Risk Factor Analysis of Dengue Hemorrhagic Fever in Forest Area with Specific Purpose (KHDTK) belonging to Universitas Diponegoro

Henry Setyawan Susanto[1], *Mateus Sakundarno* Adi[1], *Dwi* Sutiningsih[1], *Muh.* Fauzi[1], *Martini* Martini[1*], and *Hussain* Ali[2]

[1]Department of Epidemiology and Tropical Disease, Faculty of Public Health, Universitas Diponegoro, Semarang, Central Java, Indonesia
[2]Entomology Section, Agricultural Research Institute, Tarnab, Peshawar, Pakistan

Abstract. Dengue fever (DHF) remains a public health challenge in Indonesia, particularly in forest areas where disease vectors like Aedes spp. mosquitoes pose risks. The Kawasan Hutan Dengan Tujuan Khusus (KHDTK) of Diponegoro University, including Kalongan and Mluweh Villages, has potential as a DHF vector habitat, making risk factor analysis crucial for dengue disease control. This study aimed to analyze the risk factors for DHF in Kalongan and Mluweh Villages. This cross-sectional study analyzed DHF risk factors among 200 respondents (150 in Kalongan and 50 in Mluweh). Data were collected through questionnaires, mosquito larvae inspection (PJN), and species identification. Bivariate analysis was used to examine the relationship between education and knowledge levels and attitudes toward DHF prevention. The larvae identification results showed that Aedes aegypti (53.3%), Aedes albopictus (45.3%), and Culex (1.3%) larvae were found in Kalongan Village. In Mluweh Village, Aedes aegypti (53.3%), Aedes albopictus (37.8%), and Culex (8.9%) larvae were found. Bivariate analysis showed a significant relationship between education level ($p = 0.024$) and knowledge level ($p = 0.001$) and attitudes toward DHF prevention. These findings provide insights into the risk factors for DHF in forested areas and support targeted vector control and community-based prevention strategies.

1 Introduction

In order to support the implementation of the Tri Dharma Perguruan Tinggi (Three Pillars of Higher Education) and the development of educational forests, Diponegoro University obtained the right to manage the Special Purpose Forest Area (KHDTK) in August 2020 from the Ministry of Environment and Forestry. This KHDTK is part of the Penggaron Forest, which was previously managed by Perum Perhutani, specifically by KPH Semarang Barat, and consists mostly of secondary forests and ecotourism sites. The establishment of the KHDTK was formalized through a Memorandum of Understanding (MoU) (No. 23/MOU/DIR/2020 and 4584/UN7.P/KS/2020) between Perum Perhutani and Diponegoro University, which serves as the basis for cooperation in education, research, and sustainable forest resource management [1].

The 99.65-hectare Wanadipa Research Forest of Diponegoro University is located adjacent to the Central Java Valley Nature Park, which is being developed as a world-class tourist destination. This proximity enhances the area's potential for integrated eco-edutourism

*Corresponding martini@live.undip.ac.id

development. The area is divided into functional blocks in accordance with the regulations of the Ministry of Environment and Forestry, including zones for research and education, agroforestry, edutourism, and special conservation. KHDTK Wanadipa serves as a forest research and education facility for the UNDIP academic community and as a center for ecotourism and sustainable business development, with management involving local communities to improve the quality of research, forest resource utilization, and community-based services [2,3].

KHDTK is located in Susukan Village, East Ungaran Subdistrict, Semarang Regency, directly bordering Kalongan and Mluweh Villages, which have the potential to affect social interactions and the health conditions of the surrounding community. Forest areas face environmental health challenges, including air pollution from forest fires, water quality affected by the surrounding environment, and exposure to disease vectors. Forests and their surroundings are the natural habitat of various vectors, such as Aedes mosquitoes. Larvae surveys indicate the presence of Aedes in potential mosquito breeding sites near settlements, increasing the risk of disease transmission in surrounding communities [4–6].

Changes in forest cover and land use conversion affect the microclimate—temperature, humidity, and rainfall—which impacts the population of Aedes aegypti, the main vector of dengue fever. Studies show that conversion of forests to intensive agriculture or built-up areas is often followed by an increase in dengue fever incidents within a year, while the expansion of community forests is associated with a decrease in cases [7,8].

Kalongan Community Health Center, a primary health facility in East Ungaran District, serves five villages: Kalongan, Kawengen, Susukan, Mluweh, and Kalikayen, covering an area of ±26.68 km² with a population of approximately 36,231[9]. Monitoring data shows an increasing trend in dengue fever cases between 2022 and 2024: 1 case in 2022, 2 cases in 2023, and a sharp increase to 16 cases in 2024 [10]. Although the absolute number is still low, this sharp increase calls for greater vigilance and effective vector control interventions.

Based on these conditions, this study aims to identify public health issues in the villages of Mluweh and Kalongan within the Diponegoro University KHDTK area, analyze the underlying risk factors, and design specific interventions based on the problem-solving cycle.

2 Methods

This study was conducted using a cross-sectional design to identify public health problems in Kalongan and Mluweh Villages, which are located within the KHDTK (Special Purpose Forest Area) of Diponegoro University. This study employed the Problem Solving Cycle approach, which consists of several stages.

a. Situation analysis based on secondary data and field observations,
b. Identification, analysis, and prioritization of public health problems using the Modified Criteria for Urgency Assessment (MCUA),
c. Identification and analysis of the root causes,
d. Prioritization of intervention alternatives and development of an action plan [11].

Through this process, dengue fever (DHF) was identified as a key health issue in the region.

The study population included residents of Kalongan and Mluweh Villages, both under the catchment area of the Kalongan Primary Health Center. Proportional stratified sampling was applied by dividing the population into two strata based on the village, with samples drawn proportionally according to population size: 151 respondents from Kalongan and 49 from Mluweh, totaling 200 respondents. Data collection methods included structured interviews using questionnaires, mosquito larvae inspections (PJN), and ovitrap placement to monitor the presence of Aedes spp. mosquitoes [12].

This study was approved by the Health Research Ethics Committee of the Faculty of Public Health, Universitas Diponegoro.

3 Results And Discussion

3.1 Larval Density Status and Breeding Site Distribution in Kalongan and Mluweh Villages

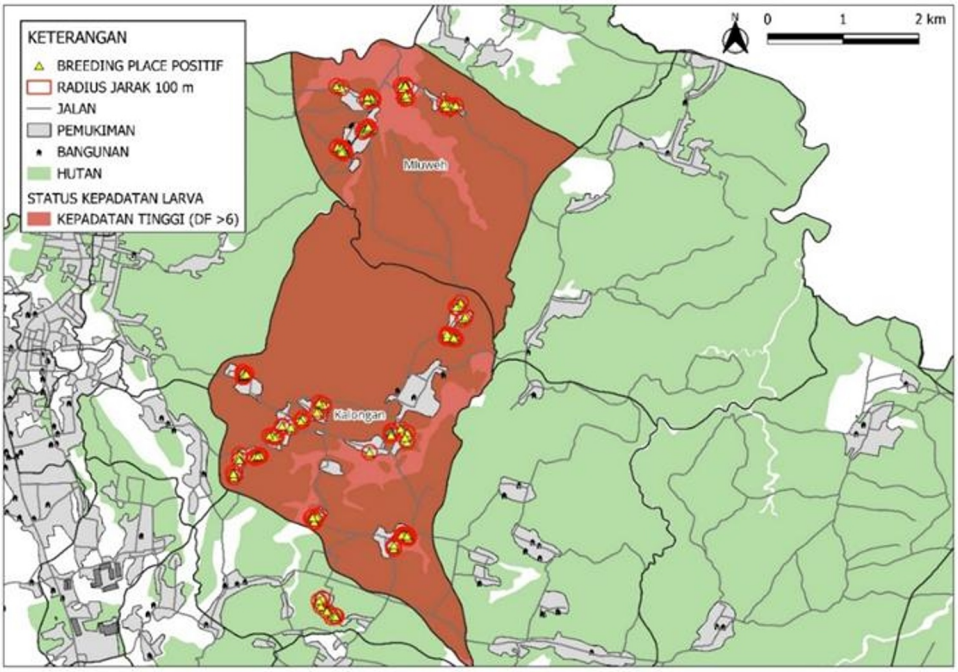

Fig. 1. Map of Larva Density Status and Presence of Breeding Sites in Kalongan Village and Mluweh Village

Larval density is commonly classified into three categories: low (DF = 1), moderate (DF = 2–5), and high (DF = 6–9) [13]. Spatial analysis indicated that both Kalongan and Mluweh Villages were situated within areas of high larval density (DF > 6). Elevated vector density is a recognized risk factor for dengue transmission, as a greater abundance of vectors is associated with an increased probability of human infection. This pattern is consistent with findings from previous studies, including research conducted in a hospital setting in Semarang (DF = 6; high category), in Sibolga (DF = 5; moderate category), and in Ternate City (DF = 8.7; high category) [1,4,9].

Larval surveys revealed 48 larva-positive breeding sites in Mluweh Village and 105 in Kalongan Village. All reported dengue cases in both villages were found within a 100-meter radius of larva-positive breeding sites, indicating a strong spatial association between breeding sites and disease incidence. Larval identification in Kalongan Village showed the presence of Aedes aegypti (53.3%), Aedes albopictus (45.3%), and Culex spp. (1.3%). In Mluweh Village, Aedes aegypti accounted for 53.3% and Aedes albopictus 37.8%, and Culex spp. 8.9% [2,7].

Aedes aegypti was slightly more dominant than *Aedes albopictus* in both the Kalongan and Mluweh areas. This aligns with the established role of *Ae. aegypti* is the primary vector of dengue transmission in urban and peri-urban areas, attributed to its endophilic (preferring to rest indoors) and endophagic (feeding indoors) behaviors [2,6,10]. Meanwhile, the

proportion of *Ae. The proportion of Ae. albopictus was* 45.3% in Kalongan and 37.8% in Mluweh, indicating its significant potential as a secondary vector for DENV. *Ae. albopictus* is more adaptable to semi-forest or peri-domestic environments with vegetation, exhibiting exophagic (feeding outdoors) and exophilic (resting outdoors) tendencies, thus necessitating vector control measures that also target outdoor areas [4,9,11]. Consistent with this, Hashim et al. found that *Ae. albopictus* preferred breeding sites located outdoors, specifically in the forested area of the Universiti Sains Malaysia campus in Penang, which was surrounded by student residences, faculty buildings, and offices [11]. Similarly, studies in Brazil have shown that *Ae. albopictus* can be found hundreds of meters into the forest from its edge, although its frequency and density decline with increasing distance from the forest boundary [12]. Although *Culex* spp. is not a recognized vector of dengue, its occurrence, albeit in small proportions, reflects environmental conditions conducive to the proliferation of multiple mosquito species. Such conditions may indirectly contribute to an increased burden of vector-borne diseases, including filariasis and Japanese encephalitis, in certain endemic regions [9,10,12].

Of the 150 water-holding containers examined in Mluweh, 48 were positive for larvae, whereas in Kalongan, 105 out of 450 containers were larva-positive. These findings underscore the high vector breeding potential in both villages, particularly in Kalongan village [1–3].

3.2 Association Between Education Level and Attitudes Toward Dengue Prevention and Control

Table 1. Most respondents with poor attitudes toward dengue prevention and control had a medium level of education. Among respondents with poor attitudes, 97 (77.0%) had a medium level of education, 49 (94.2%) had a low level of education, and 18 (81.8%) had a high level of education. Similarly, among respondents with positive attitudes, most had a medium level of education. Of the respondents with positive attitudes toward dengue prevention and control, 29 (23.0%) had a medium level of education, 4 (18.2%) had a high level of education, and 3 (5.8%) had a low level of education.

Table 1. Association Between Education Level and Attitudes Toward Dengue Prevention and Control

Educational Level	**Attitude**		**Total**	**p-value**	**OR (95% CI)**
	Negative	**Positive**			
	f (%)	**f (%)**			
Low Education	49 (94.2)	3 (5.8)	52 (100)	0,042	Ref
Medium Education	97 (77.0)	29 (23.0)	126 (100)		0.276 (0.056–1.353)
Higher Education	18 (81.8)	4 (1.,2)	22 (100)		1.345 (0.422–4.292)

Based on binary logistic regression analysis, education level was found to be significantly associated with attitude toward dengue prevention and control (Wald test, p = 0.042). Compared with respondents with low education (reference), those with medium education had 0.28 times the odds of having a positive attitude (OR = 0.276; 95% CI: 0.056–1.353), while respondents with higher education had 1.35 times the odds (OR = 1.345; 95% CI: 0.422–4.292). Although the overall relationship was significant, differences between individual education categories were not statistically significant.

A higher level of education enables individuals to access and comprehend health-related information more easily, making them more likely to adopt a proactive attitude toward disease prevention and control. In contrast, individuals with lower educational attainment may have a limited understanding of the importance of preventive actions, which can affect their attitudes toward dengue control efforts [13,14].

A study conducted in Aceh supports this finding, suggesting that while education level may not directly determine attitude, other factors such as occupation, socioeconomic status, and personal experience with dengue fever may play crucial roles in shaping individual attitudes toward dengue prevention and control [6]. A similar study conducted at Puskesmas Baros reported a significant association between education level and dengue prevention practices [12]. However, this finding contrasts with that of Desya, who reported no significant relationship between education level and attitudes toward dengue prevention. Desya argued that a higher level of education does not necessarily translate into better attitudes compared to those with lower education levels [15].

3.3 Association Between Knowledge Level and Attitudes Toward Dengue Prevention and Control

Table 2 shows that respondents with poor attitudes toward dengue prevention and control mostly had low levels of knowledge, with 94 respondents (91.3%) compared to 70 respondents (72.2%) who had good knowledge of dengue fever. Meanwhile, among respondents with positive attitudes, the majority had good knowledge, with 27 respondents (27.8%) compared to only 9 respondents (8.7%) with poor knowledge.

Table 2. Association Between Knowledge Level and Attitudes Toward Dengue Prevention and Control

Knowledge Level	**Attitude**		**Total**	**p-value**	**OR (95% CI)**
	Negative	**Positive**			
	f (%)	**f (%)**			
Poor Knowledge	94 (91,3)	9 (8,7)	103 (100)	0,001	4.029 (1.783–9.105)
Good Knowledge	70 (72,2)	27 (27,8)	97 (100)		

Based on a bivariate analysis using the chi-square test, the p-value obtained was 0.001 ($p < 0.05$), indicating a significant association between the level of knowledge about dengue and attitudes toward its prevention and control. These findings are consistent with previous studies, suggesting that adequate knowledge of dengue plays an important role in shaping positive attitudes toward disease prevention and control efforts [6,13,14]. Darmawan (2009)

also found a significant relationship between community knowledge and attitudes in preventing dengue. The study concluded that the higher a person's knowledge of dengue, the more likely they are to have a positive attitude toward prevention measures [13]. Other studies have reported similar findings, indicating a significant association between the level of knowledge and family attitudes toward dengue prevention in Menteng Subdistrict, Palangka Raya City [12]. Ruminem et al. further emphasized that individual autonomy in taking preventive actions is more likely to be consistent and sustainable when grounded in strong knowledge. Consequently, individuals with higher levels of knowledge tend to exhibit more positive attitudes, whereas limited knowledge may be associated with less supportive attitudes [14,15].

3.4 Multivariate Analysis of the Association Between Education Level, Knowledge, and Attitudes Toward Dengue Prevention and Control

Table 3. Multivariate Analysis of the Association Between Education Level, Knowledge, and Attitudes Toward Dengue Prevention and Control

Variable	B	p-value	Exp(B)	(95% CI)
Education Level				
Low Education			1.00	
Medium Education	1.537	0.017	4.65	1.32 – 16.35
Higher Education	0.855	0.302	2.35	0.46 – 11.93
Knowledge Level				
Poor Knowledge			1.00	
Good Knowledge	1.408	0.001	4.09	1.76 – 9.47

Nagelkerke $R^2 = 0.163$ Omnibus Test: $\chi^2 = 20.942$; df = 3; $p < 0.001$

Multivariate analysis using binary logistic regression (Enter method) was performed to determine the independent effect of education level and knowledge level on attitudes toward dengue prevention and control. The overall model was statistically significant (Omnibus Test: $\chi^2 = 20.942$; df = 3; $p < 0.001$) with a Nagelkerke R^2 value of 0.163. After adjusting for education level, respondents with good knowledge were 4.1 times more likely to have a good attitude compared to those with poor knowledge (OR = 4.09; 95% CI: 1.76–9.47; p = 0.001). Meanwhile, respondents with medium education had 4.6 times higher odds of having a good attitude compared to those with low education (OR = 4.65; 95% CI: 1.32–16.35; p = 0.017), whereas higher education was not significantly associated with attitude (OR = 2.35; 95% CI: 0.46–11.93; p = 0.302), as shown in Table 3.

4 Conclusion

The study indicates that dengue fever is an emerging health concern in the KHDTK area. Although the number of DHF cases in Kalongan Village is not classified as high, an increase from 2023 to 2024 suggests a potential rise in the future.

The presence of Aedes aegypti, Aedes albopictus, and Culex larvae further highlights the need for increased attention and preventive measures to reduce the risk of dengue transmission in this area.

Furthermore, the study found a significant association between education level and knowledge level with attitudes toward dengue prevention and control. Respondents with good knowledge were more likely to have a positive attitude, and those with medium education had higher odds of exhibiting good attitudes compared to those with low education. Multivariate logistic regression confirmed these independent effects, indicating that both education and knowledge play a key role in shaping community attitudes toward dengue prevention, even after controlling for each other.

References

1. Sinaga, M. & Simanungkalit, C. Aedes aegypti Mosquito Density in Angin Nauli Village, North Sibolga District (In Indonesian). *J. Ilm. Keperawatan Imelda* **7,** (2021).
2. Widjajanti, W. Aedes Sp. Larva Density: Vector of Dengue Hemorrhagic Fever Transmission in Three Regencies of Central Kalimantan Province (In Indonesian). *Bul. Penelit. Kesehat.* **48,** (2020).
3. Kusuma, T. C., Hadi, M. & Hidayat, J. W. Butterfly Community Structure (Lepidoptera: Rhopalocera) in Wanadipa Undip Forest Research Station, Semarang Regency, Central Java (In Indonesian). *Bioma Berk. Ilm. Biol.* **24,** (2022).
4. Harapan, H. *et al.* Knowledge, Attitude, and Practice Regarding Dengue Virus Infection among Inhabitants of Aceh, Indonesia: A Cross-sectional Study. *BMC Infect. Dis.* **18,** (2018).
5. Setiyaningsih, R. *et al.* Malaria Vector Bioecology in Various Ecosystems in Donggala Regency, Central Sulawesi Province (In Indonesian). *Vektora J. Vektor dan Reserv. Penyakit* **11,** (2019).
6. Tomia, A., Hadi, U. K., Soviana, S. & Retnani, E. B. Maya Index and Larval Density of Aedes aegypti in Ternate City, North Maluku (In Indonesian). *BALABA J. LITBANG Pengendali. PENYAKIT BERSUMBER BINATANG BANJARNEGARA* (2019). doi:10.22435/blb.v15i2.1936
7. Pereira dos Santos, T. *et al.* Potential of Aedes albopictus as a Bridge Vector For Enzootic Pathogens at The Urban-forest Interface in Brazil. *Emerg. Microbes Infect.* **7,** (2018).
8. Yuanita, Y. N., Setiani, O. & Wahyuningsih, N. E. Spatial Analysis of Breeding Place and Larva Density Existence with DHF (Dengue Hemorrhagic Fever) Incidence Rate in Pringsewu District, Indonesia. *Int. J. English Lit. Soc. Sci.* **4,** (2019).
9. Putri, R. & Naftassa, Z. The Relationship between Education Level and Community Knowledge with Dengue Fever Prevention Behavior in Kemiri Village, Jayakerta District, Karawang in 2016 (In Indonesian). *MAGNA MEDICA Berk. Ilm. Kedokt. dan Kesehat.* **1,** (2018).

10. Mulyadi, E. & Dewi, S. K. The Relationship between Knowledge and Education Level on Dengue Fever Prevention in the Baros Community Health Center Working Area (In Indonesian). *J. Public Heal. Innov.* **3,** (2023).
11. Carolina, P. The Relationship Between Knowledge and Family Attitudes in the Prevention of Dengue Hemorrhagic Fever (DHF) (In Indonesian). *J. Kesehat. Saelmakers PERDANA* **7,** 97–103 (2024).
12. Ruminem, R., Sari, R. P. & Sapariyah, S. The Relationship between Knowledge and Student Attitudes in the Prevention of Dengue Hemorrhagic Fever (DHF) at SD Negeri No. 015, Samarinda Ulu District (In Indonesian). *J. Kesehat. Pasak Bumi Kalimantan* **1,** (2019).
13. Funna, D. A., Asniar, A. & Alam, T. S. The Relationship between Mothers' Educational Level and Knowledge, Attitudes, and Practices for the Prevention of Dengue Hemorrhagic Fever in Banda Aceh City (In Indonesian). *Holist. Nurs. Heal. Sci.* **7,** (2024).
14. Arisandi Mustika, A., Bakri, S. & Wulan S. R. Wardani, D. Land Use Change in Lampung Province and Its Impact on Dengue Fever Incidence (In Indonesian). *J. Sylva Lestari* **4,** (2016).
15. Ummi, K., Wahyuningsih, N. E. & Hapsari. Aedes Sp. Mosquito Larva Density (House Index) as an Indicator for Dengue Fever Vector Surveillance in Semarang City (In Indonesian). *J. Kesehat. Masy.* **5,** (2017).