JPPIPA 11(12) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Immune Response to Dengue Fever Infection in Endemic Areas of Lombok Barat

Erlin Yustin Tatontos[1*], Ersandhi Reshnleksmana[1], Urip[1]

[1] Department of Medical Laboratory Technology, Poltekkes Kemenkes Mataram, West Nusa Tenggara, Indonesia.

Received: October 16, 2025
Revised: November 19, 2025
Accepted: December 25, 2025
Published: December 31, 2025

Corresponding Author:
Erlin Yustin Tatontos
erlintatontos64@gmail.com

DOI: 10.29303/jppipa.v11i12.13163

Abstract: Dengue infection makes the body create immune responses, such as the formation of immunoglobulins. In Lombok Barat, 222 DHF cases with three fatalities are reported, with a CFR of 1.4%. The aim of this study was to determine the immune response to dengue fever in West Lombok. Analytical observational research method with cross-sectional study. Population included DHF patients in endemic areas of Lombok Barat, a total of 33 respondents suspected of dengue fever. Data on immune responses were gathered using dengue IgM and IgG tests. Respondent immune responses exhibited that 21.2% tested positive and 78.8% tested negative for IgM, while 63.6% tested positive and 36.4% tested negative for IgG. Statistical analysis of dengue fever infection with IgM using the Chi-square test obtained $p = 0.049 < \alpha = 0.05$, while dengue fever infection with IgG was $p = 0.113 > \alpha = 0.05$. The results of the analysis showed that there was a significant relationship between dengue fever infection and IgM test results, but there was no significant relationship between dengue fever infection and IgG test results. Most of the DHF infections in Lombok Barat were categorized as primary infections.

Keywords: Dengue infection; IgG; IgM; Immune response

Introduction

Dengue fever has become one of the serious public health issues, with 3.9 billion across 128 countries identified as at a high risk of Aedes mosquito-borne infection (Bhatt et al., 2013). At the beginning of 2023, the world faced a significantly increasing number of dengue fever cases, while fatalities had been reported in endemic areas, with further spread into areas which were previously free from dengue fever (WHO, 2023).

Several factors, such as climate change, unplanned urbanization programs, and increasing human-driven mobility, contribute to the spread of mosquito vectors and the increased risk of transmission (Bhatia et al., 2022; Purba et al., 2023; Urip et al., 2023). Recent studies also elaborate on the importance of understanding circulating dengue virus serotypes and their impacts on severity levels of the disease (Yung et al., 2015).

Additionally, the development of effective and safe dengue vaccines is the top-priority agenda in disease control measures (Chua et al., 2014). Integrated vector control measures, including environmental control, insecticide utilization, and community participation, remain the key strategy in reducing DHF burdens (Dwiyanthi et al., 2023; Tatontos et al., 2022; WHO, 2018).

Dengue infection refers to a viral infection, which in its development is divided into Dengue Fever (DF), Dengue Hemorrhagic Fever (DHF), and Severe Dengue (SD) or Dengue Shock Syndrome (DSS)(WHO, 2011). The dengue virus belongs to the group of arthropod-borne viruses, classified under the genus *Flavivirus* and the family *Flaviviridae*. This virus possesses four serotypes (DENV-1, DENV-2, DENV-3, and DENV-4), which have been identified to circulate in some parts of the world, particularly in tropical and subtropical regions, including Indonesia (Khetarpal & Khanna, 2016; Tatontos et al., 2021; Utama et al., 2019).

Each viral serotype is sufficiently distinct that no cross-protection occurs, allowing outbreaks involving

How to Cite:
Tatontos, E. Y., Reshnleksmana, E., & Urip. (2025). Immune Response to Dengue Fever Infection in Endemic Areas of Lombok Barat. *Jurnal Penelitian Pendidikan IPA*, *11*(12), 853-860. https://doi.org/10.29303/jppipa.v11i12.13163

multiple serotypes (hyperendemicity) to arise. Subsequent infection with a different serotype can lead to severe complications (Schaefer et al., 2023; Sukohar, 2014; Wang et al., 2020). The infection is transmitted to humans through the bite of an infected female Aedes mosquito. Infection by one of the virus serotypes is 75% asymptomatic is asymptomatic or may present with clinical symptoms. Dengue viral infection causes the body to give clinical responses and form antibodies (Wila & Nusa, 2020).

Secondary dengue infection refers to a subsequent dengue infection occurring after a previous episode of dengue. A subsequent infection with a different serotype can cause dengue disease with a higher severity level. Previous research reveals that 98% of dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS) cases are categorized as secondary dengue infection. The pathophysiological mechanisms underlying the increased severity of secondary dengue infection are not yet fully understood but are allegedly associated with Antibody-Dependent Enhancement (ADE) mechanisms (Marvianto et al., 2023).

Dengue infection triggers the body to create immune responses, among which is the formation of immunoglobulins. One of the diagnostic components of DHF is based on serological testing for dengue-specific IgM and IgG antibodies (Arshad et al., 2021; Changal et al., 2016; Wila & Nusa, 2020).

According to data from the Ministry of Health, there were 131,265 dengue cases in 2022, with 40% cases experienced by children aged 0-14 years. Meanwhile, the fatalities reached 1,135 cases, with 73% identified to occur in children aged 0-14 years (Kaligis et al., 2023; Kemenkes RI, 2023).

Nearly 20-30% of dengue hemorrhagic fever cases progress to shock, and among those who develop shock, 40-50% lead to fatality. Most death cases in children with dengue fever are the consequences of dengue shock syndrome (Kusuma, 2025; Wang et al., 2019). DHF with DSS mainly occurs in children under 15 years, although several cases are noticeable in adults. Early symptoms include sudden fever and a range of other nonspecific signs and symptoms. During the acute phase of the disease, it is hardly possible to differentiate dengue fever from other diseases found in tropical regions (Burrell et al., 2017; Sukmawathi et al., 2024).

In 2021, a total of 2,697 DHF cases were reported in West Nusa Tenggara, with an incidence rate (IR) of 50.9/100,000 population, exceeding the national target of ≤ 49/ 100,000. The number of deaths reached 21, resulting in a case fatality rate (CFR) of 0.8%, slightly higher than the national target of 0.7%. In Lombok Barat, DHF cases reached 222 patients, with three deaths at a CFR of 1.4% (Dikes Provinsi NTB, 2021).

The national target for dengue fever Case Fatality Rate (CFR) is < 1%, and data on dengue IgM and IgG immune responses in West Lombok are currently unavailable. Therefore, this research is needed to monitor virus spread, determine transmission patterns (primary or secondary infection), strengthening dengue fever surveillance and guide disease control strategies (Sukmawathi et al., 2024).

Method

The research used an analytical observational design. The population and samples included DHF patients in endemic areas of Lombok Barat, namely in the service areas of Puskesmas Gerung, Puskesmas Kuripan, and Puskesmas Kediri. The samples represented a subset of the population, consisting of a minimum of 33 respondents.

Data collection began with a preparatory phase, which included enumerator training through a Focus Group Discussion (FGD) activity.

The collected data were primary and secondary on DHF cases, DHF patient characteristics, and the results of immune response testing in DHF patients in Lombok Barat.

Respondent criteria are suspected DHF based on medical diagnosis and platelet levels. The diagnosis of dengue fever is determined based on clinical and laboratory criteria including acute fever, bleeding manifestations, thrombocytopenia and hemoconcentration (WHO, 2009).

Data on respondent characteristics included respondent age, sex, levels of education, and levels of knowledge about DHF infection, collected through interviews and questionnaire distribution. Validity of questionnaire instruments based on literature (Guzman & Harris, 2015; Kemenkes RI, 2022; Lambrechts et al., 2010; Nastiti et al., 2021; Sim & Dimopoulos, 2010; WHO, 2009).

In this study, respondents underwent an NS1 test before the immune response test with IgM and IgG tests. Respondent immune response data was obtained from IgM and IgG tests using Fast Clear Q Dengue IgM/IgG with a sensitivity of 95.7% and a specificity of 98.3%, with a total accuracy of 99.1% (Puspita & Aryati, 2018).

Data processing was made up of the following stages: variable coding, tabulation, and computation using the SPSS program. Moreover, data analysis was carried out by conducting descriptive analysis (percentage) and data analysis with Chi-square test.

Result and Discussion

In this study there were 33 respondents from dengue fever endemic areas in West Lombok (Dinas Kesehatan Lombok Barat, 2022), composed of 12 patients from the service area of Puskesmas Kuripan, 11 patients from the service area of Puskesmas Kediri, and 10 patients from the service area of Puskesmas Gerung, were observed. The analysis results of respondent characteristics, covering age, sex, levels of education, and levels of knowledge about DHF infection, are explained in the following sections.

Age and DHF Infection

Table 1 indicates respondent age characteristics with DHF infection in Lombok Barat.

Table 1. Respondent age with DHF infection in Lombok Barat

Age group (year)	DHF Infection				Total	
	Sub-total (Negative)	Percentage (%)	Sub-total (Positive)	Percentage (%)	Sub-total	Percentage (%)
Infant and toddler (0-5)	0	0	2	100	2	100
Child (6-12)	2	25	6	75	8	100
Adolescent (13-18)	3	42.9	4	57.1	7	100
Adult (19-44)	1	10	9	90	10	100
Pre-elderly (45-59)	1	16.7	5	83.3	6	100
Total	7		26		33	

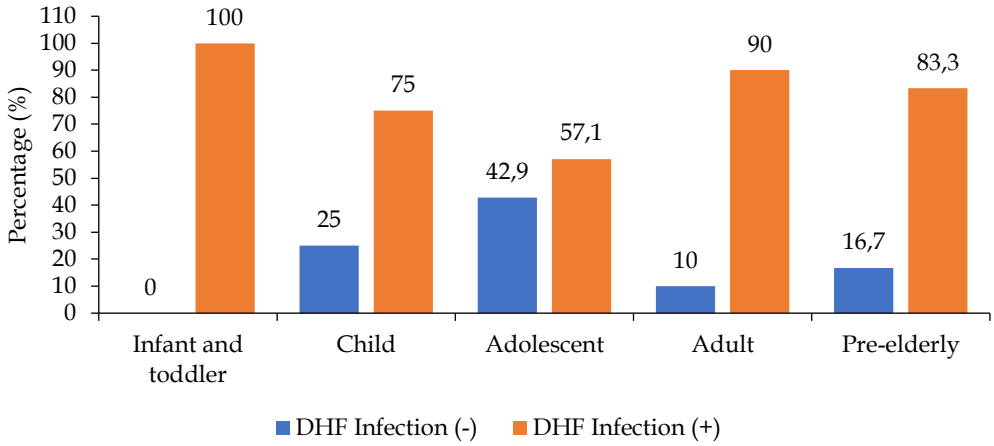

Figure 1. Respondent age with DHF infection in Lombok Barat

All infant and toddler (0-5 year) respondents tested (100%) positive for DHF while adolescent (13-18 year) 57.1%. Respondent age with DHF infection in Lombok Barat can be seen in Figure 1.

Age characteristics with DHF infection suggested that a higher prevalence of DHF cases occurred in children and young adults (Kusuma, 2025; Sabrina, 2024). In infants and toddlers (0-5 years), susceptibility to DHF infection may be due to immature immunity, while susceptibility among young adults is primarily the result of intense outdoor activities, increasing the risk of contact with the vector. Facchinelli et al. (2023) add that children often play outdoors in areas with potential *Aedes aegypti* breeding sites, making them more susceptible to dengue virus exposure.

Sex and DHF Infection

Table 2 presents respondent sex with DHF infection in Lombok Barat.

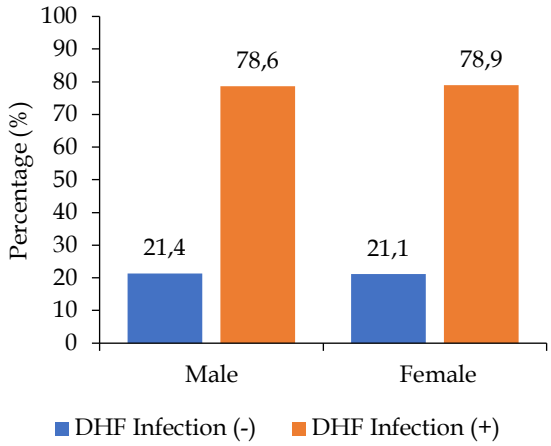

Figure 2. Respondent sex with DHF infection in Lombok Barat

The case distribution showed a higher number of infection cases in females (78.9%) compared to that in males (78.6%), with a relatively slight difference.

Respondent sex with DHF infection in Lombok Barat can be seen in Figure 2.

Other research also demonstrates no significant relationship between sex and DHF occurrence in Minahasa (Klein & Flanagan, 2016). From a physiological perspective, females tend to exhibit a stronger humoral immune response, including antibody production, making them more susceptible to diseases affected by a hyperactive immune response (Baitanu et al., 2022). And yet, a high infection rate in both sexes, as exhibited in this present study, confirms the dominance of environmental factors as key determinants.

Table 2. Respondent sex with DHF infection in Lombok Barat

Sex	DHF infection				Total	
	Sub-total (Negative)	Percentage (%)	Sub-total (Positive)	Percentage (%)	Sub-total	Percentage (%)
Male	3	21.4	11	78.6	14	100
Female	4	21.1	15	78.9	19	100
Total	7		26		33	

Levels of Education and DHF Infection

Table 3 suggests respondent levels of education with DHF infection in Lombok Barat. Based on education level, not completing elementary school and higher education, the dengue fever infection rate is the same at 100%, respectively, relative to junior high school at 50%. Respondent levels of education with DHF infection in Lombok Barat can be seen in Figure 3.

The results also exhibited that formal education alone was insufficient to protect individuals from DHF infection without healthy behaviors and supporting environmental conditions. Research performed in West Jakarta also found no significant association between levels of education and DHF occurrence despite good levels of knowledge among the community (Yandika, 2022). According to Misnawati et al. (2025), changes in preventive behaviors are more influenced by culture and the availability of facilities, such as mosquito nets, fogging, or the PSN 3M Plus program.

Table 3. Respondent levels of education with DHF infection in Lombok Barat

Levels of education	DHF Infection				Total	
	Sub-total (Negative)	Percentage (%)	Sub-total (Positive)	Percentage (%)	Sub-total	Percentage (%)
Not completing elementary school	0	0	2	100	2	100
Elementary school	2	18.2	9	81.8	11	100
Junior high school	3	50	3	50	6	100
Senior high school	2	16.7	10	83.3	12	100
Higher education	0	0	2	100	2	100
Total	7		26		33	

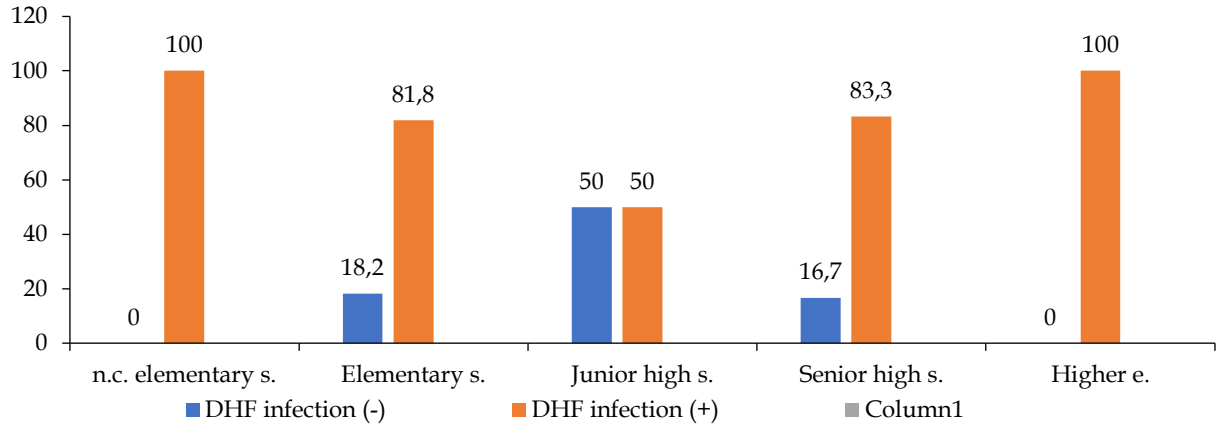

Figure 3. Respondent of level education with DHF infection in Lombok Barat

Levels of Knowledge and DHF Infection

Table 4 exhibits respondent levels of knowledge with DHF infection in Lombok Barat. In other words, the tendency for high positivity rates across all levels of knowledge groups explicate that knowledge alone

cannot serve as the primary protective factor against infection.

This condition lays out that environmental factors, specifically the quality of sanitation, the presence of vector breeding sites, and levels of community exposure to vector bites, exert dominant effects. That is, although respondents come with a sufficient understanding of the disease, transmission methods, and preventive measures, it is not always directly proportional to a lower incidence of positive cases (Rahmah et al., 2023; Yandika, 2022). This phenomenon is likely due to the limited application of preventive behaviors amid unsupportive environmental conditions, such as poor drainage systems or high vector density (Arsyadin et al., 2023; Abdul, 2023; Panggabean et al., 2025). Similarly, a study in Lubuk linggau also indicates that levels of knowledge are correlated with preventive practices but do not always have a direct relationship with infection status, as the presence of *Aedes aegypti* vectors remains the key factor (Yuniar et al., 2024).

Table 4. Respondent levels of knowledge with DHF infection in Lombok Barat

Levels of knowledge	DHF infection				Total	
	Sub-total (Negative)	Percentage (%)	Sub-total (Positive)	Percentage (%)	Sub-total	Percentage (%)
Low	2	14.3	12	85.7	14	100
Moderate	4	36.4	7	63.6	11	100
High	1	12.5	7	87.5	8	100
Total	7		26		33	

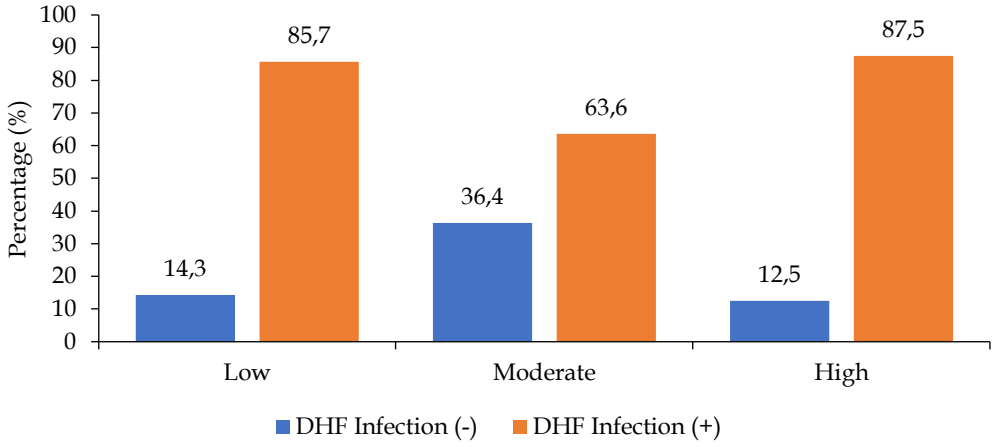

Figure 4. Respondent levels of knowledge with DHF infection in Lombok Barat

Immune Response to Dengue Infection

A total of 32 respondents (97%) experienced their first episode of DHF infection, while one respondent (3%) had a history of more than one infection. Table 1 demonstrates respondent immune responses to dengue infection with IgM and IgG tests. Respondent immune responses exhibited that 21.2% tested positive and 78.8% tested negative for IgM, while 63.6% tested positive and 36.4% tested negative for IgG. Respondent immune responses to DHF infection in Lombok Barat can be seen in Figure 5.

Statistical analysis of dengue fever infection with IgM using the Chi-square test obtained $p = 0.049 < \alpha = 0.05$, while dengue fever infection with IgG was $p = 0.113 > \alpha = 0.05$. The results of the analysis showed that there was a significant relationship between dengue fever infection and IgM test results, but there was no significant relationship between dengue fever infection and IgG test results in this study. Most of the DHF infections in Lombok Barat were categorized as primary infections.

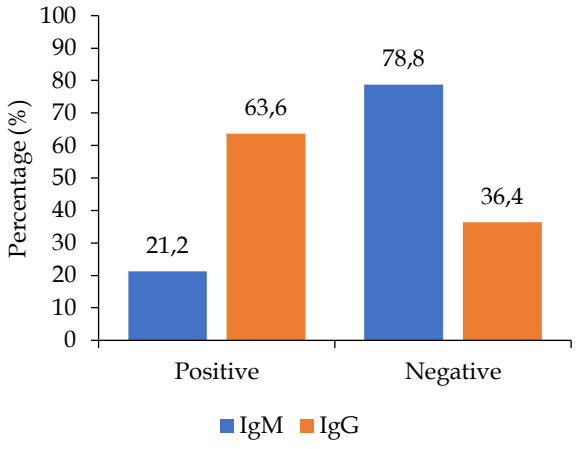

Figure 5. Respondent immune responses to DHF infection in Lombok Barat

Immunological theory explains that IgM serves as a marker of the acute phase, whereas IgG signifies a secondary infection (Guzman & Harris, 2015). IgM is more sensitive for early diagnosis, while IgG is more relevant to predicting the risk of secondary infection (Waggoner, 2016). The results of a study at Sanglah General Hospital in Denpasar showed that serological tests showed that 3 (8%) people had positive IgM, 14 (39%) people had positive IgG, and 19 (53%) people had positive IgM and IgG. Prior studies found a higher occurrence of secondary infection (IgG positive) than that of primary infection (Trisnadewi & Wande, 2016).

In Indonesia, the circulation of multiple dengue serotypes (DEN-1 to DEN-4) has been reported, which elevates the risk of secondary infection. This finding elucidates the high detection rate of IgG, even though it is not significantly associated with the current infection status.

Table 5. Respondent immune responses to DHF infection in Lombok Barat

Test result	IgM		IgG	
	Sub-total	Percentage (%)	Sub-total	Percentage (%)
Positive	7	21.2	21	63.6
Negative	26	78.8	12	36.4
Total	33	100	33	100

Conclusion

The IgM immune response among clinically diagnosed DHF patients was 21.2%, while the IgG response was 63.6%. Statistical analysis of dengue fever infection with IgM using the Chi-square test obtained $p=0.049 < \alpha = 0.05$, while dengue fever infection with IgG was $p = 0.113 > \alpha = 0.05$. The results of the analysis showed that there was a significant relationship between dengue fever infection and IgM test results, but there was no significant relationship between dengue fever infection and IgG test results in this study. Most of the DHF infections in Lombok Barat were categorized as primary infections.

Acknowledgments

We would like to take this opportunity to express our deepest gratitude to the Director of the Mataram Health Polytechnic and his staff who have provided financial support and a research location (West Lombok Regency, West Lombok Health Service, Gerung Community Health Center, Kuripan Community Health Center, Kediri Community Health Center) to the researchers so that this research can be carried out.

Author Contributions

Conceptualization, investigation, E.Y.T., E.R., and U; drafting, E.R. and U; review and editing, E.Y.T. and E.R.

Funding

This research was funded by DIPA Poltekkes Kemenkes Mataram fiscal year 2025.

Conflicts of Interest

The authors declare no conflict of interest.

References

Abdul, H. H. (2023). The Relationship between Mosquito Nest Eradication Behavior and the Habit of Using Mosquito Repellent Against Dengue Hemorrhagic Fever in Pekat Village, Sumbawa District, Sumbawa Regency. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 87–92. https://doi.org/10.29303/jppipa.v9i1.2035

Arshad, S., Ahmed, M., Khan, F., Khurram, M., & Usman, B. (2021). Presenting Complaints in Acute Dengue Infection and Differences in Presenting Complaints between Primary and Secondary Dengue Infections. *Cureus*, *13*(11), e19320. https://doi.org/10.7759/cureus.19320

Arsyadin, A., Aqwam, A., Khairunissa, R., Endang, H. K., Rosita, R., & Fahrul, H. A. (2023). Dengue Hemorrhagic Fever in Bima City: A Study. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4869–4879. https://doi.org/10.29303/jppipa.v9i6.4787

Baitanu, J. Z., Masihin, L., Rustan, L. D., Siregar, D., & Aiba, S. (2022). Hubungan antara Usia, Jenis Kelamin, Mobilitas, dan Pengetahuan dengan Kejadian Demam Berdarah Dengue di Wulauan, Kabupaten Minahasa. *MANUJU*, *4*(5), 1230-1241. https://doi.org/10.33024/mnj.v4i5.6348

Bhatia, S., Bansal, D., Patil, S., Pandya, S., Ilyas, Q. M., & Imran, S. (2022). A Retrospective Study of Climate Change Affecting Dengue: Evidences, Challenges and Future Directions. *Frontiers in Public Health*, *10*(May), 1–16. https://doi.org/10.3389/fpubh.2022.884645

Bhatt, S., Gething, P. W., Brady, O. J., Messina, J. P., Farlow, A. W., Moyes, C. L., … Hay, S. I. (2013). The Global Distribution and Burden of Dengue. *Nature*, *496*(7446), 504–507. https://doi.org/10.1038/nature12060

Burrell, C. J., Howard, C. R., & Murphy, F. A. (2017). Epidemiology of Viral Infections. In *Fenner and White's Medical Virology*, pp. 185–203. https://doi.org/10.1016/B978-0-12-375156-0.00013-8

Changal, K. H., Raina, A. H., Raina, A., Raina, M., Bashir, R., Latief, M., … Changal, Q. H. (2016).

Differentiating Secondary from Primary Dengue Using IgG to IgM Ratio in Early Dengue: An Observational Hospital Based Clinico-Serological Study from North India. *BMC Infectious Diseases*, *16*(1), 715. https://doi.org/10.1186/s12879-016-2053-6

Chua, M. N., Luong, C. Q., Rusmil, K., Wirawan, D. N., Nallusamy, R., & Pitisuttithum, P. (2014). Clinical Efficacy and Safety of a Novel Tetravalent Dengue Vaccine in Healthy Children in Asia: A Phase 3, Randomised. *The Lancet*, *6736*(14), 1–8. http://dx.doi.org/10.1016/S0140-6736(14)61060-6

Dikes Provinsi NTB. (2021). *Jumlah Kasus Demam Berdarah Dangue (DBD) di Provinsi NTB Tahun 2021*. Dikes Provinsi NTB. Retrieved from https://data.ntbprov.go.id/dataset/jumlah-kasus-demam-berdarah-dangue-dbd-di-provinsi-ntb

Dinas Kesehatan Lombok Barat. (2022). *Profil Kesehatan Lombok Barat Tahun 2022*.

Dwiyanthi, K. L., Setiani, O., & Adi, M. S. (2023). Spatial Analysis of Dengue Hemorrhagic Fever Incidents Distribution and Dengue Virus Detection in Tanjung Priok. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 815–821. https://doi.org/10.29303/jppipa.v9iSpecialIssue.5394

Facchinelli, L., Badolo, A., & McCall, P. J. (2023). Biology and Behaviour of Aedes aegypti in the Human Environment: Opportunities for Vector Control of Arbovirus Transmission. *Viruses*, *15*(3). https://doi.org/10.3390/v15030636

Guzman, M. G., & Harris, E. (2015). Dengue. *Lancet (London, England)*, *385*(9966), 453–465. https://doi.org/10.1016/S0140-6736(14)60572-9

Kaligis, E. C., Ratag, B. T., & Langi, F. F. L. (2023). Analysis of Dengue Hemorrhagic Fever Surveillance Data (2012-2021) in Indonesia. *Indonesian Journal of Public Health and Preventive Medicine*, *2*(1). https://doi.org/10.35790/ijphpm.v2i1.51398

Kemenkes RI. (2022). *Profil Kesehatan Indonesia*. Jakarta: Kementerian Kesehatan RI.

Kemenkes RI. (2023). *Atasi Dengue, Kemenkes Kembangkan Dua Teknologi ini – Sehat Negeriku*. Jakarta: Kementerian Kesehatan RI.

Khetarpal, N., & Khanna, I. (2016). Dengue Fever: Causes, Complications, and Vaccine Strategies. *Journal of Immunology Research*, *2016*(3). https://doi.org/10.1155/2016/6803098

Klein, S. L., & Flanagan, K. L. (2016). Perbedaan Jenis Kelamin dalam Respons Imun. *Nature Reviews Immunology*, *16*(10), 626–638. https://doi.org/10.1038/nri.2016.90

Kusuma, S. S. (2025). Clinical Manisfestations and Complications of Dengue Infection in Children: Insights and Comparisons with Adult Cases. *Cermin Dunia Kedokteran*, *52*(8), 6–9. https://doi.org/10.55175/cdk.v52i8.1518

Lambrechts, L., Scott, T. W., & Gubler, D. J. (2010). Consequences of the Expanding Global Distribution of Aedes albopictus for Dengue Virus Transmission. *PLOS Neglected Tropical Diseases*, *4*(5), e646. https://doi.org/10.1371/journal.pntd.0000646

Marvianto, D., Ratih, O. D., & Wijaya, K. F. N. (2023). Infeksi Dengue Sekunder: Patofisiologi, Diagnosis, dan Implikasi Klinis. *Cermin Dunia Kedokteran*, *50*(2), 70–74. https://doi.org/10.55175/cdk.v50i2.518

Misnawati, M., Yusriadi, Y., Astri, Z., Abbas, A., & Asbar, A. (2025). Exploring Teachers' Initial Perceptions of Corpus Linguistics and Their Readiness to Incorporate Corpora in Classroom Instruction: A Qualitative Analysis. *The Qualitative Report*, *30*(1), 3024-3042. https://doi.org/10.46743/2160-3715/2025.6867

Nastiti, S. A., Ramadanintyas, K. N., & Marsanti, A. S. (2021). Factors Related to Incident Dengue Hemorrhagic Fever (DHF). *Jurnal Kesehatan Prima*, *15*(2), 149–155. https://doi.org/10.32.807/jkp.v15i2.681

Panggabean, M., Panggabean, Y. C., Siahaan, L., Sinambela, A. H., Sepala, I., & Siregar, S. (2025). The Relationship between House Environmental Condition and Mosquito Larvae Density (Diptera: Culicidae) in Medan Denai Sub-District, Medan City. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 1066–1074. https://doi.org/10.29303/jppipa.v11i7.11076

Purba, I. E., Nababan, D., & Kaban, E. S. (2023). Risk Factors of Dengue Hemorrhagic Fever. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8131–8139. https://doi.org/10.29303/jppipa.v9i10.4882

Puspita, D., & Aryati, A. (2018). SD Dengue Duo® (NS1, IgG, IgM) Rapid Test dalam Menunjang Diagnosis Infeksi Virus Dengue. *Indonesian Journal of Clinical Pathology and Medical Laboratory*, *16*(2), 97. https://doi.org/10.24293/ijcpml.v16i2.980

Rahmah, A., Sary, L., Perdana, A. A., & Sary, L. (2023). Prevention Behavior of Dengue Hemorrhagic Fever in Community Leaders in the Work Area of the Hajimena Health Center, South lampung Regency. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5346–5352. https://doi.org/10.29303/jppipa.v9i7.3741

Sabrina, P. I. (2024). *Profil Penderita DBD pada Anak di Rumah Sakit Umum Karsa Husada Batu Tahun 2021-2023* (Undergraduate Thesis). Universitas Islam Negeri Maulana Malik Ibrahim. Retrieved from http://etheses.uin-malang.ac.id/71712/1/210701110010.pdf

Schaefer, T. J., Panda, P. K., & Wolford, R. W. (2023). *Dengue Fever*. Treasure Island (FL).

Sim, S., & Dimopoulos, G. (2010). Dengue Virus Inhibits

Immune Responses in Aedes aegypti Cells. *PLOS ONE*, *5*(5), e10678. https://doi.org/10.1371/journal.pone.0010678

Sukmawathi, N., Sawitri, A., & Megawati, I. (2024). Implementation of the Dengue Fever Surveillance System at the Klungkung District Health Office. *Journal La Medihealtico*, *5*(1), 1134–1144. https://doi.org/10.37899/journallamedihealtico.v5i5.1685

Sukohar, A. (2014). Demam Berdarah Dengue (DBD). *Medula*, *2*(2), 1–15. Retrieved from https://media.neliti.com/media/publications/152633-ID-demam-berdarah-dengue-dbd.pdf

Tatontos, E. Y., Fihiruddin, F., & Inayati, N. (2021). Accurate Detection of Viral Serotipe Dengue Hemorrhagic Fever Through Aedes Sp Mosquitos Using Reverse Transcriptase Polymerase Chain Reaction (RT-PCR). *Jurnal Riset Kesehatan*, *10*(2 SE-Articles), 148–152. https://doi.org/10.31983/jrk.v10i2.7706

Tatontos, E. Y., Getas, I. W., & Urip, U. (2022). Effectiveness of the Combination of Lethal Ovitrap Attractant of Local Organic Materials and Natural Larvicides in Dengue Hemorrhagic Fever Endemic Areas. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 2961–2968. https://doi.org/10.29303/jppipa.v8i6.2448

Trisnadewi, N. N. L., & Wande, I. N. (2016). Demam Berdarah Dengue (DBD), Pemeriksaan Serologi, Infeksi Primer, Infeksi Sekunder. *E-Jurnal Medika Udayana*, *5*(8). Retrieved from https://ojs.unud.ac.id/index.php/eum/article/view/22872

Urip, U., Rizki, K., Tatontos, E. Y., Gunarti, G., & Kholik, K. (2023). The Density of Aedes aegypti Larvae Density and the Incidence of Dengue Hemorrhagic Fever in the Pesingahan Environment, Pagesangan Barat Village, Mataram. *Info Kesehatan*, *21*(1). https://doi.org/10.31965/infokes.vol21iss1.986

Utama, I. M. S., Lukman, N., Sukmawati, D. D., Alisjahbana, B., Alam, A., Murniati, D., … Parwati, K. T. M. (2019). Dengue Viral Infection in Indonesia: Epidemiology, Diagnostic Challenges, and Mutations from an Observational Cohort Study. *PLOS Neglected Tropical Diseases*, *13*(10), e0007785. https://doi.org/10.1371/journal.pntd.0007785

Waggoner, J. J. (2016). Clinical Presentation in Nicaraguan with Zika Virus, Chikunguna Virus, and Dengue Virus. *Clinical Infectious Diseases*, *63*, 1584-1590. https://doi.org/10.1093/cid/ciw589

Wang, W. H., Lin, C. Y., Chang, K., Urbina, A. N., Assavalapsakul, W., Thitithanyanont, A., … Wang, S. F. (2019). A Clinical and Epidemiological Survey of the Largest Dengue Outbreak in Southern Taiwan in 2015. *International Journal of Infectious Diseases*, *88*, 88–99. https://doi.org/10.1016/j.ijid.2019.09.007

Wang, W. H., Urbina, A. N., Chang, M. R., Assavalapsakul, W., Lu, P. L., Chen, Y. H., & Wang, S. F. (2020). Dengue Hemorrhagic Fever – A Systemic Literature Review of Current Perspectives on Pathogenesis, Prevention and Control. *Journal of Microbiology, Immunology and Infection*, *53*(6), 963–978. https://doi.org/10.1016/j.jmii.2020.03.007

WHO. (2009). *DHF Guidelines for Diagnosis, Treatment, Prevention and Control*. WHO. https://doi.org/10.1176/pn.41.1.0029b

WHO. (2011). Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever. In *WHO Regional Publication SEARO*. https://doi.org/10.1017/CBO9781107415324.004

WHO. (2018). *Integrated Management Strategy for Dengue Prevention and Control in the Region of the Americas*. WHO.

WHO. (2023). *Dengue- Global situation*. Retrieved from https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON498

Wila, R. W., & Nusa, R. (2020). Gambaran Klinis dan Respon Imun Penderita Demam Berdarah Dengue di Rumah Sakit Kristen Lindi Mara Sumba Timur Selama Bulan Januari Sampai dengan Desember 2018. *Balaba: Jurnal Litbang Pengendalian Penyakit Bersumber Binatang Banjarnegara*, *16*(2), 209–216. https://doi.org/10.22435/blb.v16i2.2816

Yandika, A. (2022). Hubungan antara Tingkat Pendidikan dan Tingkat Pengetahuan Masyarakat Terhadap Kejadian Demam Berdarah. *Cerdika: Jurnal Ilmiah Indonesia*, *2*(10), 874–882. https://doi.org/10.59141/cerdika.v2i10.458

Yung, C. F., Lee, K. S., Thein, T. L., Tan, L. K., Gan, V. C., Wong, J. G. X., … Leo, Y. S. (2015). Dengue Serotype-Specific Differences in Clinical Manifestation, Laboratory Parameters and Risk of Severe Disease in Adults, Singapore. *American Journal of Tropical Medicine and Hygiene*, *92*(5), 999–1005. https://doi.org/10.4269/ajtmh.14-0628

Yuniar, V. T., Raharjo, M., Martini, M., & Nurjazuli, N. (2024). Hubungan Pengetahuan dengan Kejadian Demam Berdarah Dengue di Kota Lubuklinggau Sumatera Selatan. *Jurnal Kesehatan Lingkungan Indonesia*, *23*(2), 234-240. https://doi.org/10.14710/jkli.23.2.234-240