RISK FACTORS OF PHYSICAL ENVIRONMENT AND SOCIOECONOMIC INCIDENCE OF DHF IN RIAU

Avisya Mutia Rani[1*], Masrizal[2], Ade Suzana Eka Putri[3]
Master of Epidemiology Faculty of Public Health, Universitas Andalas, Padang, Indonesia[1,2,3]
**Corresponding Author :* avisyamutiarani@gmail.com

ABSTRAK
Di Provinsi Riau, kasus meningkat 1,5 kali lipat pada tahun 2024 dibandingkan tahun sebelumnya. Penelitian ini bertujuan menganalisis faktor risiko lingkungan fisik dan sosial ekonomi terhadap kejadian DBD di Provinsi Riau. Penelitian ini menggunakan desain studi ekologi. Sampel penelitian ini seluruh kasus DBD di Provinsi Riau tahun 2022-2024, data iklim dari Website NASA Power Prediction of Worldwide Energy Resources, data sosial ekonomi dari BPS Provinsi Riau. Analisis menggunakan analisis univariat, bivariat (korelasi), multivariat (regresi linear berganda), dan spasial. Hasil penelitian menunjukkan bahwa terdapat hubungan yang signifikan antara kelembaban udara, curah hujan, kecepatan angin, dan tingkat kemiskinan dengan kejadian DBD di Provinsi Riau. Berdasarkan hasil pemetaan, Kota Dumai dan Kota Pekanbaru secara konsisten mencatat jumlah kasus DBD tinggi selama tiga tahun berturut-turut (2022–2024). Kota Pekanbaru dan Kota Dumai merupakan daerah endemis DBD di Provinsi Riau, dengan beban kasus tinggi dalam tiga tahun terakhir. Persebaran spasial kasus DBD mencerminkan adanya keragaman karakteristik lingkungan fisik dan sosial ekonomi antarwilayah. Kecepatan angin berperan penting dalam dinamika penularan karena dapat memengaruhi jangkauan terbang nyamuk Aedes aegypti, memperluas area potensial penularan, serta menciptakan kondisi lingkungan yang mendukung aktivitas vektor. Oleh karena itu, strategi pengendalian DBD perlu difokuskan pada wilayah dengan risiko tinggi dan mengintegrasikan informasi iklim, termasuk kecepatan angin, ke dalam sistem kewaspadaan dini serta perencanaan intervensi berbasis risiko.

Kata kunci **:** DBD, iklim, kecepatan angin, sosial ekonomi

ABSTRACT
In Riau Province, DHF cases will increase 1.5 times in 2024 compared to the previous year. This study aims to analyze the physical environment and socioeconomic risk factors for DHF incidence in Riau Province. This research used an ecological study design. The sample of this study was all DHF cases in Riau in 2022-2024, climate data from the NASA Power Prediction of Worldwide Energy Resources website, socio-economic data from BPS Riau. The analysis used univariate, bivariate (correlation), multivariate (multiple linear regression), and spatial analysis. The results showed that there was a significant relationship between air humidity, rainfall, wind speed, and poverty level with the incidence of DHF in Riau. Among these variables, wind speed was the most dominant factor with the highest regression coefficient value (B = 8.869). Based on the mapping results, Dumai and Pekanbaru City consistently recorded a high number of DHF cases for three consecutive years (2022-2024). Pekanbaru and Dumai City are DHF endemic areas in Riau, with high caseloads in the last three years. The spatial distribution of DHF cases reflects the diversity of physical environment and socioeconomic characteristics between regions. Wind speed plays an important role in transmission dynamics because it can affect the flight range of Aedes aegypti mosquitoes, expand potential transmission areas, and create environmental conditions that support vector activity. Therefore, dengue control strategies should focus on high-risk areas and integrate climate information, including wind speed, into early warning systems and risk-based intervention planning.

Keywords ***:** DHF, climate, wind speed, socioeconomic*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a disease caused by the Dengue virus and transmitted from one individual to another through the bite of the *Aedes aegypti* mosquito as the main vector. (Widyantoro et al., 2021) DHF is commonly found in tropical and subtropical regions and can affect various age groups, ranging from children under 5 years old to adults aged 15 years and above. (Dwi Julianti et al., 2023) This disease is considered dangerous due to its rapid transmission rate, thus requiring serious attention and prevention measures. (Sembiring et al., 2021) DHF remains a widespread health problem, both socially and economically. From a social perspective, this disease can cause anxiety and panic within families, increase the risk of death among family members, and reduce life expectancy at both the individual and community levels. (Setyaningsih et al., 2021) Meanwhile, economically, DHF imposes a significant financial burden due to the high cost of treatment. (Selni, 2020) Additionally, indirect impacts are also felt, such as lost work time and extra expenses for care-related needs, including transportation costs during the treatment period. (Anugrah Sidharta et al., 2023)

Based on data from the World Health Organization (WHO) in 2023, around 390 million people worldwide are infected with the dengue virus every year. A total of 3,9 billion people in 128 countries is at risk of exposure to this virus, with 70% of cases occurring in Asia. The Philippines has the highest number of dengue cases, reaching 52%, followed by Thailand with 30%, while Indonesia ranks third with 29% of the total population infected with dengue virus in Asia. (World Health Organization (WHO), 2022) According to data from the Indonesian Ministry of Health in 2023, the Case Fatality Rate (CFR) for dengue fever reached 0,96%, exceeding the 0.7% limit set in the National Dengue Control Strategy. This CFR figure has increased compared to the previous year. In the same year, Riau Province recorded the highest Incidence Rate (IR) at 80,9 per 100,000 population, followed by East Kalimantan (78,1 per 100,000 population) and Bali (59,8 per 100,000 population). (Menteri Kesehatan Republik Indonesia, 2022)

DHF cases in Riau Province showed significant fluctuations between 2022 and 2024. In 2022, there were 2.373 cases of DHF with an Incidence Rate (IR) of 35,9 per 100.000 population, and the highest IR was in Pekanbaru City at 78,9 per 100.000 population, while the highest CFR was in Indragiri Hulu District at 2,6%. In 2023, there was a decrease in the number of DHF cases to 2.153 cases with an IR of 29,5 per 100.000 population, and the highest CFR occurred in Indragiri Hilir District at 2,5%. In 2024, there was an increase in the number of DHF cases, with 3.181 cases and an IR of 43,6 per 100.000 population. Bengkalis District and Dumai City had the highest IR in Riau, exceeding the provincial target and strategy of an IR ≤49 per 100.000 population and a CFR of less than 1%.

There has been no specific research examining the relationship between physical and socioeconomic environmental factors and the incidence of DHF in Riau Province. Areas with high incidence rates, such as the city of Pekanbaru, tend to have environmental factors that support the growth of *Aedes aegypti* mosquitoes, such as high population density, suboptimal sanitation, and stagnant water that serves as a breeding ground for mosquitoes. In addition, the relatively high poverty rate in some areas can limit access to health facilities, sanitation facilities, and information on disease prevention. Low levels of education also contribute to a lack of public awareness about the importance of maintaining a clean environment and implementing dengue prevention measures. Therefore, a more in-depth analysis of physical and socioeconomic environmental factors can help in designing more effective and comprehensive prevention strategies in Riau, especially to reduce the incidence of dengue cases in areas that still have high incidence rates. Therefore, the researcher wishes to conduct a study entitled: Physical and Socioeconomic Environmental Risk Factors for Dengue Fever Cases in Riau Province from 2022 to 2024.

METHOD

The type of research conducted was quantitative research with an ecological study design descriptive and observational based on time and location. The unit of observation in the ecological study design was a large population group. Aggregate data was usually limited by the geographical boundaries of an area. In this study, aggregate data was taken from the administrative region of Riau Province. The researchers focused on environmental physical factors (temperature, humidity, rainfall, wind speed) and socioeconomic factors (population density, poverty rate, education level) observed based on the place and time related to dengue fever cases in Riau Province from 2022 to 2024.

The sample used was the total number of dengue fever cases that occurred in the Riau Provincial Health Office in 2022, amounting to 2.373 cases, in 2023 amounting to 2.153 cases, and in 2024 amounting to 3.181 cases, with a total of 7.707 dengue fever cases in the last 3 years. These figures represent the total number of dengue fever cases distributed throughout the Riau Province. The unit of analysis in this study was the entire Riau Province, consisting of 12 districts/cities (Bengkalis District, Indragiri Hilir District, Indragiri Hulu District, Kampar District, Meranti Islands District, Kuantan Singingi Regency, Pelalawan Regency, Rokan Hilir Regency, Rokan Hulu Regency, Siak Regency, Dumai City, and Pekanbaru City) with monthly data (January-December) for 3 years (2022-2024), resulting in a total of 432 analysis units.

In this study, the data used is in the form of aggregate data, which is a type of secondary data. Secondary data is data that is not obtained directly from the research target. The data was taken from the Riau Provincial Health Office, climate data from the NASA Power Prediction of Worldwide Energy Resources website, and demographic data from the Riau Provincial Statistics Agency.

RESULTS

The province of Riau has a tropical climate and a climate pattern that supports the life cycle of the *Aedes Aegypti* mosquito, which is a vector for dengue fever. Based on observations from dengue fever case monitoring reports in the province of Riau, information on the development of dengue fever cases from January 2022 to December 2024 is shown in Figure 1 below:

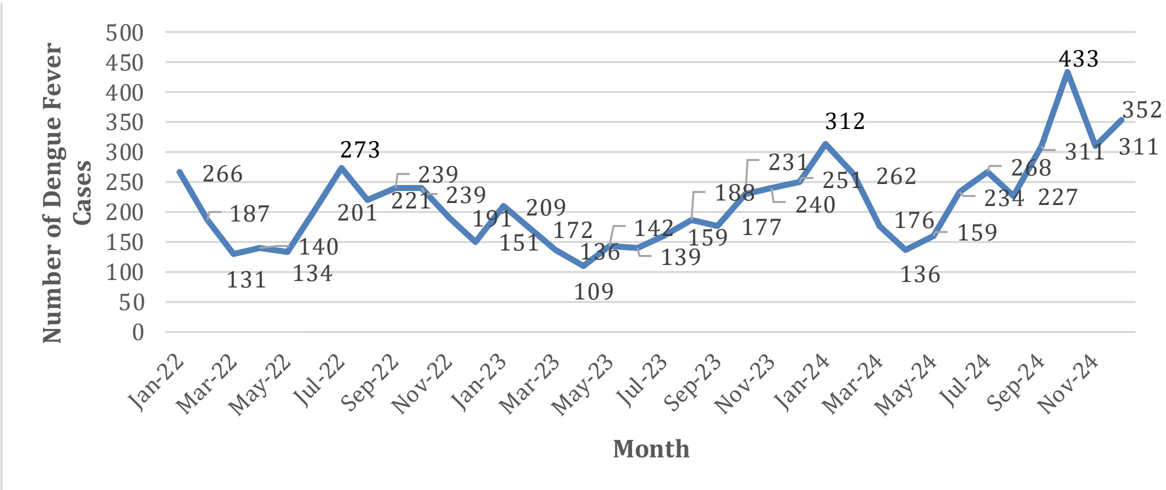

Figure 1. Monthly Dengue Fever Incidence Based on Riau Level in 2022-2024

Based on figure 1, the number of dengue fever cases per month in Riau Province from January 2022 to December 2024 shows significant fluctuations. The highest peak occurred in October 2024 with 433 cases, followed by September 2022 with 273 cases and August 2023 with 312 cases. Meanwhile, the lowest number of cases was recorded in March 2023 with only 109 cases. This pattern shows a tendency for cases to increase at the end of the year, especially during the transition season and the beginning of the rainy season, which is thought to support the development of mosquito vectors. The significant spike in cases at the end of 2024 indicates the need for vigilance and strengthened prevention efforts during this period.

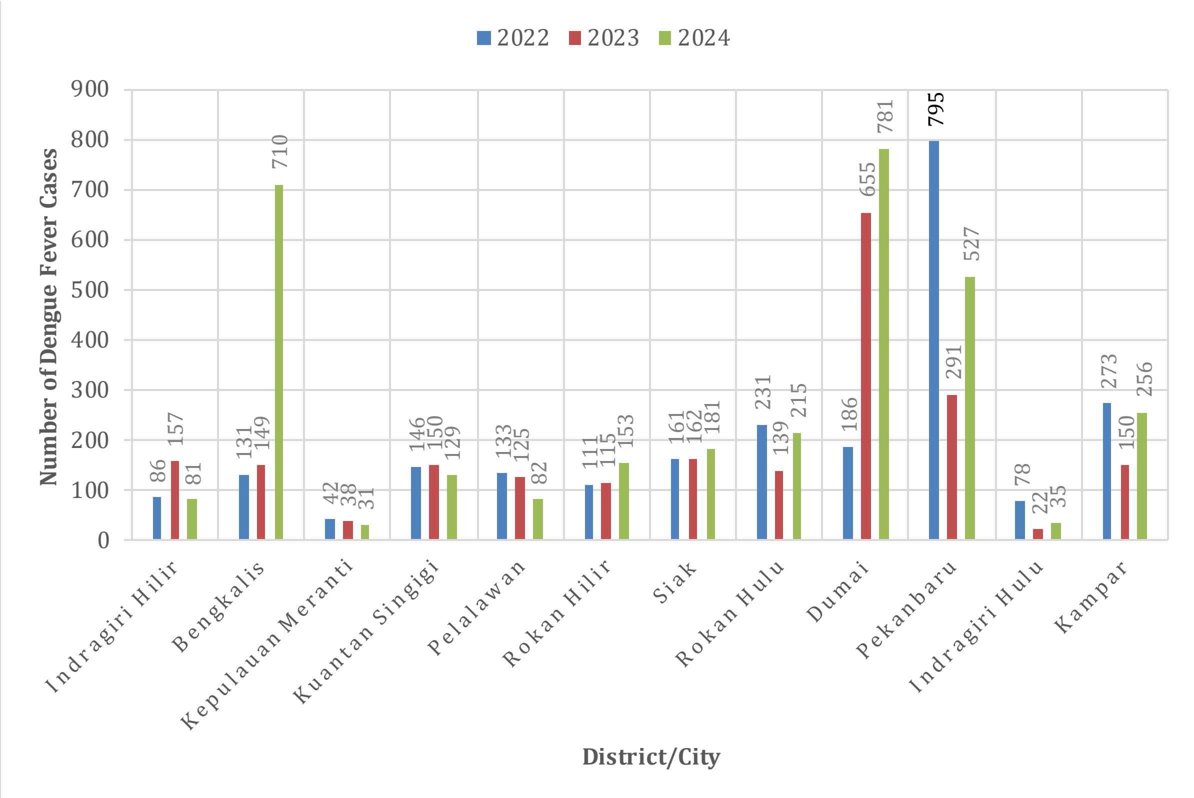

Figure 2. Annual Dengue Fever Incidence by District/City in Riau 2022-2024

Based on figure 2 above, Bengkalis Regency experienced a significant spike in dengue fever cases in 2024 compared to the previous two years. Dumai City showed a sharp upward trend from year to year, with the highest number of cases recorded in 2024. Pekanbaru City experienced a decline in cases in 2023 compared to 2022, but saw a drastic increase again in 2024, becoming the highest in the province. Meanwhile, several regencies such as Meranti Islands, Indragiri Hilir, and Indragiri Hulu also showed an increase in cases in the last year. Conversely, areas such as Kuantan Singingi, Pelalawan, and Rokan Hulu showed a more stable trend. This pattern reflects a shift and increases in the burden of dengue fever in various regions, which needs to be responded to by strengthening adaptive surveillance and control systems.

Table 1. Correlation Analysis between Risk Factors and Dengue Fever Incidence in Riau Province from 2022 to 2024

Variable	r	*p-value*
Temperature	0,093	0,053
Air Humidity	-0,104	0,031*
Rainfall	-0,186	0,001*
Wind Speed	0,220	0,001*
Population Density	0,077	0,110
Poverty Rate	-0,093	0,054
Education Level	-0,063	0,193

Based on table 1, the correlation analysis between risk factors and dengue fever incidence in Riau Province from 2022 to 2024 shows that several environmental variables have significant associations with dengue incidence. Air humidity ($p = 0.031$), rainfall ($p = 0.001$), and wind speed (p = 0.001) were significantly correlated with dengue incidence. The correlation between air humidity and dengue incidence was negative and weak (r = -0.104), indicating that lower humidity tends to be associated with a slightly higher incidence of dengue fever. Rainfall also showed a negative and weak correlation (r = -0.186), suggesting that higher rainfall may reduce dengue incidence. In contrast, wind speed had a positive and weak correlation (r = 0.220), meaning that increased wind speed is associated with a higher dengue incidence. Meanwhile, temperature, population density, poverty rate, and education level showed no significant correlation with dengue incidence (p > 0.05).

Multivariate analysis with multiple linear regression was performed to determine the magnitude of the relationship between independent variables and dependent variables after controlling for other variables that had a significant relationship. In this study, multivariate analysis was performed to find the most dominant variable among physical and socioeconomic factors. In performing multivariate analysis, the first step was to select the results of bivariate analysis. Multivariate analysis was continued for variables with a p-value ≤ 0.25. Next, multivariate analysis modeling was performed by entering variables that met the criteria and analyzing them simultaneously. After the analysis, if a variable with a p-value > 0,05 was found, that variable was then removed one by one from the multivariate analysis model.

Table 2. Initial Stage of Multivariate Analysis Model

Variables	B	r	R Square	*p-value*
(*Constant*)	-262,328	0,350	0,122	0,005
Temperature	2,115			0,187
Air Humidity	2,461			0,001
Rainfall	-0,048			0,001
Wind Speed	9,067			0,001
Population Density	0,003			0,308
Poverty Rate	-0,699			0,011
Education Level	0,274			0,344

Based on table 2, it was found that the level of education, population density and temperature had the most significant value, namely p-value ≥0,05. Thus, the level of education, population density, and temperature will be excluded and cannot be included in the next multivariate model. Next, multivariate analysis will continue using the four remaining variables, namely humidity, rainfall, wind speed, and poverty rate.

Table 3. Results of Regression Analysis of Air Humidity, Rainfall, Wind Speed, Poverty Rate with Dengue Fever Incidence in Riau

Variables	B	r	R Square	*p-value*
(*Constant*)	-152,217	0,340	0,115	0,005
Air Humidity	1,977			0,001
Rainfall	-0,050			0,001
Wind Speed	8,869*			0,001*
Poverty Rate	-0,499			0,010

Based on table 3, the results of the multiple linear regression analysis show a correlation coefficient (r) of 0,340, indicating that air humidity, rainfall, wind speed, and poverty rate have a relationship strength of 34.0% with the incidence of DHF in Riau. The R Square value obtained from the multiple linear regression analysis is 0,115, which means that the independent variables (air humidity, rainfall, wind speed, and poverty rate) can explain 11,5% of the variation in dengue fever incidence in Riau. The results of the multiple linear regression analysis indicate that air humidity, rainfall, wind speed, and poverty rate have a significant effect on the incidence of DHF in Riau. Air humidity shows a positive effect with a regression coefficient of 1,977 (p = 0,001), meaning that each one-percent increase in humidity is estimated to increase nearly two dengue cases. In contrast, rainfall has a negative effect with a coefficient of -0,050 (p = 0,000), suggesting that higher rainfall tends to reduce the number of dengue cases. Poverty rate also shows a negative relationship (B = -0,499; p = 0,010), indicating that areas with higher poverty levels tend to record fewer dengue cases, possibly due to differences in settlement distribution or regional accessibility. Meanwhile, wind speed is identified as the most dominant variable, with the highest coefficient value of 8,869 (p = 0,000), suggesting that each one-unit increase in wind speed could lead to a significantly greater increase in dengue cases compared to other variables.

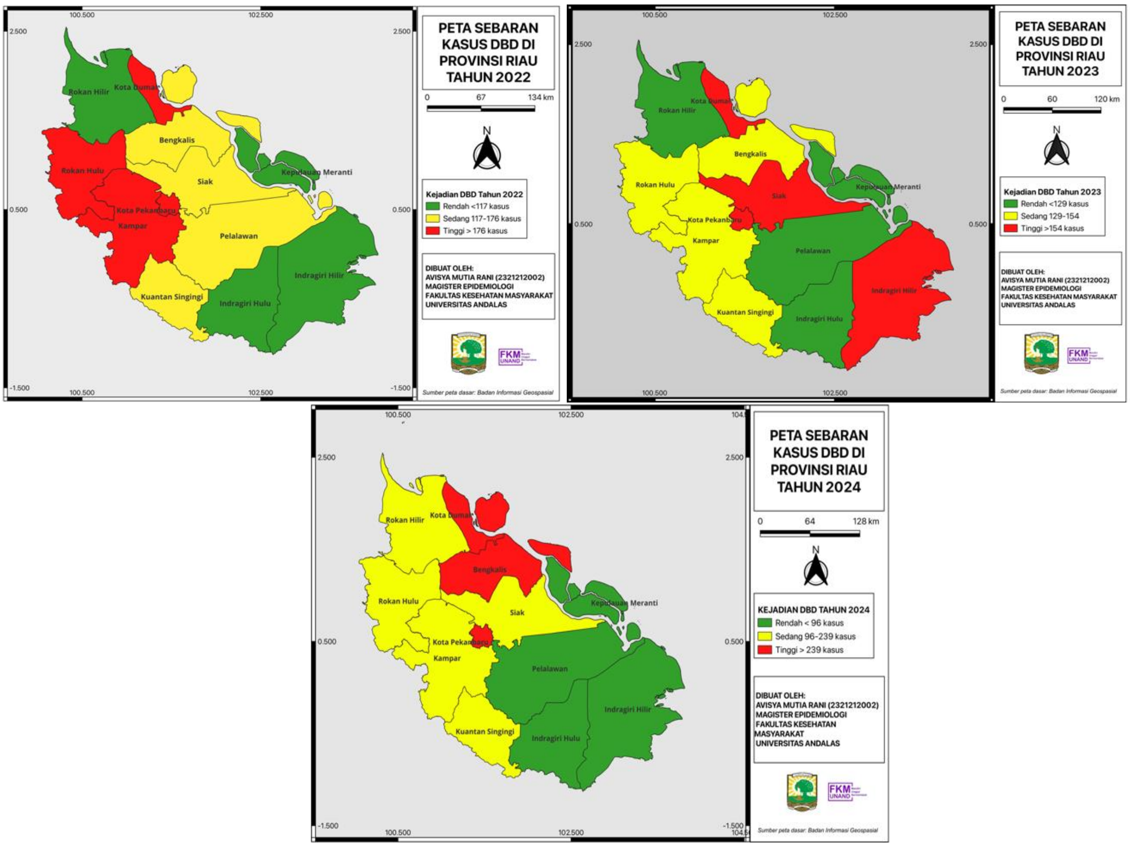

Figure 3. Map of Dengue Fever Cases in Riau in 2022-2024

Based on figure 3, the spatial distribution of DHF cases in Riau Province from 2022 to 2024 shows a clear variation in disease concentration across regions and over time. In 2022, Pekanbaru City and Kampar Regency recorded the highest number of cases (≥176), indicated in red, followed by Dumai City, Rokan Hulu, and Bengkalis with moderate levels (117–176 cases), while most other districts such as Indragiri Hilir, Kuantan Singingi, and Kepulauan Meranti reported low incidence rates (<117 cases). In 2023, there was a noticeable shift in the distribution pattern, where Pekanbaru City and Indragiri Hilir became the areas with the highest incidence (≥154 cases), suggesting a movement of case concentration toward the eastern and southern coastal areas, likely due to environmental factors or increased population mobility. By 2024, dengue cases remained highest in Pekanbaru, Dumai, and Bengkalis (≥239 cases), moderate in Kampar, Rokan Hulu, and Siak (176-239 cases), and lowest in Indragiri Hilir, Kuantan Singingi, and Pelalawan (<176 cases). Overall, Figure 3 indicates that urban and densely populated regions such as Pekanbaru and Dumai consistently experience higher dengue incidence, whereas southern and coastal regions tend to have lower cases, possibly reflecting geographic influences or more effective vector control measures.

DISCUSSION

The multiple linear regression analysis revealed that wind speed was the most dominant variable influencing DHF incidence in Riau, as indicated by its highest regression coefficient (B = 8,869) in the final model. This suggests that for every one-unit increase in wind speed, the number of DHF cases tends to rise more significantly compared to other variables, assuming all else remains constant. Although the strength of the correlation is relatively weak, the dominance of this coefficient highlights wind speed as the strongest statistical contributor in explaining variations in dengue incidence. Its significance lies in its ability to represent more complex environmental dynamics than other climatic factors. While wind speed does not directly cause an increase in cases, it can influence the spatial spread of vectors at the local scale. In densely populated and interconnected areas such as Riau, wind movement facilitates the dispersion of *Aedes aegypti* mosquitoes toward new areas, even though their natural flight range is limited. Low to moderate wind speeds allow passive vector transmission across nearby areas without being disrupted by extreme weather conditions, thus expanding potential transmission zones. Furthermore, wind speed can serve as an indirect indicator of environmental factors not captured by other variables such as temperature, rainfall, or humidity. In coastal and open residential regions common in Riau, gentle winds may facilitate mosquito movement between dwellings, thereby increasing the overall transmission risk.

Beyond climatic factors, socioeconomic conditions also play an important role in shaping the environmental impact on dengue transmission. In areas with high poverty rates, vector prevention and control efforts are often limited due to resource constraints, inadequate access to healthcare services, and poor environmental infrastructure. Similarly, low educational levels may hinder public understanding of the importance of Clean and Healthy Living Behavior, which is essential for sustainable dengue prevention. In this context, wind speed has a dual role, both statistically as a dominant variable in the analytical model and ecologically as a supporting factor for vector spread. Therefore, it can be considered a predictive indicator for mapping high-risk areas for dengue transmission, particularly where complex interactions between climatic and socioeconomic conditions exist. Consequently, dengue control efforts in Riau Province should integrate environmental management with adaptive, community-based socioeconomic interventions to achieve more effective prevention outcomes.

CONCLUSION

The study on the distribution and frequency of DHF cases and their association with physical and socioeconomic environmental factors in Riau Province from 2022 to 2024 revealed notable spatial and statistical patterns. The lowest incidence of DHF occurred in Kepulauan Meranti Regency, while the highest was recorded in Dumai City. Variations in environmental conditions were also observed, with the lowest temperature in Kuantan Singingi and the highest average temperature in Kepulauan Meranti; the lowest humidity in Kepulauan Meranti and the highest in Rokan; the lowest rainfall in Indragiri Hulu and the highest in Indragiri Hilir; and the lowest wind speed in Rokan Hulu with the highest in Indragiri Hilir. Pekanbaru City showed the highest population density and the lowest poverty rate, whereas Kepulauan Meranti had both the highest poverty rate and the lowest education level. Spatial mapping consistently indicated Pekanbaru and Dumai as high-risk areas for dengue each year, while Indragiri Hulu and Kepulauan Meranti remained low-risk zones. Bivariate analysis identified significant but weak correlations between dengue incidence and humidity (negative), rainfall (negative), and wind speed (positive). Furthermore, multivariate analysis confirmed that wind speed was the most dominant factor influencing dengue incidence in Riau, with the highest significance level and regression coefficient, suggesting that increasing wind speed contributes significantly to higher dengue case numbers.

ACKNOWLEDGMENT

The author sincerely acknowledges Universitas Andalas for its continuous support and contribution throughout the course of this research. Special thanks are extended to the Faculty of Public Health, as well as to the Riau Provincial Health Office and the Riau Central Bureau of Statistics for their valuable cooperation, data provision, and technical assistance. Their guidance, encouragement, and support played a crucial role in the successful completion of this study.

REFERENCES

Anugrah Sidharta, A., Diniarti, F., & Darmawansyah. (2023). Analisis Spasial Faktor Risiko Kejadian Demam Berdarah Dengue Di Kota Bengkulu. Jurnal Vokasi Kesehatan (JUVOKES), 2, 43–56. *Retrieved from* https://journal.bengkuluinstitute.com/index.php/juvokes

Dwi Julianti, T., Ena Sari, R., Lesmana, O., Hidayati, F., & Eka Putri, F. (2023). *The Relationship of Host and Environmental Factors to Events Dengue Hemorrhagic Fever*. *KESANS : International Journal of Health and Science*, *2*(12), 1046–1064. doi: 10.54543/kesans.v2i12.221

Fahliani, N., & Septiani. (2020). Pengaruh Substitusi Tepung Daun Kelor *(Moringa oleifera Lam.)* Terhadap Sifat Organoleptik dan Kadar Kalsium *Snack Bar. Jurnal Gizi dan Pangan Soedirman*, 4(2): 216-228. https://jos.unsoed.ac.id/index.php/jgps

Firdanti E., *et al.* (2021). Permasalahan Stunting pada Anak di Kabupaten yang Ada di Jawa Barat. *Jurnal Kesehatan Indra Husada*, hlm, 126-133. https://ojs.stikesindramayu.ac.id/index.php/JKIH/article/view/333

Hardiansyah, M., & Supriasa, I.D.N. (2016). *Ilmu Gizi Teori dan Aplikasi.* Jakarta: Buku Kedokteran EGC.

Heluq, D.Z., & Mundiastuti, L. (2018). Daya Terima dan Zat Gizi *Pancake* Substitusi Kacang Merah *(Phaseolus Vulgaris L)* dan Daun Kelor *(Moringa Oleifera)* sebagai Alternatif Jajanan Anak Sekolah. *Jurnal Media Gizi Indonesia*, 13(2): 133-140. https://doi.org/10.20473/mg.v13i2.133-140

Istiqomah, Finda. (2020). *Pengaruh Substitusi Wijen Giling (Sesamum Indicum), Putih Telur dan Susu Skim Terhadap Mutu Organoleptik, Daya Terima, Kandungan Gizi dan Nilai Ekonomi Gizi pada Es Krim*. Universitas Airlangga, Surabaya.

Krisnadi, A.D. (2015). *Kelor Super Nutrisi.* Blora: Morindo Moringa Indonesia.

Letlora, J.A.S., Sineke, J., & Purba, R.B. (2020). Bubuk Daun Kelor sebagai Formula Makanan Balita Stunting. *Jurnal GIZIDO*, 12(2): 105-112. https://ejurnal.poltekkes-manado.ac.id/index.php/gizi/article/download/1256/877

Menteri Kesehatan Republik Indonesia. (2022). Laporan Tahunan 2022 Demam Berdarah Dengue.

Selni, P. S. M. (2020). Faktor - Faktor Yang Berhubungan Dengan Kejadian Demam Berdarah Dengue Pada Balita. Jurnal Kebidanan, 9(2), 89–96. doi: 10.35890/jkdh.v9i2.161

Sembiring, M. A., Agus, T. A., & Sibuea, M. F. L. (2021). Penerapan Metode Algoritma K-Means Clustering Untuk Pemetaan Penyebaran Penyakit Demam Berdarah Dengue (DBD). *Journal of Science and Social Research*, *4*(3), 336–341. Retrieved from http://jurnal.goretanpena.com/index.php/JSSR

Setyaningsih, D., Haryanti, T., Azmiardi, A., Kesehatan, J., Veteran, U., & Sukoharjo, B. N. (2021). Hubungan Faktor-faktor Lingkungan Fisik dengan Kejadian Demam Berdarah Dengue. Jurnal Ilmu Kesehatan Masyarakat Berkala (JIKeMB), 3(1), 30–40.
Widyantoro, W., Nurjazuli, N., & Darundianti, Y. H. (2021). Hubungan Faktor Cuaca dengan Kejadian Demam Berdarah di Kabupaten Bantul. Jurnal Aisyah : Jurnal Ilmu Kesehatan, 6(4). doi: 10.30604/jika.v6i4.863
World Health Organization (WHO). (2022). *Dengue*.