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MAPPING OF DENGUE HEMORRHAGIC FEVER (DHF) VULNERABILITY AND CASE CLUSTERING USING A GEOGRAPHIC INFORMATION SYSTEM (GIS) IN ACEH BESAR DISTRICT, 2025

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ABSTRACT

Breeding places that are frequently found are one of the risk factors for the transmission of dengue hemorrhagic fever (DHF). The purpose of this study is to describe the distribution of breeding place presence through mapping and to determine the extent of transmission risk as part of efforts to mitigate DHF risk in Lhoknga Subdistrict, Aceh Besar District. This research is a descriptive study conducted through a survey. Data collection was carried out through field surveys, identifying subject and object points using GPS. The study was conducted in Lhoknga Subdistrict, Aceh Besar District at March 2025 The results showed that in Lhoknga Subdistrict, 89 breeding place points and 16 DHF cases were found, spread across the entire subdistrict. The types of breeding place groups for the filariasis vector included 28 points in bushy areas, 29 points in water puddles, 20 points in wastewater drainage channels (SPAL), and 12 points in rice fields. It is recommended that the Lhoknga Health Center utilize the GIS mapping results as a basis for determining priority interventions in high-risk DHF areas, such as conducting selective fogging, empowering jumantik (mosquito larvae monitoring) cadres, and increasing public education in high-risk villages. For the community, it is necessary to raise awareness and encourage active participation in maintaining environmental cleanliness, routinely applying the 3M Plus strategy, and regularly participating in mosquito nest eradication (PSN) activities.

INTRODUCTION

According to the World Health Organization (WHO), Dengue Hemorrhagic Fever (DHF) is a viral infectious disease transmitted by *Aedes aegypti* and *Aedes albopictus* mosquitoes. Over the past few decades, DHF has emerged as a rapidly growing global public health concern due to rapid urbanization and climate change. Dengue Hemorrhagic Fever (DHF) is classified as a prevalent tropical disease that frequently affects humans (Yusmahendra et al., 2023). Caused by dengue virus infection, DHF remains one of the most serious public health concerns in Indonesia (Sari et al., 2022). The number of DHF cases in Indonesia has shown an increasing trend and wider geographical distribution, particularly among children, while frequently triggering outbreaks and contributing to mortality

(Periatama et al., 2022). The threat of DHF persists, especially during the rainy season, when the number of cases tends to increase due to the expansion of breeding sites for the primary vector, *Aedes aegypti* (Nitbani & Siagian, 2022). This mosquito transmits the dengue virus by biting infected individuals, subsequently causing damage to capillary blood vessels and disrupting the blood coagulation system (Sanjaya, 2024).

The transmission of Dengue Hemorrhagic Fever (DHF) is influenced by various geographical factors. The increasing incidence of DHF is associated with complex determinants, including rapid population growth, uncontrolled urbanization, inadequate mosquito vector control in endemic areas, and the expansion of transportation networks (Prayoga, 2022).

A study conducted by Setyawan and Setyaningsih (2021) demonstrated that the spatial distribution of DHF cases was random. During the 2016–2018 period, Gomolong Village recorded the highest Incidence Rate (IR). Furthermore, Pearson Product Moment analysis revealed that population density was not statistically associated with the number of DHF cases in Sragen Regency during the study period, with a *p*-value of 0.304, exceeding the significance threshold of 0.05 (Setyawan & Setyaningsih, 2021).

Another study conducted in the service area of Kedungmundu Community Health Center, Tembalang District, Semarang City, identified a clustered spatial distribution pattern of DHF cases. This finding was supported by the Average Nearest Neighbor (ANN) analysis, which yielded a value of 0.52 (<1), indicating spatial clustering. In addition, the study demonstrated a significant correlation between population density and the number of Dengue Hemorrhagic Fever cases (Ilham, 2024).

Dengue Hemorrhagic Fever (DHF) remains an unresolved public health problem in Indonesia, as reflected by the failure to achieve the national morbidity target of 49 cases per 100,000 population. This condition is further evidenced by the high morbidity rate reported in 2015, which reached 50.7 cases per 100,000 population (Lang et al., 2021). Globally, DHF is widely distributed across tropical and subtropical regions. Approximately 2.5 billion people, representing two-fifths of the world's population, are at risk of dengue virus infection. More than 100 countries have reported dengue outbreaks, with an estimated 500,000 cases requiring hospitalization and thousands of deaths occurring annually (Agnesia et al., 2023).

Epidemiological data from 2017 indicate that the burden of DHF in Indonesia remains substantial. Among a total population of 261,890,872, there were 59,047 reported cases and 444 deaths, corresponding to an incidence rate of 0.75% (Baitanu et al., 2022). At the

provincial level, all 23 districts and municipalities in Aceh Province reported DHF cases. Of the province's total population of 5,189,466, there were 2,591 reported cases and 12 deaths, resulting in an incidence rate of 49.93 per 100,000 population and a Case Fatality Rate (CFR) of 0.46% (Kamila & Mauliza, 2022).

The Indonesian Ministry of Health reported a marked increase in DHF cases nationwide in 2022. The number of reported cases increased from 73,518 in 2021 to 143,266 in 2022, while the number of deaths rose from 747 to 1,237, resulting in a Case Fatality Rate (CFR) of 0.86%. In Aceh Province, 2,079 cases and 16 deaths were reported. The highest numbers of cases were recorded in Banda Aceh City (366 cases) and Bireuen Regency (299 cases). At a more localized level, Lhokseumawe City reported an increase to 41 cases, while by 2024, Lhoknga Community Health Center had managed 11 DHF cases (Ministry of Health of the Republic of Indonesia, 2022).

The Mosquito Breeding Site Elimination Program (*Pemberantasan Sarang Nyamuk* [PSN]) through the 3M Plus Movement is one of the Indonesian government's primary strategies for controlling Dengue Hemorrhagic Fever (DHF) (Sutriyawan et al., 2022). This program is considered more effective than other preventive measures because it targets the root cause of dengue transmission by interrupting the life cycle of *Aedes aegypti* through the elimination of mosquito breeding sites (Periatama et al., 2022). A previous study concluded that community behavior is a key determinant of the increasing incidence of DHF, with the implementation of the 3M Plus strategy representing an essential preventive behavior (Khairani et al., 2024). The 3M Plus activities include draining and tightly covering water storage containers, recycling or disposing of unused items that can collect water, and implementing additional sustainable measures to enhance public awareness of environmental cleanliness and vector control (Kastari & Prasetyo, 2022).

A map is fundamentally a visual representation of a geographic area that conveys information through specific symbols. As an information medium, maps support the decision-making process by facilitating discussions and enhancing understanding of regional conditions. Therefore, maps serve not only as the final output but also as an integral component of the analytical and decision-making process (Setiyowati et al., 2021). Mapping refers to the entire process of creating a map, beginning with data collection, followed by data processing, and culminating in the presentation of information in a visual map format (Setiyowati et al., 2021). Based on these definitions, mapping can be understood as the process of collecting and processing data, which are subsequently represented on a

base map at a specified scale to illustrate the spatial distribution of particular conditions or phenomena in the real world (Setiyowati et al., 2021).

The increasing demand for geographic information has highlighted the need to identify areas with a high prevalence of Dengue Hemorrhagic Fever (DHF). Managing such complex information requires an integrated information system capable of efficiently processing both spatial and non-spatial data. A Geographic Information System (GIS) provides an appropriate solution to this need. GIS is a framework that integrates digital technology, geospatial data, and human resources to collect, process, analyze, and present location-based information. The output of GIS is spatial data, which are geographically referenced using a specific coordinate system and serve as the primary basis for spatial analysis (Hamdani & Utomo, 2021).

According to data from the Lhoknga Community Health Center, DHF cases were still reported in its service area in 2024. However, information regarding the spatial distribution of DHF cases, mosquito breeding sites, and vector density in Lhoknga District remains limited. Such spatial information is essential for identifying high-risk areas, prioritizing intervention programs, implementing mosquito breeding site elimination activities, and developing more targeted and effective DHF control strategies (Ilham, 2024; Hamdani & Utomo, 2021).

Therefore, this study aims to map the spatial distribution of Dengue Hemorrhagic Fever (DHF) cases, mosquito breeding sites, and the presence of mosquito larvae using a Geographic Information System (GIS) in Lhoknga District, Aceh Besar Regency. The findings of this study are expected to provide valuable spatial information for identifying high-risk areas and to support evidence-based decision-making in planning and implementing more effective and sustainable DHF prevention and control programs (Setyawan & Setyaningsih, 2021; Ilham, 2024; Hamdani & Utomo, 2021).

RESEARCH METHODS

This study employed a descriptive design using a point location mapping approach to describe the spatial distribution of Dengue Hemorrhagic Fever (DHF) cases and vector breeding sites within the service area of the Lhoknga Community Health Center, Aceh Besar Regency. The study was conducted in March 2025 and included **1**6 households with confirmed DHF cases and 89 potential mosquito breeding sites. Data were collected through field observations using Global Positioning System (GPS) devices, Google Earth, photographic documentation, and Geographic Information System (GIS) software, while

secondary data were obtained from health records, official reports, and demographic and geographic documents. The collected data were processed through editing, coding, and data entry into ArcGIS for spatial analysis. Descriptive (univariate) analysis was used to summarize the characteristics of the study variables, whereas GIS-based spatial analysis was performed to map the distribution of DHF cases and identify spatial patterns as random, clustered, or dispersed.

RESULTS AND DISCUSSION

Results

DHF Cases in Lhoknga District

Data from the Lhoknga Community Health Center indicated that 16 DHF cases were recorded in 2024. The reporting system at the Lhoknga Community Health Center is still conducted manually, resulting in a considerable delay between data collection, presentation, and analysis. This condition may hinder the timely provision of treatment and early preventive measures that should ideally be implemented promptly. Consequently, efforts to control the spread of Dengue Hemorrhagic Fever (DHF) become less effective. Reporting is defined as the process of communicating classified data to relevant stakeholders according to predetermined objectives. Therefore, Community Health Centers are expected to ensure that data and information are available promptly, accurately, up-to-date, continuously, accountable, and delivered in a timely manner.

The public demand for geographical information has continued to increase. Managing such complex information requires an integrated information system capable of processing both spatial and non-spatial data efficiently. A Geographic Information System (GIS) provides an appropriate solution to this need. GIS integrates digital technology, geographical data, and human resources to collect, process, and transform data into geographic-based information. The resulting information consists of spatial data referenced by specific geographic coordinate systems. In the health sector, GIS is designed to facilitate the storage of dengue patient data, thereby improving data retrieval and identification. In addition, GIS serves as a valuable tool for epidemiological investigations and for monitoring areas vulnerable to dengue transmission, enabling more targeted disease control interventions.

To date, there has been insufficient information regarding the spatial distribution of Dengue Hemorrhagic Fever (DHF) cases and mosquito vector density in Lhoknga District. Therefore, this study aims to develop a spatial distribution map of DHF cases and mosquito

density based on the number of reported cases. It is expected that the visualization of DHF case distribution will provide valuable information for identifying high-risk areas, as illustrated in the distribution map presented below.

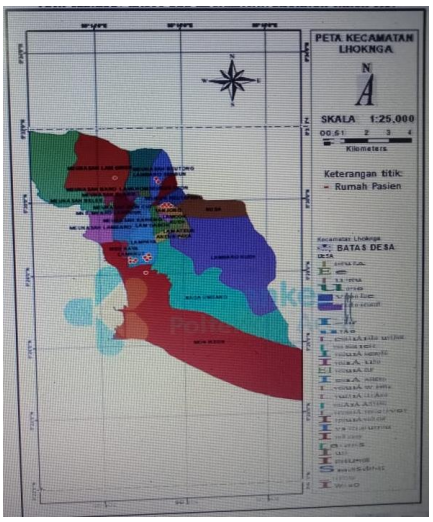

Figure 1. Spatial Distribution Map of DHF Cases in Lhoknga District, 2024

Breeding Sites of DHF Vectors in Lhoknga District

Several factors influence the transmission of Dengue Hemorrhagic Fever (DHF), including the presence of breeding sites, resting sites, mosquito density, and the Larvae-Free Index (LFI) (Wahyono et al., 2010). Preliminary observations in Sukaraja Village revealed a large amount of plastic waste, particularly disposable drinking cups and used plastic bottles. These containers have the potential to become breeding sites for *Aedes aegypti*, the primary vector of DHF. In this regard, the Center for Health Data and Information of the Indonesian Ministry of Health (*Pusdatin Kemenkes*, 2017) emphasizes the importance of eliminating and covering standing water to prevent mosquito breeding.

Interviews with village midwives in Lhoknga District revealed that the dominant contributing factor was community behavior, particularly the disposal of household waste into rivers. Plastic cups and bottles discarded into waterways often become trapped beneath residential houses rather than being carried away by the current. Consequently, these objects accumulate rainwater and become mosquito breeding sites (*breeding places*). These interview findings were consistent with field observations conducted by the researchers, as illustrated in the following map.

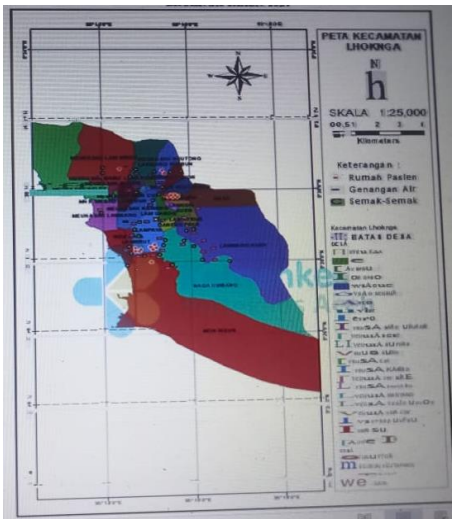

Figure 2. *Distribution Map of DHF Vector Breeding Sites in Lhoknga District, 2024*

Presence of DHF Vector Larvae

Environmental conditions are one of the primary determinants of Dengue Hemorrhagic Fever (DHF) transmission. This is attributed to the tendency of *Aedes* spp. mosquitoes to breed in various water-holding containers, such as bathtubs, flower vases, and other water storage containers, which become increasingly abundant during the rainy season. Adult *Aedes* mosquitoes infected with the dengue virus subsequently act as vectors by transmitting the virus through their bites, resulting in the rapid spread of the disease among humans.

Larval surveys constitute a critical component of DHF transmission control strategies. The results of these surveys serve as key indicators for predicting the risk of dengue virus transmission within a particular area. One of the principal indicators used is the Larvae-Free Index (LFI). An area is considered larvae-free when its LFI reaches at least **95%**. Achieving this target substantially reduces the risk of DHF transmission, whereas values below this threshold indicate a higher transmission risk. This is because dengue transmission involves complex interactions among four components: the vector (mosquito), the virus, the environment, and humans.

Strategies to interrupt DHF transmission focus on three main approaches: minimizing mosquito breeding habitats, reducing contact between mosquitoes and humans, and implementing direct interventions to interrupt the transmission cycle. Among these approaches, vector control during the pre-adult (larval) stage is considered the most effective and efficient. This is because *Aedes* spp. larvae occupy predictable and specific habitats, primarily clean water storage containers in various environments. Furthermore,

the larval stage represents the longest phase of the mosquito life cycle, lasting approximately 6–8 days, thereby providing a broader window of opportunity for effective intervention.

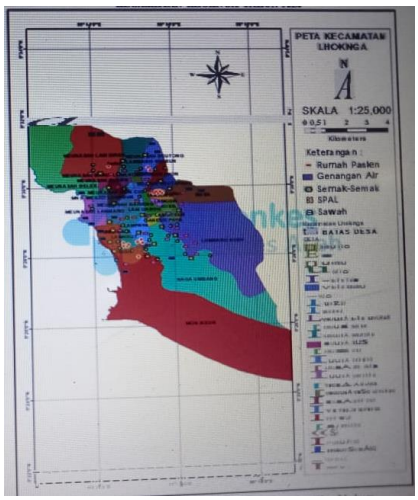

Figure 3. *Distribution Map of the Presence of DHF Vector Larvae in Lhoknga District, 2024*

Discussion

Distribution of DHF Cases and Mosquito Density

The findings of this study showed that 16 cases of Dengue Hemorrhagic Fever (DHF) were reported in 2024. The density of dengue mosquito larvae is strongly influenced by seasonal variation, particularly the rainy season, which creates standing water. Stagnant water serves as a breeding habitat for mosquitoes and consequently increases the potential for disease transmission. A study conducted in Peurada Village, Banda Aceh City, reported a lower Density Figure (DF) of 3.3, indicating a moderate level of mosquito density.

A study conducted in four regions—Banjarmasin City, Tulungagung Regency, Malang City, and Kediri City—confirmed that these areas are endemic for Dengue Hemorrhagic Fever (DHF). This status was evidenced by the annual occurrence of DHF cases, frequent outbreaks, and substantial mortality within the community. Disease transmission generally increases during the rainy season, when stagnant water provides ideal mosquito breeding sites. Nationally, DHF incidence in Indonesia has fluctuated over time but has shown an overall increasing trend in morbidity and geographical spread. This escalation has been driven by the expanding distribution of mosquito vectors in both residential and non-residential environments.

DHF Cases in Lhoknga District

A study conducted by the Surveillance Team of the Center for Environmental Health Engineering and Disease Control (*Balai Besar Teknik Kesehatan Lingkungan dan Pengendalian Penyakit* [BBTKLPP]) identified Tuban Regency as one of the areas with a high incidence of DHF in East Java Province. According to records from BBTKLPP Surabaya, Tuban ranked seventh in DHF incidence in 2019. Epidemiological data from the Tuban District Health Office reported 153 DHF cases in 2020, representing a decline from 398 cases in 2019 and returning to the same level recorded in 2018 (153 cases). Nevertheless, continuous surveillance and vigilance remain essential to prevent future outbreaks. Furthermore, Bangilan District was identified as one of the areas with a high disease burden, ranking third among the twenty districts in Tuban Regency. The number of DHF cases in Bangilan doubled from 8 cases in 2020 to 16 cases in 2021, while complete data for 2022 were unavailable.

Mosquito breeding sites represent a critical component of the mosquito life cycle because they are essential for the survival and reproduction of vector populations. *Aedes* spp., the primary vector of Dengue Hemorrhagic Fever (DHF), are well adapted to environments characterized by high rainfall and humid conditions. Their principal breeding habitats consist of stagnant clean water found both inside and outside residential areas. A high density of *Aedes* larvae constitutes one of the major risk factors for DHF transmission. Larval population density can be assessed using several entomological indicators, one of which is the House Index (HI).

DHF Vector Breeding Sites in Lhoknga District

The findings of the present study are consistent with those reported by Azizah, Hermawati, and Susanna (2018). Their study explained that water storage containers should be cleaned by scrubbing the inner walls with soap to remove and destroy mosquito eggs attached to the surface. The recommended cleaning frequency is at least once a week to interrupt the mosquito life cycle and prevent larvae from developing into adult mosquitoes. In addition, dirty water containers provide favorable conditions for the growth of microorganisms that serve as food sources for mosquito larvae, thereby accelerating their development.

A study by Muda and Haqi (2019) confirmed a significant correlation between the frequency of cleaning household water storage containers (at least once per week) and mosquito larval density. This finding indicates that regular cleaning has a direct effect on

reducing the presence of larvae in Rangkah Village. Similarly, Nadifah (2017) reported that *Aedes aegypti* mosquitoes are capable of breeding in a wide variety of water-holding containers located in both domestic and peri-domestic environments, particularly containers capable of retaining water. Furthermore, a study by Washliyah, Tarore, and Salaki (2019) identified bathtubs, buckets, water dispensers, and flower vases or pots as the most common breeding sites for *Aedes* mosquitoes.

Approximately 35% of respondents reported that they did not regularly drain and scrub the walls of secondary water-holding containers, such as flower vases and water dispenser reservoirs. Draining containers without scrubbing their walls is considered ineffective because mosquito eggs attached to the container surfaces remain intact. Moreover, cleaning intervals of less than once per week provide sufficient time for mosquitoes to complete their life cycle, which may continue for several months.

According to Gafur and Saleh (2016), water storage containers can be classified based on several characteristics, including container type, location, construction material, color, and physical condition. These containers generally constitute part of everyday household facilities. Their study identified a relationship between container characteristics and the presence of mosquito larvae. The authors recommended that water storage containers be tightly covered while remaining easy to clean. Properly covering water containers prevents mosquitoes from entering and laying eggs, whereas uncovered containers present a substantially higher risk of becoming mosquito breeding sites. Additional factors, including poor sanitation, slippery and moss-covered container walls, dirty container bottoms, and improperly covered containers, were identified as major contributors to larval development.

Presence of DHF Mosquito Larvae in Lhoknga District

The findings of this study indicate that respondents generally owned large-capacity water storage containers that were not cleaned regularly or thoroughly. The observed cleaning practices also did not include scrubbing the inner walls of the containers. These findings are consistent with those of Azizah, Hermawati, and Susanna (2018), who recommended that water storage containers be scrubbed with soap to remove mosquito eggs adhering to the container walls. Routine cleaning, conducted at least once per week, is essential to interrupt the mosquito life cycle. Conversely, dirty water containers promote the growth of microorganisms that serve as a food source for mosquito larvae.

Only 35% of respondents reported regularly draining and scrubbing water storage containers, including flower vases and water dispenser reservoirs. Cleaning without scrubbing the container walls is ineffective because mosquito eggs remain firmly attached to the surfaces. Furthermore, respondents did not clean their water storage containers on a weekly basis, thereby allowing mosquitoes sufficient time to reproduce and complete their life cycle over several months.

A study conducted by Gafur (2015) demonstrated a significant association between covering water storage containers and the presence of mosquito larvae. Properly covered water storage containers substantially reduced the likelihood of larval infestation. Likewise, Azizah, Hermawati, and Susanna (2018) reported a significant relationship between container covering practices and larval presence (p = 0.041; OR = 2.0), indicating that uncovered containers are significantly more likely to harbor mosquito larvae than properly covered containers.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the findings of this study on the Mapping of Factors Associated with Dengue Hemorrhagic Fever (DHF) Using a Geographic Information System (GIS), the following conclusions can be drawn. The spatial distribution of DHF cases within the service area of the Lhoknga Community Health Center in 2024 was uneven, with the highest concentration of cases occurring in several villages characterized by high population density and poor environmental sanitation. The study identified 89 breeding sites of DHF vectors distributed throughout Lhoknga District. Based on the classification of DHF vector breeding sites, 29 locations were identified in stagnant water, 28 locations in rice fields, 20 locations in wastewater drainage systems (Sistem Pembuangan Air Limbah [SPAL]), and 12 locations in other waterlogged agricultural areas. Environments with abundant stagnant water, such as discarded containers, used tires, and uncovered water storage containers, provide ideal breeding habitats for *Aedes aegypti* mosquitoes.

Recommendations

For the Lhoknga Community Health Center, it is recommended to utilize the GIS-based mapping results as a basis for prioritizing interventions in high-risk DHF areas. These interventions may include targeted fogging, strengthening the capacity of larval surveillance volunteers (Jumantik cadres), and enhancing community health education in

villages identified as having a high risk of DHF transmission. For the community, community members are encouraged to increase their awareness and actively participate in maintaining environmental cleanliness by consistently implementing the 3M Plus strategy and participating in regular Mosquito Breeding Site Eradication (PSN) activities. For future researchers, future studies are expected to integrate additional variables, including climatic factors (temperature, rainfall, and humidity) and vector density, to improve the accuracy of spatial models in predicting the occurrence of Dengue Hemorrhagic Fever (DHF).

REFERENCES

Agnesia, Y., Sari, S. W., & Ramadhani, D. W. (2023). *Dengue hemorrhagic fever (DHF): Determinants and prevention*. NEM Publisher.

Asmar, L., Marita, Y., & Yansyah, E. J. (2023). Factors associated with dengue hemorrhagic fever (DHF) prevention in Pulau Panggung Village, Tanjung Agung Community Health Center, Muara Enim Regency. *Journal of Health Science Cluster, 3*(3), 120–132.

Azzahra, J., Narsa, A. C., & Gama, N. I. (2023). Analysis of the characteristics and treatment profiles of pediatric dengue hemorrhagic fever patients at Samarinda Medika Citra Hospital during 2020–2021. *Journal of Science and Health, 5*(Special Issue 1), 10–18.

Baihaki, M. A., Andriyai, A. F., Handayani, D. R. A., Sari, D. N., Hanifah, N. A. T., & Istiqomah, S. H. (2023). Utilization of lemongrass as a mosquito repellent for dengue hemorrhagic fever prevention in Beran Kidul Hamlet, Tridadi, Sleman, Special Region of Yogyakarta. *JUDIMAS: Journal of Community Service, 10*(2), 83–90.

Baitanu, J. Z., Masihin, L., Rustan, L. D., Siregar, D., & Aiba, S. (2022). Association of age, sex, mobility, and knowledge with dengue hemorrhagic fever incidence in Wulauan, Minahasa Regency. *Malahayati Nursing Journal, 4*(5), 1230–1241.

Daihan, D. U., & Ikawati, Z. (2023). Mapping potential epidemic diseases in Indonesia to support early detection and early warning systems. *Journal of Citizenship, 7*(2), 1879–1886.

Firdaus, R., Kamalia, N., Nurohmah, T., Juniadi, A., & Indriyanti, D. (2022). Community education on dengue hemorrhagic fever prevention in Sumuranja Village, Pulo Ampel, Serang. *Batara Wisnu: Indonesian Journal of Community Services, 2*(3), 430–437.

Fitri Rahmawati, Y. (2022). *Spatial distribution of dengue hemorrhagic fever cases in relation to the entomological index of dengue vectors in the working area of Mlati II Community Health Center in 2021* (Undergraduate thesis). Poltekkes Kemenkes Yogyakarta.

Hamdani, M. A., & Utomo, S. (2021). Geographic information system (GIS) for Bandung tourism using Google Maps API and PHP. *Journal of Information and Communication Technology, 11*(1).

Handayani, D. A. (2023). *Spatial distribution of dengue hemorrhagic fever vectors based on patient data in the working area of Ngemplak II Community Health Center using a geographic information system* (Undergraduate thesis). Poltekkes Kemenkes Yogyakarta.

Ichsan, B. (2022). *Introduction to medical and public health research methodology*. Muhammadiyah University Press.

Ilham, R. (2024). *Spatial analysis of dengue hemorrhagic fever distribution using a geographic information system (GIS) approach in coastal settlements of Sayung District, Demak Regency* (Undergraduate thesis). Universitas Islam Sultan Agung.

Kamila, N. A., & Mauliza, Z. (2022). Association between platelet count and hematocrit level in dengue hemorrhagic fever patients aged 6–11 years. *Syiah Kuala Medical Journal, 22*(2), 46–52.

Kastari, S., & Prasetyo, R. D. (2022). Association between 3M-Plus behavior and dengue hemorrhagic fever incidence in Sintang Regency. *Ruwa Jurai: Journal of Environmental Health, 16*(3), 129–137.

Khairani, N., Asih, F. R., & Effendi, S. U. (2024). Association between 3M Plus preventive behavior and dengue hemorrhagic fever incidence in the working area of Bintuhan Community Health Center. *Journal of Health Vocations, 3*(1), 35–42.

Lang, F., Syamsul, M., & Nur, N. H. (2021). Implementation of the 3M strategy for dengue hemorrhagic fever prevention in the working area of Panambungan Community Health Center. *Journal of Health Quality Development, 1*(1), 38–43.

Majelis Ulama Indonesia. (2021). *Water, hygiene, sanitation, and environmental health from an Islamic perspective*. Majelis Ulama Indonesia.

Mawaddah, F., Pramadita, S., & Triharja, A. (2022). Association between environmental sanitation, family behavior, and dengue hemorrhagic fever incidence in Pontianak City. *Journal of Wetland Environmental Technology, 10*(2), 215–228.

Ningrum, S. A., & Kartika, D. (2023). *Vector control management*. Uwais Inspirasi Indonesia.

Nitbani, M. P., & Siagian, E. (2022). Association of community knowledge, attitudes, and practices with dengue hemorrhagic fever prevention. *Klabat Journal of Nursing, 4*(2), 27–34.

Owa, A. F. (2024). *Density of Aedes spp. eggs based on ovitrap color in Kelapa Lima Village* (Undergraduate thesis). Poltekkes Kemenkes Kupang.

Periatama, S., Lestari, R. M., & Prasida, D. W. (2022). Association between 3M Plus behavior and dengue hemorrhagic fever incidence. *Surya Medika Journal, 7*(2), 77–81.

Pratiwi, H. D., Prasetyo, H., & Amrullah, A. E. (2022). Analysis of dengue hemorrhagic fever prevention behavior: A literature review. *Journal of Scientific Studies in Health and Technology, 4*(2), 35–42.

Prayoga, D. (2022). Analysis of factors contributing to the low implementation of mosquito breeding site eradication in Gumuk Village, Banyuwangi Regency. *Preventive: Journal of Public Health, 13*(3).

Retang, P. A., Salmun, J. A., & Setyobudi, A. (2021). Association between community behavior and dengue hemorrhagic fever incidence in the working area of Bakunase Community Health Center. *Public Health Media, 3*(1), 63–71.

Sanjaya, K. D. D. (2024). *Description of Aedes aegypti larvae in mosquito breeding sites in Gunaksa Village, Dawan District, Klungkung Regency* (Undergraduate thesis). Poltekkes Kemenkes Denpasar.

Sari, R. K., Djamaluddin, I., Djam'an, Q., & Sembodo, T. (2022). Community empowerment in dengue hemorrhagic fever prevention at Karangdoro Community Health Center. *ABDIMAS-KU: Journal of Medical Community Service, 1*(1), 25.

Setiyadi, N. A., Damoto, S., Arozaq, M., et al. (2021). *Geographic information systems in public health*. Muhammadiyah University Press.

Setiyowati, R., Sutanto, S., Saputro, D. R. S., & Widyaningsih, P. (2021). Training and mentoring in developing spatial data-based digital maps using QGIS 3.8.3. *Budimas: Journal of Community Service, 3*(2), 457–464.

Setyawan, D. A., & Setyaningsih, W. (2021). Spatial distribution of dengue hemorrhagic fever cases in Sragen Regency. *Disease Prevention and Public Health Journal, 15*(1), 42.

Sutriyawan, A., Darmawan, W., Akbar, H., Habibi, J., & Fibrianti, F. (2022). Factors influencing mosquito breeding site eradication through the 3M Plus strategy for dengue hemorrhagic fever prevention. *Journal of Public Health Sciences, 11*(1), 23–32.

Yudhastuti, R. (2021). *Vector and rodent control*. Zifatama Jawara.

Yusmahendra, D., Lestari, V. D., Mawarti, I., & Sari, P. L. (2023). Education on dengue hemorrhagic fever prevention at the Rifahiyatul Bilad Baiturrahim orphanage in Jambi City. *Journal of Community Service, Department of Nursing, 1*(2), 16–21.