Americas, where the number of cases surpassed seven million by the end of April 2024. In addition, the number of cases in this region was reported to be more than three times higher in the same period in 2023, illustrating how rapidly this health problem is developing (WHO, 2024).

Research conducted by Gwee, Chua, and Pang (2021) reported 14,972 cases of dengue hemorrhagic fever, the majority of which originated from Asia with 11,421 (76.3%) cases, followed by the Americas with 2,357 (15.7%), Africa with 833 (5.6%), Europe with 297 (2.0%), and Oceania with 14 (0.1%). Countries in Asia with the highest numbers of dengue hemorrhagic fever cases include Thailand, Myanmar, Indonesia, and the Philippines. In the Americas, the country with the most dengue hemorrhagic fever cases is Mexico (X, Gwee et al., 2021).

In Indonesia, dengue fever was first reported in 1968 in the city of Surabaya, where 58 people were infected and 24 people died. The incidence of dengue fever has continued to fluctuate each year. In 2014 there were 100,347 dengue cases with 907 deaths; in 2015 cases increased to 129,650 with 1,071 deaths; and in 2016 cases again increased to 202,314 with 1,593 deaths. In 2017, 68,407 people were infected and 493 died, while in 2018 there were 53,075 cases with 344 deaths. In 2019, as of January there were 13,683 reported cases and 133 deaths (Ministry of Health of the Republic of Indonesia, 2019).

Based on research conducted by Rezekieli Zebua et al. (2022) covering 34 provinces in Indonesia from 2017 to 2021, there were notable changes in dengue hemorrhagic fever cases. In 2017, cases were recorded at 26.10%, 24.75% in 2018, 51.53% in 2019, 40% in 2020, and 27% in 2021. The results of the study showed that changes and increases in dengue hemorrhagic fever were particularly dramatic in 2019, with an incidence of 51.53%.

Data from the DKI Jakarta Provincial Health Office in 2023 recorded 10,705 dengue hemorrhagic fever cases with 2 deaths. The region with the most cases was East Jakarta with 2,621 cases and no deaths, followed by North Jakarta with 2,476 cases and 1 death. South Jakarta reported 2,279 cases without deaths, West Jakarta 2,210 cases without deaths, and Central Jakarta 1,109 cases with 1 death. The Thousand Islands Regency recorded 10 cases without deaths. By 2024, dengue cases in Jakarta had increased significantly to 26,097 cases with 18 deaths (Jakarta Health Office, 2024).

In North Jakarta, the Tanjung Priok Sub-district has experienced notable changes in the incidence of dengue hemorrhagic fever. In 2024, Tanjung Priok Sub-district recorded 153 cases, Sungai Bambu Sub-district 86 cases, Kebon Bawang Sub-district 156 cases, Warakas Sub-district 119 cases, Papanggo Sub-district 123 cases, Sunter Agung Sub-district 218 cases, and Sunter Jaya Sub-district 226 cases (DKI Jakarta Health Office, 2024).

One of the factors contributing to the increasing incidence of dengue fever is climate change. Erratic climate patterns are believed to increase waterlogging, which provides breeding sites for Aedes mosquitoes and thus becomes one of the triggers for the rise in dengue fever cases. Temperature, precipitation, and humidity are also considered important climatic factors that influence mosquito growth and dengue outbreaks (Alvin Faiz Bara Mentari & Hartono, 2023; Ardhya, 2024; Gunasta et al., 2021). Currently, almost all provinces in Indonesia have been affected by dengue hemorrhagic fever (Apriliana, 2017).

Research conducted by Pramudi (2023) found that climate change influences the incidence of dengue hemorrhagic fever in Indonesia. Several provinces demonstrate the impact of climatic characteristics such as humidity, rainfall, and temperature on dengue cases, with incidence more strongly associated with rainfall and temperature. However, humidity and other factors also play a role, which is related to geographical conditions and community behaviors toward dengue prevention.

Maintaining cleanliness is very important in Islamic teachings. A well-known saying states that cleanliness is part of faith. Physical and mental hygiene are inseparable; cleansing oneself with water is an example of physical cleanliness (Fajriansyah et al., 2021; Isom Mudin et al., 2021). In addition, Islam also requires its followers to maintain environmental cleanliness, because physical and mental hygiene alone is not sufficient. An unclean environment can increase the breeding of Aedes aegypti mosquitoes (Indonesia, 2021).

Allah SWT has revealed that the existence of Aedes aegypti and Aedes albopictus mosquitoes carries certain wisdoms, one of which is their role as vectors for the transmission of dengue fever. The risk of transmission increases as the mosquito population grows. Therefore, as knowledgeable people (ulul albab), humans are required not to underestimate small matters, including efforts to prevent and control mosquitoes, in order to minimize the spread of dengue fever.

Based on the description above, although meteorological factors are known to play a role in the transmission of DHF, the specific pattern of this relationship in the Tanjung Priok area has not been thoroughly studied (Agus Susanto et al., 2020). The significant increase in cases in recent years underscores the urgency of this research. Therefore, this study aims to analyze the relationship between meteorological factors (air temperature, humidity, rainfall, and wind speed) and the prevalence of DHF in the working area of the Tanjung Priok Community Health Center, North Jakarta, for the period 2018–2024. The results of this study are expected to provide up-to-date insights into the dynamics of DHF transmission in relation to local climate, serve as a reference for future research, and contribute to more effective, evidence-based DHF control strategies in the region.

METHOD

This study is an observational analytical research with a cross-sectional survey design that aims to analyze the relationship between meteorological factors such as temperature, humidity, rainfall, and wind speed and the prevalence of dengue hemorrhagic fever (DHF) at the Tanjung Priok Health Center, North Jakarta. The study population includes all dengue cases recorded over the past six years, as well as meteorological data obtained from the National Aeronautics and Space Administration (NASA). The research sample consists of all available data on dengue cases and meteorological factors during that period, without any additional selection process. The type of data used is secondary data, which includes the prevalence of dengue cases and meteorological variables. Data collection is carried out through two main sources, namely the annual report of the Tanjung Priok Health Center and meteorological data from NASA, with procedures starting from applying for permission to the North Jakarta Health Office and continuing to data acquisition for subsequent processing according to the research objectives.

Data measurement is conducted by converting daily data into monthly data using quantitative techniques, whereby dengue prevalence is measured based on the number of recorded cases, while meteorological data are measured in their respective standard units. Furthermore, the data are analyzed using regression analysis methods to identify the relationship between meteorological factors and the prevalence of dengue in the study area.

RESULT AND DISCUSSION

Univariate Analysis

Temperatures

Analysis of air temperature was carried out to see the variation in maximum, average, and minimum temperature in each month during the observation period. Air temperature is one of the climatic factors that can affect environmental dynamics and the proliferation of disease vectors.

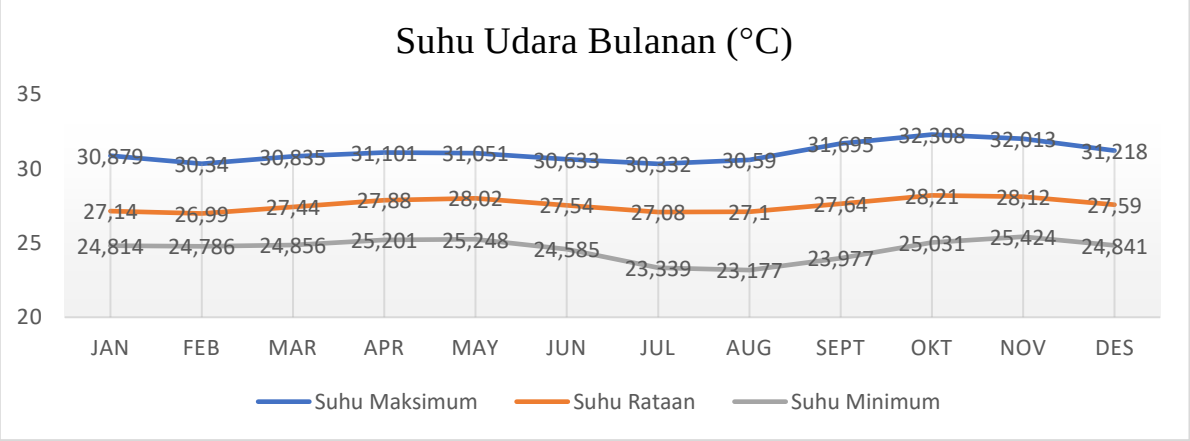

Figure 1. Monthly temperature variations in the tanjung priok area

The air temperature in the tanjung priok area, north jakarta during the period 2015–2024 shows a relatively stable pattern with seasonal fluctuations. The highest monthly maximum temperature was recorded in october at 32.3°c, while the lowest monthly minimum temperature occurred in august at 23.1°c. The average annual temperature ranges from 26.99°c to 28.21°c. Peak temperatures generally occur in dry months such as september and october, while minimum temperatures are more dominant in the middle of the year.

Air humidity

Air humidity plays a role in supporting the life of aedes aegypti mosquitoes as vectors of dengue transmission. Changes in humidity over time can reflect differences in rainy and dry seasons. For this reason, monthly air humidity data in the tanjung priok area during the period 2015–2024 is presented in table 4 to provide an overview of the variations in air humidity in the tanjung priok area.

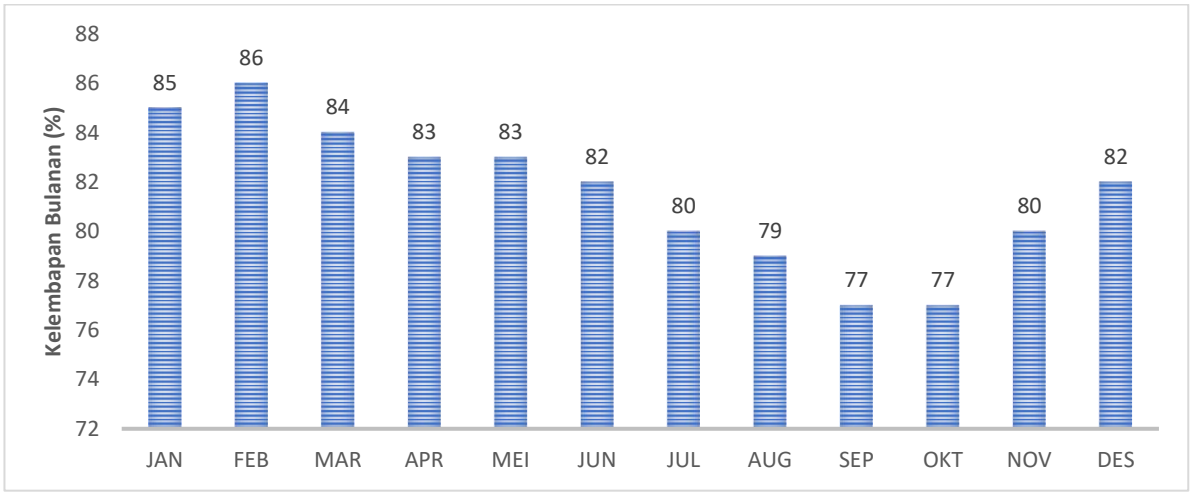

Figure 1. Average monthly humidity in the tanjung priok area for the period 2015-2024

The annual relative humidity in tanjung priok also shows seasonal variation, with the highest average in february (86%) and lowest in september and october (77%). This pattern illustrates that the highest humidity occurs during the rainy season, especially early in the year, while the dry season shows lower humidity.

Rainfall

Rainfall is related to the formation of puddles that can be a breeding ground for mosquitoes. The high and low rainfall every month gives an idea of the wet and dry periods. Monthly rainfall data in the tanjung priok area in the 2015–2024 period can be seen on the graph as a basis for understanding the rainfall patterns that occur in the tanjung priok area.

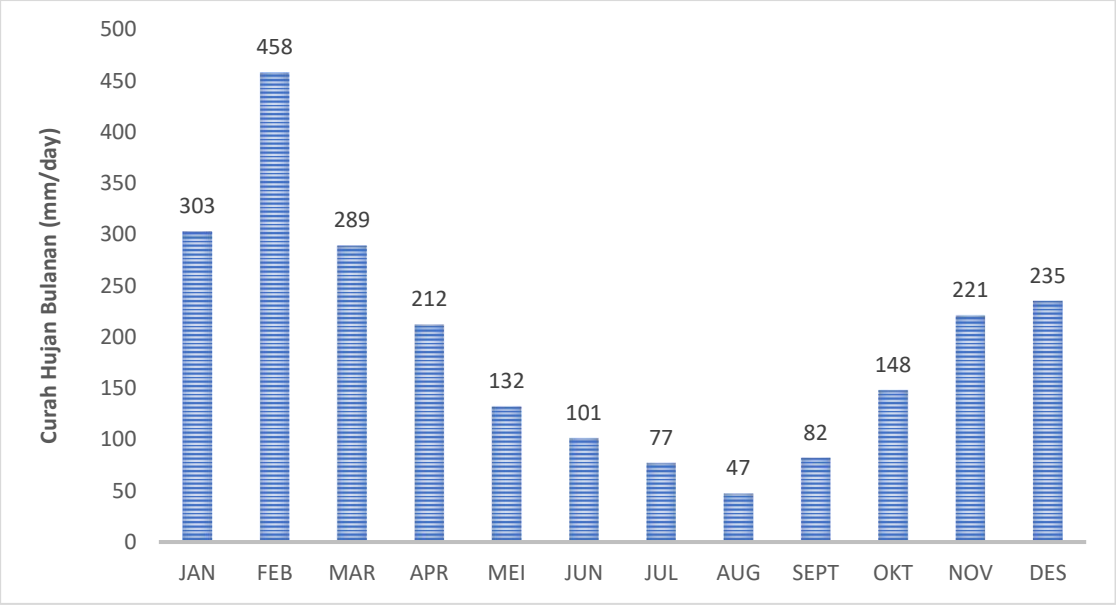

Figure 2. Average monthly rainfall in tanjung priok area

Climate data for 2015-2024 shows annual rainfall with an average total of 2306 mm/year.

(lakitan, 2002)

In the classification of climates according to schmidt ferguson's climate calculations is divided into 3 categories. The categories to determine wet months and dry months are as follows:

Dry moon (bk): if in one month it has a total of rainfall <60 mm.

Humid moon (bl): if in one month it has a total rainfall of 60-100 mm.

(ruqoyah, ruhiat and saefullah, 2023) (ruqoyah, ruhiat and saefullah, 2023)

After totaling for climate classification according to schmidt ferguson's climate calculations, the number of dry, humid and wet months in the tanjung priok area for the 2015-2025 period was obtained, namely:

Total dry months 20 months

Number of months reduced to 10 months

Number of wet months 90 months

Schmidt ferguson determined bb, bl and bk year after year during the observation period which were then summed up and averaged. It can be formulated:

The determination of the type of climate uses the value of q, with the formula:

$$\text{tipe iklim} = \frac{\text{jumlah bulan kering}}{\text{jumlah bulan basah}} \times 100$$

$$= \frac{20}{90} \times 100\%$$

$$= 22{,}22$$

Then, after the result of the value of q, determine the type of climate according to schmidt-ferguson

Very wet climate: $q < 14.3$

Wet climate: $14.3 \leq q < 33.3$

Temperate climate: $33.3 \leq q < 60$

Temperate climate: $60 \leq q < 100$

Temperate climate: $100 \leq q < 167$

Dry climate: $167 \leq q < 300$

Very dry climate: $q \geq 300$

It was concluded that the climate in the tanjung priok area of north jakarta includes **a type b climate, namely wet.**

Wind direction and speed

The direction and speed of the wind are climatic elements that can affect the spread of mosquitoes and environmental humidity. Wind patterns also describe the influence of different monsoon systems in each season. Data on wind direction and speed in the tanjung priok area during the period 2015–2024 are shown in figure 4 and figure 5 to show the distribution in the tanjung priok area.

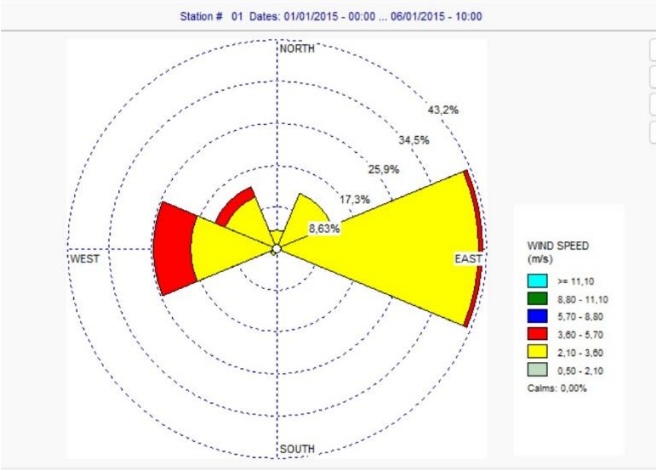

Figure 3. Distribution of wind direction and speed in the tanjung priok area.

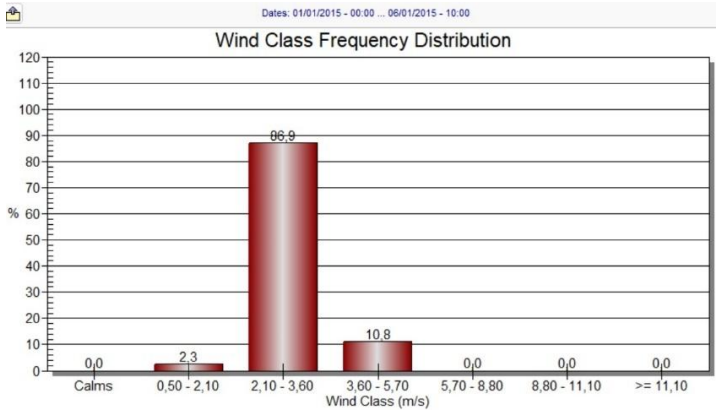

Figure 4. Graph of the distribution of wind direction and speed in the tanjung priok area.

Based on observation data on wind direction and speed, it is known that the wind direction in the tanjung priok area varies, but is dominated by gusts from the east to the west sector. This reflects the influence of the western monsoon winds at the beginning of the year and the eastern monsoon towards the middle of the year. The average wind speed is in the range of 2.0 to 4.6 m/s, with the highest speed reaching 4.64 m/s.

Number of dengue cases in the tanjung priok area for the 2018-2024 period

The number of dengue cases every month provides an overview of the trend of increasing or decreasing disease incidence from year to year. This data is important to see the peak of cases as well as the seasonal patterns that occur. Data on the number of dengue cases in the tanjung priok area during the 2018–2024 period can be seen in this graph.

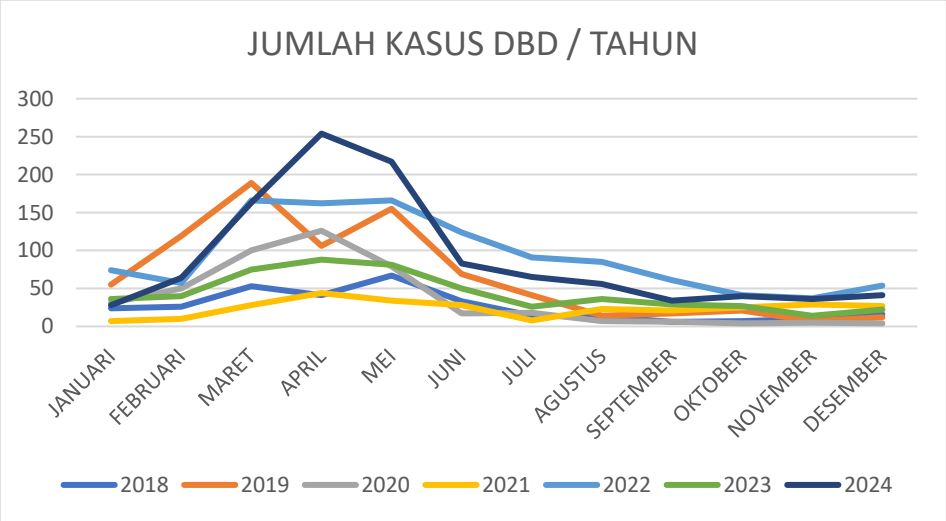

Figure 6. Graph of total dengue cases in the tanjung priok area for the 2018-2024 period

Dengue cases in tanjung priok show sharp fluctuations from year to year. Significant increases were seen in 2019 and 2022, with the number of cases reaching 805 and 1,118 cases, respectively. Monthly trends show that the peak of cases occurs from march to may, coinciding with the peak of the rainy season and high air humidity. In 2024, the number of cases was recorded at 1,081, with large spikes in april (254 cases) and may (217 cases). Population data is needed as a basis for calculating the prevalence of dengue disease, because it shows the size

of the population at risk. Data on the number of residents in tanjung priok district by sub-district in the 2018–2024 period can be seen in table 1.

Table 1. Number of inhabitants of tanjung priok

Year	Neighborhoods	Population
2018	Sunter agung	86.362
	Sunter jaya	76.215
	Papanggo	48.321
	Warakas	55.509
	Bamboo river	36.807
	Kebon bawang	63.340
	Tanjung priok	43.018
	Total	**409.572**
2019	Sunter agung	90.459
	Sunter jaya	77.957
	Papanggo	50.305
	Warakas	50.845
	Bamboo river	31.254
	Kebon bawang	52.113
	Tanjung priok	41.110
	Total	**394.043**
2020	Sunter agung	90.974
	Sunter jaya	78.010
	Papanggo	50.512
	Warakas	51.007
	Bamboo river	31.276
	Kebon bawang	52.146
	Tanjung priok	41.115
	Total	**395.040**
2021	Sunter agung	87.660
	Sunter jaya	78.366
	Papanggo	49.268
	Warakas	56.547
	Bamboo river	37.803
	Kebon bawang	64.422
	Tanjung priok	43.734
	Total	**417.800**
2022	Sunter agung	88.809
	Sunter jaya	80.289
	Papanggo	50.552
	Warakas	57.133
	Bamboo river	37.643
	Kebon bawang	64.198
	Tanjung priok	40.320
	Total	**418.944**

Year	Neighborhoods	Population
2023	Sunter agung	88.323
	Sunter jaya	80.428
	Papanggo	50.344
	Warakas	56.780
	Bamboo river	37.351
	Kebon bawang	63.334
	Tanjung priok	43.393
	Total	**419.953**
2024	Sunter agung	88591
	Sunter jaya	80487
	Papanggo	50523
	Warakas	57080
	Bamboo river	37555
	Kebon bawang	63903
	Tanjung priok	43393
	Total	**421.532**

Prevalence of dengue cases in the tanjung priok area for the period 2018-2024

Prevalence is the proportion of the population that is suffering from illness at any given time. Prevalence is used to determine the disease situation that exists in a given period. Prevalence counts old cases and new cases, calculates the proportion of diseases, the likelihood of disease occurring at a certain time and can be used in health service utilization studies. (nur et al., 2022).

Prevalensi Dapat Dihitung Menggunakan Rumus:

$$P = \frac{\text{Jumlah Kasus Yang Ada Selama Satu Periode Waktu}}{\text{Number Of People/Population Over A Period Of Time}} \text{ X } 100\%$$

The Results Of The Prevalence In Tanjung Priok Sub-District Can Be Seen In Table 8.

Table 1. Prevalence Of Dengue In Tanjung Priok For The 2018-2024 Period

Year	Dengue Cases	Population	Result
2018	310	409.572	0,076
2019	805	394.043	0,204
2020	447	395.040	0,113
2021	284	417.800	0,068
2022	1118	418.944	0,267
2023	524	419.953	0,125
2024	1081	421532	0,256

The Relationship Between Minimum Temperature And Dengue Prevalence In Tanjung Priok Area

(Morin, Comrie and Ernst, 2013; WHO, 2020) Aedes aegypti dan proses replikasi virus dengue di dalam tubuh vektor. Suhu di bawah 20–22°C dapat menghambat aktivitas metabolik

nyamuk, memperpanjang masa perkembangan larva, dan menurunkan kemampuan nyamuk untuk menularkan virus, sedangkan suhu optimum bagi siklus hidup nyamuk berada pada kisaran 25–30°C. Karena suhu minimum di wilayah penelitian ini masih berada dalam kisaran optimal tersebut, kondisi termal tidak menjadi faktor pembatas bagi populasi nyamuk Aedes aegypti (WHO, 2020).

The results of the analysis showed that the minimum temperature did not have a significant relationship with the prevalence of dengue. The insignificance of this relationship can be explained by the stability of the minimum temperature, which does not vary enough to affect mosquito population dynamics. In the context of tropical areas such as North Jakarta, the minimum temperature difference between the rainy and dry seasons is very small, so it does not cause significant changes in mosquito biological processes. Aedes aegypti mosquitoes can still thrive and survive throughout the year because they do not experience environmental pressure in terms of temperature. This contrasts with subtropical regions that have sharper temperature differences, where extreme temperature drops can kill mosquito populations or slow down virus transmission.

These findings are in line with a study conducted in Asunción, Paraguay, which also reported that average minimum temperatures had no meaningful relationship with dengue incidence. Based on the results of the analysis, the minimum temperature IRR value was 1.11, with a percentage increase in risk of 11.1%, but the 95% confidence interval (95% CI = 0.969–1.272) included the value 1, so it was considered statistically insignificant (Gómez-Dantés et al., 2022). This is also in line with research conducted by Rutler and Imita (2020). The results of the Spearman Rho correlation test between the incidence of dengue and air temperature, including minimum temperature, obtained a value of r = –0.125, which shows a correlation with very weak strength and a negative direction. This means that an increase in air temperature is likely to be followed by a decrease in the number of dengue cases, although the association is very weak. In addition, a p-value of 0.512 was obtained, which was greater than $\alpha = 0.05$, so it can be concluded that there is no significant relationship between air temperature and dengue incidence in Talaud Islands Regency.

Another factor that can explain the absence of this relationship is the compensation of environmental factors and human behavior. In dense urban areas such as Tanjung Priok, the presence of artificial water containers (such as buckets, gutters, bathtubs, and discarded plastic containers), which are the main breeding grounds for Aedes aegypti, tends to be stable throughout the year, so it does not depend heavily on temperature conditions. Mosquito populations are more influenced by water storage practices, environmental sanitation, and waste management systems than by variations in minimum temperature. In addition, vector control efforts such as fogging, the use of abate, and increased public awareness can also reduce mosquito populations even when temperature conditions support their breeding (Naji et al., 2020; Tanriverdi et al., 2021; Amoah & Nkosazana, 2022; Iankoon et al., 2022).

It is concluded that minimum air temperature does not have a significant relationship with the prevalence of dengue hemorrhagic fever (DHF). Although there are seasonal fluctuations in minimum temperature in the Tanjung Priok area, the variation is relatively small and does not have a significant effect on the number of dengue cases. The results of the regression analysis showed a very weak and statistically insignificant correlation coefficient, in line with findings from other regions such as Asunción, Paraguay, and Talaud Islands

Regency. Therefore, in the context of this study, minimum air temperature cannot be used as a strong predictive variable to explain variations in dengue cases, and further studies are needed on other environmental and non-environmental factors that contribute more to the increase in dengue prevalence.

The Relationship Between Average Temperature And Dengue Prevalence In The Tanjung Priok Area

The average temperature in the Tanjung Priok area during the 2015–2024 period ranged from 26.9°C to 28.2°C. This pattern indicates that the average temperature in the Tanjung Priok area is relatively constant throughout the year, with less noticeable differences between the rainy and dry seasons. Based on the results of the analysis, no significant relationship was found between average temperature and dengue prevalence, which suggests that average temperature did not have a significant influence on the prevalence of dengue during the study period.

This is in line with research conducted by Ashari R and Nasrianti (2017), which obtained a correlation coefficient between temperature and dengue fever incidence of 0.224 with a p-value of 0.484, where $p > \alpha$. Therefore, it can be concluded that there is no meaningful or significant relationship between temperature and the incidence of dengue fever in Bone Regency in 2013–2015.

Several studies also confirm that the variability of daily temperature (diurnal temperature range) or extreme temperatures (minimum and maximum) plays a greater role in influencing the ability of mosquitoes to transmit viruses than average temperature. In addition, the relationship between climate and dengue is non-linear, where after exceeding the optimal temperature, an increase in temperature is not always followed by an increase in cases and can even reduce the survival of mosquitoes and viruses in the mosquito's body (Mordecai, 2019). Therefore, in regions with stable temperatures within the optimal range, small changes in average temperature will not have a significant impact on dengue prevalence. Other factors such as humidity, rainfall, environmental conditions, population density, and vector control efforts are also reported to be more dominant in influencing dengue prevalence in tropical areas with relatively constant temperatures (Anam, 2016; Budiyanto, 2020; AW, 2015; Alya Nuralifya et al., 2025).

Based on the results of the analysis, it can be concluded that the average air temperature does not have a significant relationship with the prevalence of dengue hemorrhagic fever (DHF) cases in the Tanjung Priok area during the 2015–2024 period. Although air temperature is an important factor in the dynamics of dengue transmission, the results of this study show that there is no meaningful relationship between average temperature and case prevalence. This can be explained by the fact that the average temperature in the Tanjung Priok area is relatively stable throughout the year and lies within the optimal range for the development of Aedes aegypti mosquitoes, so small fluctuations do not have a significant effect on case variation (Campbell, Haldeman and Gomez, 2021).

These findings are reinforced by previous studies in other regions, such as in Bone Regency, which also showed no significant relationship between average air temperature and DHF incidence. Thus, it can be concluded that the average temperature in the Tanjung Priok area does not have a significant relationship with DHF prevalence. The stability of temperature within the optimum range for the survival of Aedes aegypti means that this factor does not play

a major role in influencing transmission dynamics. This confirms that in tropical areas with relatively constant temperatures, variations in DHF cases are more strongly determined by environmental factors, community behavior, and the effectiveness of vector control programs. Therefore, DHF prevention strategies in areas such as Tanjung Priok should focus on improving environmental cleanliness, managing water storage containers, and promoting clean and healthy living behaviors to break the chain of disease transmission.

The Relationship Between Maximum Temperature And Dengue Prevalence In The Tanjung Priok Area

Based on the results of the analysis of rainfall data in the Tanjung Priok area for the 2015–2024 period, the average annual rainfall reached 2,306 mm/year, with peak rainfall occurring in February (average 458 mm) and the lowest rainfall in August (average 47 mm). This pattern shows a clear difference between the rainy season and the dry season, with the rainy season lasting from December to March and the dry season occurring from June to August. Based on the analysis, the relationship between rainfall and dengue prevalence was not statistically significant, indicating that during the study period, rainfall fluctuations did not directly affect the prevalence of dengue in the Tanjung Priok area (Ardhya, 2024; Diyah Ruswanti, 2020).

This is in line with research by Fan, Jingchun et al. (2015), which used the Egger test on the maximum temperature variable and showed a slope value of 0.0407 with $p = 0.750$ ($p > 0.05$) and a 95% confidence interval (−0.25015 to 0.33158) that included zero. The results concluded that maximum temperature did not have a significant influence on the prevalence of dengue fever. Another study conducted by Rakhmatsani and Susanna (2024) using the Spearman correlation test obtained a correlation coefficient (r) between air temperature variables, including maximum temperature, and dengue incidence of −0.097, indicating a very weak correlation. The p-value of 0.297 also shows that there is no significant relationship between temperature variables and dengue incidence.

Although the maximum temperature in the Tanjung Priok area is within the effective range for the life cycle of Aedes aegypti mosquitoes (around 26–32°C), this study shows no significant association with dengue prevalence. This can be explained by the relatively small difference in monthly maximum temperature (30.3–32.3°C), which is insufficient to substantially affect mosquito population dynamics and the extrinsic incubation period of the dengue virus. According to Mordecai (2019), temperature plays an important role in the duration of the extrinsic incubation period (EIP), which is the time required for the virus to develop in the mosquito's body before it can be transmitted to humans. However, the effect of temperature becomes significant mainly when there are extreme variations below 20°C or above 34°C. Because the maximum temperature in Tanjung Priok remains within the optimal range, its biological effects on the development of mosquitoes and the virus tend to be minimal.

In addition to temperature factors, environmental and social conditions in dense urban areas such as Tanjung Priok also affect dengue prevalence. Under relatively stable temperature conditions, other factors such as rainfall, humidity, availability of breeding sites, and community behavior in maintaining environmental cleanliness play a more dominant role in increasing or decreasing disease cases (Brady et al., 2020). For example, high rainfall can increase the number of temporary breeding sites in open water containers, while unhygienic water storage practices also increase the risk of mosquito larvae development. Therefore,

although maximum temperature supports mosquito survival, its effect can be masked by stronger environmental variables that have a greater influence on dengue virus transmission.

These findings are also supported by studies in other regions that show no significant correlation between maximum temperature and dengue incidence. Thus, it can be concluded that maximum temperature in the Tanjung Priok area does not have a significant relationship with dengue prevalence. Although maximum temperature in this region is within the optimal range to support the survival of Aedes aegypti mosquitoes, limited temperature fluctuations and climatic stability mean that this factor does not play a major role in determining variation in dengue cases. Environmental factors such as rainfall, humidity, and community behavior make a more dominant contribution to transmission. Therefore, in efforts to control dengue, interventions should focus on environmental management, vector control, and increasing public awareness to maintain cleanliness and prevent standing water that serves as mosquito breeding sites.

The Relationship Between Rainfall And The Prevalence Of Dengue In The Tanjung Priok Area

Based on the results of the analysis of rainfall data in the Tanjung Priok area for the 2015–2024 period, the average annual rainfall reached 2,306 mm/year, with peak rainfall occurring in February (average 458 mm) and the lowest rainfall in August (average 47 mm). This pattern shows a clear difference between the rainy season and the dry season, with the rainy season lasting from December to March and the dry season occurring from June to August. Based on the analysis, the relationship between rainfall and dengue prevalence was not statistically significant. Thus, during this study period, rainfall fluctuations did not directly affect the prevalence of dengue in the Tanjung Priok area.

These findings are in line with research conducted in the working area of the Gamping I Health Center, Sleman (2015–2017), which also reported no significant relationship between rainfall and dengue incidence ($p > 0.05$), even though the correlation direction was positive ($r = 0.079$) (Nugroho, 2019). Similar results indicate that high rainfall is not always followed by an increase in dengue cases, especially when other environmental factors, such as drainage systems, waste management, and community behavior, reduce the potential for mosquito breeding sites.

The difference in results between regions may be due to topographic factors, drainage infrastructure, population density, microclimate, and the effectiveness of vector control programs. In the Tanjung Priok area, although rainfall is relatively high in the rainy season, the presence of a fairly good urban drainage system, especially in the port area, can reduce the formation of standing water that serves as a habitat for Aedes aegypti larvae. In addition, the characteristics of urban environments dominated by hard surfaces (such as asphalt and concrete) cause rainwater to flow quickly into drains, thereby reducing the likelihood of prolonged standing water accumulation. This factor helps explain why high rainfall is not always directly proportional to increased mosquito populations in densely populated urban areas such as Tanjung Priok.

Although rainfall plays an important role in providing aquatic media for mosquito breeding, its effect on dengue transmission is twofold. Light to moderate rainfall can create many temporary water reservoirs that are ideal for the growth of Aedes aegypti larvae, whereas high-intensity rainfall can cause puddles to overflow or be flushed away, destroying larval

habitats (Sari, Widyaningsih and Rahmawati, 2021). Extreme rainfall conditions can also reduce the flying activity of adult mosquitoes and hinder their search for human hosts, thereby reducing the potential for dengue virus transmission. Therefore, in a wet climate such as North Jakarta, rainfall variations are not always aligned with increases in dengue prevalence. In addition, non-climatic factors such as community behavior in managing clean water and household waste also affect disease transmission risk; for example, the habit of storing water in open containers during the dry season can create ideal breeding sites for mosquitoes despite high rainfall. Thus, human and environmental factors interact in a complex way with the dynamics of dengue transmission, making rainfall not the only determining variable.

These findings are consistent with several studies in other regions that also show that rainfall is not the sole factor determining increases in dengue cases. Therefore, it can be concluded that rainfall does not have a significant relationship with the prevalence of dengue fever in the Tanjung Priok area during the 2015–2024 period. Although rainfall has the potential to create mosquito breeding grounds, high-intensity rain can in fact wash away larvae and reduce adult mosquito activity, thereby inhibiting dengue virus transmission. In areas with good drainage systems and high public awareness of environmental cleanliness, the influence of rainfall on dengue cases becomes weaker. Thus, dengue control efforts should focus on behavioral and environmental sanitation factors, not solely on climatic conditions.

The Relationship Between Humidity And The Prevalence Of Dengue In The Tanjung Priok Area

Based on the results of the analysis of air humidity data in the Tanjung Priok area for the 2015–2024 period, the highest average monthly relative humidity was recorded in February (86%) and the lowest in September–October (77%). This pattern shows that air humidity tends to be high in the rainy season and decreases in the dry season. This difference in humidity is influenced by the intensity of rainfall and air temperature, where the rainy season increases relative humidity due to the high water vapor content in the atmosphere. Based on the analysis, the relationship between air humidity and dengue prevalence was not statistically significant. This indicates that, during the study period, changes in air humidity did not have a direct effect on fluctuations in the prevalence of dengue in the Tanjung Priok area.

This result is in line with research conducted by Nurlaela H.L. (2023), where the p-value of 0.160 was greater than α (0.05). The statistical test showed an r value of 0.184, indicating a positive (same-direction) relationship with very weak correlation strength; however, this r value has no practical meaning because the p-value is greater than α (0.05), which means there was no significant relationship between air humidity and dengue case data in Gowa Regency in 2017–2021.

Differences in results between regions can be caused by the interaction of humidity with other climatic factors, such as temperature and precipitation, as well as local environmental conditions such as the availability of breeding sites, population density, and the effectiveness of vector control programs. In Tanjung Priok, although humidity tends to be high in the rainy season, it is likely that other factors, such as wind speed, which in this study proved to be significant, play a more decisive role in influencing Aedes aegypti mosquito populations than air humidity.

Although air humidity in Tanjung Priok is in the range of 77–86%, which theoretically meets the conditions conducive to the growth and life cycle of Aedes aegypti (around 60–80%),

these conditions are not necessarily directly related to increased dengue prevalence. This can be explained by several factors. First, in tropical areas such as Jakarta, relative humidity tends to remain consistently high throughout the year, so the variation is not large enough to exert a noticeable influence on case fluctuations. Second, the relationship between humidity and dengue incidence is nonlinear and is often influenced by other climatic factors such as temperature and precipitation, so humidity alone is not strong enough to explain changes in incidence. Third, there is a lag effect, where the influence of climatic conditions on dengue cases may only become apparent several weeks to a month later, so simultaneous analysis within the same month often yields weak relationships. In addition, area-averaged humidity values do not necessarily represent microclimatic conditions at mosquito breeding sites, because local environmental factors such as standing water, community behavior in water storage, and sanitation play a greater role in supporting the vector cycle.

Several studies have stated that the contribution of humidity to Aedes aegypti activity is relatively small compared with temperature and precipitation, especially in tropical regions with consistently high humidity throughout the year. Aedes mosquitoes are still able to survive across a fairly wide humidity range as long as sufficient standing water is available for breeding, so humidity variations are not always directly correlated with dengue incidence.

Therefore, in this study it can be concluded that air humidity does not have a significant relationship with the prevalence of dengue in the Tanjung Priok area during the 2015–2024 period. The high and stable humidity throughout the year in the tropics means that this factor is not strong enough to explain variation in cases. Other climatic factors such as temperature, precipitation, and wind speed, as well as non-climatic factors such as community behavior and environmental cleanliness, play a greater role in determining disease dynamics. Therefore, dengue control strategies in the Tanjung Priok area need to focus on environmental management, improving clean and healthy living behaviors, and monitoring climate factors that are more sensitive to changes in mosquito populations.

The Relationship Between Wind Speed And The Prevalence Of Dengue In The Tanjung Priok Area

Based on the results of data analysis in the Tanjung Priok area for the 2015–2024 period, the average wind speed ranged from 2.0–4.6 m/s, with the dominant direction blowing from the east to the west sector. The highest speeds were recorded in the middle of the year, coinciding with the easterly monsoon period. This wind direction and speed pattern reflects the influence of the monsoon system, where at the beginning of the year the westerly monsoon winds dominate and bring high humidity, while in the middle of the year the easterly monsoon winds dominate and tend to be drier. Based on the analysis, wind speed had a significant relationship with the prevalence of dengue, with a negative direction of association, meaning that the higher the wind speed, the lower the dengue prevalence tended to be.

These wind conditions indicate that wind speed is one of the climatic factors that plays an important role in the dynamics of dengue spread in the Tanjung Priok area. The results show that when wind speed increases, the flight activity and orientation of Aedes aegypti mosquitoes in searching for hosts become disrupted. Stronger winds can hinder the ability of mosquitoes to maintain stable flight and reduce their success in finding human blood sources (Githeko and Ndegwa, 2019). In addition, high wind speeds can reduce micro-humidity around mosquito habitats, ultimately shortening the lifespan of adult mosquitoes and suppressing egg-laying

activity. Under low wind speed conditions (around 2–3 m/s), mosquitoes have optimal flight capability to move between locations and find hosts, thereby increasing transmission potential. In contrast, under higher wind conditions, mosquito orientation and effective flight distance become limited, resulting in reduced contact between mosquitoes and humans. Wind also influences the distribution of moisture and affects local humidity levels, which can disrupt the environmental stability required for optimal Aedes aegypti activity.

This finding is in line with research conducted by Musfadillah (2021), which reported a relationship between wind speed and dengue incidence with $p < 0.0001$ and a correlation value of 0.491, indicating a positive correlation with moderate strength. This suggests that in that study, higher wind speeds were associated with higher numbers of dengue cases. However, the direction of the relationship differs from that observed in the present study. This discrepancy may be influenced by geographical conditions and local climatic characteristics. In dense coastal areas such as Tanjung Priok, increases in wind speed are generally accompanied by drier and more open air, which inhibits mosquito activity and reduces transmission potential. In contrast, in more enclosed areas or regions with higher humidity, winds at moderate speeds may facilitate the dispersal of mosquitoes to new locations, increasing infection risk.

Thus, the relationship between wind speed and dengue prevalence is contextual and shaped by interactions with other environmental factors such as humidity, temperature, and housing conditions. Although the direction of the association may differ between regions, the results of this study confirm that wind speed plays a significant role in influencing dengue transmission rates in Tanjung Priok. It can be concluded that wind speed has a significant relationship with dengue prevalence in the Tanjung Priok area for the 2015–2024 period, with a negative direction of association. Increased wind speed has the potential to reduce dengue cases by inhibiting the flight activity and orientation of Aedes aegypti mosquitoes and reducing opportunities for contact with humans. These results indicate that wind factors need to be considered in dengue transmission risk analysis, especially in coastal areas affected by the monsoon system such as Tanjung Priok. Dengue control efforts in this region can be strengthened by incorporating local climate dynamics, including wind direction and speed, which ecologically influence vector behavior.

CONCLUSION

Based on the results of the study entitled “Meteorological Relationship With the Prevalence of Dengue Hemorrhagic Fever (DHF) at the Tanjung Priok Health Center in North Jakarta for the 2018–2024 Period”, it can be concluded that meteorological factors such as air temperature, air humidity, rainfall, and wind speed have different influences on the prevalence of dengue in the region. Regression analysis shows that wind speed is the only factor that has a statistically significant relationship, indicating that changes in wind speed and directional patterns affect the spread of the Aedes aegypti vector and the increase in dengue cases. Meanwhile, air temperature, humidity, and precipitation did not show a statistically significant relationship, even though descriptively they fluctuated in line with seasonal patterns, and dengue cases increased in 2019, 2022, and 2024, with peak cases occurring from March to May, coinciding with the rainy season and high humidity. Based on Islamic teachings, maintaining environmental cleanliness and preventing infectious diseases is a form of social concern (hablum minannas) and a manifestation of faith (iman bil’amal), so that clean and

healthy living behavior is a preventive measure that aligns with Islamic values in reducing the incidence of dengue fever.

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