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Host, Agent, and Environmental Risk Factors Associated with Dengue Hemorrhagic Fever Incidence and Control Measures in the Post-COVID-19 Era at Lambunga Public Health Center, East Flores District

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ABSTRACT

The Weekly Outbreak Report (W2) of Dengue Hemorrhagic Fever (DHF) from the Flores Timur District Health Office indicates a markedly fluctuating increase in DHF cases over the past three years, with a notably high mortality rate in 2020 and 2021. The number of cases has continued to rise monthly, reaching a total of 11 by September 2021. The index case involved a fatality at the Lambunga Health Center, which prompted an Epidemiological Investigation (PE) conducted jointly by the District Health Office and the health center. The case resulted in one death, corresponding to a Case Fatality Rate (CFR) of 9.09%. This study aims to analyze the contributing factors associated with DHF incidence in the service area of the Lambunga Health Center, Flores Timur Regency. This study employed a mixed-methods approach, integrating both quantitative and qualitative research methodologies. The qualitative component utilized an observational analytical design, specifically a case-control study model. The findings indicate that occupational status, the presence of mosquito larvae, the use of mosquito nets, housing density, and substandard housing conditions collectively influenced 99% of DHF incidence in the Lambunga Health Center area. Among these, the most influential factor was the habit of using mosquito nets, which exhibited the highest odds ratio (OR) of 21.154.

Keyword: *Host, Agent, Environmental Risk Factors, DHF.*

1. INTRODUCTION

The highest number of dengue cases was recorded in 2023, affecting more than 80 countries across WHO regions. Since early 2023, continued transmission combined with an unexpected surge in cases has led to a historic high of over 6.5 million reported cases and more than 7,300 dengue-related deaths (1).

The first confirmed dengue epidemics were documented in the Philippines during 1953–1954 and in Thailand in 1958, after which the disease spread across several member states in the South-East Asia and Western Pacific Regions (2). Over the past decade, the average number of dengue cases reported to the WHO has increased rapidly. Between 2000 and 2008, the mean number of dengue/dengue hemorrhagic fever (DF/DHF) cases was approximately 1,656,870—nearly three and a half times higher than the average of 479,848 cases recorded during 1990–1999. In 2008, 69 countries from the WHO regions of South-East Asia, the Western Pacific, and the Americas reported dengue fever cases (2).

Environmental and climatic changes are closely intertwined with public health outcomes. Global phenomena such as rising temperatures influence environmental components that serve as vectors or mediums for disease transmission. Elements of the environment directly relevant to human health include air quality, water resources, agricultural and processed food products, disease vectors such as insects, and human activity itself. These components interact with human populations and present potential risks for disease emergence, transmission, and spread (3).

The incidence of dengue fever in Indonesia has shown year-to-year fluctuations. In 2022, a total of 143,266 cases were

reported, resulting in 1,237 deaths. By 2023, the number of cases had decreased to 114,720, with 894 recorded fatalities. The incidence rate (IR) declined from 52.12 per 100,000 population in 2022 to 41.36 per 100,000 in 2023, while the case fatality rate (CFR) dropped from 0.86% to 0.78% over the same period. Despite these improvements, national targets for dengue control have not yet been met.

According to the Ministry of Health's Strategic Plan for 2020–2024, the objective of dengue control is to reduce the public health burden by achieving incidence rates of ≤10 per 100,000 population in 80% of districts and cities by 2022, 85% by 2023, and 95% by 2024. Additionally, the plan aims to reduce the national CFR from 0.80% in 2020 to 0% by 2030 (WHO, 2020). However, in 2022, the national dengue IR remained at 52 per 100,000 population, and only 16% of districts and cities met the target IR of ≤10 per 100,000 (4).

Conversely, the incidence of Dengue Hemorrhagic Fever (DHF) in East Nusa Tenggara (NTT) Province has fluctuated between 2020 and 2023. In 2020, a total of 5,968 DHF cases were reported, resulting in 59 deaths—equivalent to an incidence rate of 109.4 per 100,000 population and a case fatality rate (CFR) of 1.0%. In 2021, the number of cases declined significantly to 2,543 with 14 deaths (an incidence rate of 46.6 per 100,000 and a CFR of 0.6%). However, in 2022, cases rose again to 3,096 with 25 fatalities (54.67 per 100,000 and a CFR of 0.81%) (5). By 2023, the number of reported cases had decreased to 2,653, with 15 deaths, corresponding to an incidence rate of 46.25 per 100,000 and a CFR of 0.57% (6).

According to the W2 Weekly Outbreak Report on Dengue Hemorrhagic Fever (DHF) from the East Flores District Health Office, DHF cases over the past three years have shown significant variability, with particularly high mortality rates recorded in 2020 and 2021. By September 2021, a total of 11 cases had been reported, with a notable monthly increase in incidence. The initial case involved a fatality at the Lambunga Health Center, which subsequently prompted an epidemiological investigation (PE) conducted by both the District Health Office and the Health Center. This single death represented a Case Fatality Rate (CFR) of 9.09%.

DHF is now considered endemic across Indonesia, including East Flores in East Nusa Tenggara. Multiple factors contribute to its transmission, which can be analyzed using the Epidemiological Triad framework. The host factors include age, gender, level of education, occupation, knowledge, and personal habits—such as the use of mosquito nets during sleep. The agent factor is the presence of Aedes aegypti mosquito larvae, the primary vector for dengue virus transmission. The environmental factors encompass housing density and the physical condition of dwellings. A study by Fitriani, Harokan and Zaman, (2024) identified key determinants in dengue prevention efforts, including age, level of knowledge, behavior related to the draining of water storage containers, use of mosquito nets, and the active role of healthcare workers (7). Similarly, research by Nurdin and Zakiyuddin, (2018) demonstrated that the presence of Aedes aegypti mosquitoes and poor environmental sanitation significantly increase the risk of DHF incidence (8).

2. METHODS

Type and Research Design

This study employs a mixed-methods research design, which integrates both quantitative and qualitative approaches (9). The quantitative component utilizes an analytical observational method with a case-control design, aimed at identifying associations between specific exposures and the occurrence of a particular disease. In this design, individuals diagnosed with the disease constitute the case group, while those without the disease serve as the control group (10).

The qualitative component is conducted through case study analysis, providing deeper contextual insights. The mixed-methods approach is implemented sequentially: quantitative data collection and analysis are conducted in the initial phase, followed by qualitative data collection and analysis in the subsequent phase. This sequential design allows the qualitative findings to enrich and validate the quantitative results obtained in the first stage.

Population and Sample

The population refers to the entire set of research subjects (11). Sugiyono (2016) further elaborates that a population is a generalization comprising objects or subjects with specific qualities and characteristics identified by researchers for study, from which conclusions are drawn (12). In this study, the population consisted of all reported cases of Dengue Hemorrhagic Fever (DHF) within the service areas of the Lambunga and Waiwerang Health Centers, totaling 162 cases.

The sample represents a subset of the population, selected based on certain characteristics (12). This study sampled 110 DHF cases from the Lambunga Health Center’s service area, consisting of 55 members in the control group and 55 in the case group.

The variables include both independent and dependent variables in this research. Among the independent variables are demographic factors (age, gender, education, occupation), knowledge levels, behavioral factors (use of mosquito nets during sleep), agent-related factors (presence of mosquito larvae), and environmental factors (housing density and housing conditions). The dependent variable is the incidence of DHF.

Data collection was conducted using a structured questionnaire. The data were processed and analyzed using a computer-based statistical software package. The analysis involved univariate analysis, bivariate analysis using the Chi-Square test, and multivariate analysis using logistic regression. Findings are presented in both tabular and narrative formats to enhance clarity and reader comprehension.

3. RESULTS

Univariate analysis

Table 1: Univariate Analysis of Respondent Characteristics in the Lambunga Health Center Service Area

Characteristics	Samples (n=110)	Percentage (%)
Age (Years)		
>56	13	11,8
15-56	97	88,2
Gender		
Male	50	45,5
Female	60	55,5
Occupation		
Unemployed	31	28,2
Employed/Student	79	71,8
Knowledge Level		
Poor	47	42,7
Good	63	52,3
Presence of Mosquito Larvae		
Present	69	62,7
Absent	41	37,3
Habit of Using Mosquito Nets		
Does Not Use	70	63,6
Uses	40	36,4
Housing Density		
High Density	74	67,3
Low Density	36	32,7
Housing Condition		
Non-permanent	47	42,7
Permanent	63	52,3

Table 1 presents the univariate analysis of respondents in the Lambunga Health Center service area. The majority of respondents were within the 15–56 age group, totaling 97 individuals (88.2%), while only 13 respondents (11.8%) were aged over 56. Female respondents constituted a higher proportion, with 60 individuals (54.5%), compared to 50 males (45.5%). Regarding employment status, 79 respondents (71.8%) were either employed or attending school, while 31 (28.2%) were unemployed. In terms of knowledge level, 63 respondents (57.3%) demonstrated good knowledge, whereas 47 (42.7%) had limited knowledge. Larval presence was identified in 69 households (62.7%), while 41 households (37.3%) reported no

presence of larvae. Most respondents, 70 individuals (63.6%), did not use mosquito nets while sleeping, in contrast to 40 respondents (36.4%) who reported consistent use of mosquito nets. Housing density was high among 74 respondents (67.3%), while 36 (32.7%) resided in low-density housing. Lastly, 63 respondents (57.3%) lived in permanent houses, compared to 47 (42.7%) who lived in non-permanent structures.

Bivariate analysis

Table 2: Analysis of the Relationship Between Independent and Dependent Variables

Variables	DHF Incidence				Total		p value	OR	95% CI
	Case		Control						
	n	%	n	%	n	%			
Age (Years)									
>56	4	7,3	9	16,4	13	11,8	0,237	0,41	0,116-1,390
15-56	51	92,7	46	83,6	97	88,2			
Gender									
Male	26	47,3	24	43,6	50	45,5	0,848	1,158	0,546-2,454
Female	29	52,7	31	56,4	60	54,5			
Education Level									
Low	13	23,6	24	43,6	36	33,6	*0,044*	0,400	0,176-0,907
High	42	76,4	31	56,4	73	66,4			
Occupation									
Unemployed	5	9,1	26	47,3	31	28,2	*0,000*	0,112	0,039-0,322
Employed	50	90,9	29	52,7	79	71,8			
Knowledge Level									
Poor	28	50,9	19	34,5	47	42,7	0,123	1,965	0,912-4,231
Good	27	49,1	36	65,5	63	57,3			
Presence of Mosquito Larvae									
Present	48	87,3	21	38,2	69	62,7	*0,000*	11,102	4,244-29,042
Absent	7	12,7	34	61,8	41	37,3			
Habit of Using Mosquito Nets									
Does Not Use	49	89,1	21	38,2	70	63,6	*0,000*	13,222	4,829-36.203
Uses	6	10,9	34	61,8	40	36,4			
Housing Density									
High Density	48	87,3	26	47,3	74	67,3	*0,000*	7,648	2,948-19,844
Low Density	7	12,7	29	52,7	36	32,7			
Housing Condition									
Non-permanent	29	52,7	18	32,7	47	42,7	0,054	2,293	1,058-4,966
Permanent	26	47,3	37	67,3	63	57,3			

Table 2 above illustrates that, among the 55 case respondents, 51 (92.7%) were aged 15-56 years, while 4 (7.3%) were over 56 years of age. In contrast, among the control group, 46 respondents (83.6%) were aged 15-56 years, and 9 (16.4%) were over 56 years. The statistical analysis between age and the incidence of Dengue Hemorrhagic Fever (DHF) yielded a probability value (p) of 0.237, indicating no significant relationship between age and the occurrence of DHF.

The data also reveal that, of the 55 case respondents, 29 (52.7%) were female, and 26 (47.3%) were male, while among the control group, 31 (56.4%) were female, and 24 (43.6%) were male. The statistical test returned a probability value (p) of 0.848, suggesting that gender is not significantly associated with the incidence of DHF.

Regarding education, among the 55 case respondents, the majority were highly educated, with 42 respondents (76.4%) having higher education and 13 respondents (23.6%) possessing lower education. Among the 55 control respondents, 31 (56.4%) had higher education, while 24 (43.6%) had lower education. The statistical analysis produced a probability value (p) of 0.044, with an Odds Ratio (OR) of 0.400 (95% CI; 0.176-0.907). This suggests that individuals with lower education have a 0.400 times the likelihood of contracting DHF contrasted to those with higher education. Statistically, education appears to have an influence on the incidence of DHF, making it a significant candidate for inclusion in multivariable analysis.

In the case group, the majority of respondents, 50 (90.9%), were employed or attending school, while 5 (9.1%) were not working. In contrast, among the 55 control respondents, 29 (52.7%) were employed or attending school, and 26 (47.3%) were not working. The statistical test revealed a probability value (p) of 0.000, with an Odds Ratio (OR) of 0.112 (95% CI; 0.039-0.322), indicating that individuals who are employed or attending school have a 0.112 times more probable to get the dengue virus than individuals that are not employed. Statistically, employment and education appear to have a significant influence and meet the criteria for inclusion in multivariable analysis.

Among the 55 case respondents, 28 (50.9%) had poor knowledge, while 27 (49.1%) had good knowledge. Conversely, in the control group, the majority, 36 respondents (65.5%), had good knowledge, while 19 (34.5%) had poor knowledge. The statistical test yielded a probability value (p) of 0.123, suggesting that there is no significant relationship between knowledge level and the incidence of DHF.

Among the 55 case respondents, the majority, 48 individuals (87.3%), reported the presence of mosquito larvae, while 7 respondents (12.7%) indicated the absence of larvae. In contrast, among the 55 control respondents, 34 (61.8%) reported no larvae, and 21 (38.2%) observed larvae. The statistical analysis revealed a probability value (p) of 0.000, with an Odds Ratio (OR) of 11.102 (95% CI; 4.244-29.042), indicating that the presence of mosquito larvae is associated with an 11.102 times greater risk of dengue fever compared to those without larvae. Statistically, the presence of larvae significantly influences the dengue fever's spread and meets the criteria for inclusion in multivariable analysis.

In the case group, 49 respondents (89.1%) did not use mosquito nets, while 6 respondents (10.9%) reported using them. Conversely, among the 55 control respondents, 34 (61.8%) used mosquito nets, and 21 (38.2%) did not. The statistical test resulted in a probability value (p) of 0.000, with an Odds Ratio (OR) of 13.222 (95% CI; 4.829-36.203), suggesting that the individuals who answered neglected to utilize mosquito nets faced a 13.222 times greater risk of contracting dengue fever compared to those who used mosquito nets. Statistically, the use of mosquito nets significantly influences the incidence of dengue fever and qualifies as a significant factor for multivariable analysis.

Among the 55 case respondents, 48 individuals (87.3%) resided in dense housing, while 7 respondents (12.7%) lived in non-dense housing. In contrast, among the 55 control respondents, 29 (52.7%) lived in non-dense housing, and 26 (47.3%) resided in dense housing. The statistical analysis revealed a probability value (p) of 0.000, with an Odds Ratio (OR) of 7.648 (95% CI; 2.948-19.844), indicating that individuals living in dense housing are at 7.648 times greater risk of contracting dengue fever compared to those in non-dense housing. Statistically, housing density appears to be a significant factor and meets the criteria for inclusion in multivariable analysis.

Among the 55 case respondents, 29 (52.7%) lived in non-permanent houses, while 26 (47.3%) resided in permanent houses. In contrast, among the 55 control respondents, 37 (67.3%) lived in permanent houses, and 18 (32.7%) lived in non-permanent houses. The statistical test yielded a probability value (p) of 0.054, suggesting that there is no significant relationship between housing conditions and the incidence of DHF.

Multivariate analysis

Table 3: Multivariate Logistic Regression Analysis

							95% C.I. for EXP(B)	
	B	S.E	Wald	df	Sig.	Exp(B)	Lower	Upper
Education Level	-0,887	0,696	1,621	1	0,203	0,412	0,105	1,613

Occupation	-1,962	0,775	6,409	1	0,011	0,141	0,031	0,642
Knowledge Level	0,897	0,657	1,865	1	0,172	2,453	0,667	8,891
Presence of Mosquito Larvae	2,349	0,736	10,201	1	0,001	10,478	2,478	44,297
Habit of Using Mosquito Nets	2,982	0,721	17,109	1	0,000	19,734	4,803	81,085
Housing Density	1,712	0,698	6,026	1	0,014	5,542	1,412	21,747
Housing Condition	1,344	0,648	4,308	1	0,038	3,834	1,078	13,641
Constant	-1,589	1,028	2,386	1	0,122	0,204		

Furthermore, the final multivariate analysis model indicates that the variables have a p-value greater than 0.05. As shown in Table 3**,** both education and knowledge exhibit p-values greater than 0.05, and therefore, cannot be included in the final model of the subsequent multivariate analysis.

Table 4: Final Multivariate Analysis Modeling

Variables	B	*P Value*	OR	95%CI for EXP (B)
Occupation	-1,797	0,014	0,166	0,031-0,642
Presence of Mosquito Larvae	2,532	0,000	12,576	3,157-50,098
Habit of Using Mosquito Nets	3,052	0,000	21,154	5,179-86,416
Housing Density	1,461	0,028	4,309	1,173-15,835
Housing Condition	1,325	0,039	3,764	1,068-13,265

The final results of the multivariate analysis modeling demonstrate a significant relationship when the variables are analyzed collectively, including employment status, the presence of mosquito larvae, the habit of using mosquito nets, housing density, and house conditions. The strength of these relationships, ranked from the most to the least significant, is as follows: the habit of using mosquito nets (OR = 21.154), the presence of mosquito larvae (OR = 12.576), housing density (OR = 4.309), house conditions (OR = 3.764), and employment (OR = 0.166). Among these five determinant factors, the most dominant variable influencing the number of dengue disease is the habit of using mosquito nets, with the highest odds ratio (OR) of 21.154. Consequently, individuals who exhibit the following characteristics—unemployed, with mosquito larvae present, not using mosquito nets, residing in dense housing, and living in non-permanent houses—have a 99% likelihood of contracting dengue fever.

4. DISCUSSION

Age Factors in Dengue Fever Incidence

Findings from the present study revealed that the majority of DHF patients at the Lambunga Health Center were aged between 15 and 56 years, accounting for 88.2% of the cases. The Chi-square test yielded a p-value of 0.237, which is greater than the threshold of 0.05. This indicates that there is no statistically significant association between age and the incidence of DHF at the Lambunga Health Center. These findings are inconsistent with those of Sholihah, Weraman and Ratu, (2020), who reported a significant correlation between age and DHF incidence (13). Their study found that individuals aged 25–70 years were 25.020 times more likely to contract DHF than those aged 0–25 years. Similarly, a study by Umaya et al. (2012) also reported a significant association between age and DHF incidence, suggesting that age influences susceptibility to DHF (14). In contrast, the current study posits that age is not a determining factor in DHF incidence, as the disease can affect both children and adults. All age groups remain vulnerable to DHF in the absence of effective preventive measures, highlighting the importance of proactive strategies at both the individual and family levels.

Gender Factors in Dengue Fever Incidence

To date, there is no conclusive evidence linking susceptibility to dengue fever with gender differences. In the Philippines, for instance, the male-to-female ratio among dengue patients was reported as 1:1. Similarly, data from Thailand indicated no disparity in vulnerability to dengue fever between males and females (15). Nationally in Indonesia, no significant difference

has been observed in the incidence of dengue fever between boys and girls. As of now, no definitive explanation has emerged to account for any gender-based variation in DHF cases.

In the present study, gender distribution among DHF patients at the Lambunga Health Center showed that 54.5% of respondents were female. However, a Chi-square test revealed a p-value of 0.848, which exceeds the threshold of 0.05, indicating no statistically significant association between gender and the incidence of dengue fever at this health center. These findings are consistent with previous research, also found no significant relationship between gender and DHF incidence (p-value = 1.000) (16). A similar conclusion was reached in a study by Avidsyah, Asrina and Fairus Prihatin Idr, (2024), who reported no significant correlation between gender and the risk of DHF (17).

According to the researchers, the lack of a relationship between gender and DHF incidence can be attributed to the fact that both males and females share similar patterns of daily activity and environmental exposure. The Aedes aegypti mosquito, the primary vector of dengue fever, does not exhibit a preference for biting either gender. Thus, both men and women have an equal likelihood of being bitten and infected, reinforcing the conclusion that gender does not influence the risk of contracting DHF.

Educational Factors in Dengue Fever Incidence

In this study, education refers to the level of formal education completed by the respondents. Educational attainment plays a crucial role in shaping individuals' perspectives, behaviors, and their ability to engage in effective strategies for the prevention and eradication of dengue fever. Since education is closely linked to knowledge acquisition, it directly influences the public's understanding of dengue fever prevention and control, thereby impacting community health behaviors and reducing susceptibility to the disease.

The study found that the majority of respondents diagnosed with dengue fever at the Lambunga Health Center had attained a higher level of education, accounting for 66.4% of cases. Statistical analysis using the Chi-square test yielded a p-value of 0.044 at the Lambunga Health Center and 0.039 at the Waiwerang Health Center. As both values are less than 0.05, the results indicate a statistically significant relationship between education level and the incidence of dengue fever in both health centers. The odds ratio (OR) for the education variable at the Lambunga Health Center was 0.400, suggesting that individuals with lower educational attainment are several times more likely to get dengue fever than those with higher education levels. This implies that a higher level of education may serve as a protective factor by promoting awareness and preventive practices. These results are consistent with a research at the Baros Health Center, which demonstrated a correlation between higher education and improved dengue prevention behaviors (18). Similarly, research by Ningrum *et al.*, (2024) found that individuals with lower educational backgrounds were three times more likely to engage in inadequate dengue prevention practices (19).

According to the researchers, the association between education and dengue incidence is attributable to the fact that individuals with higher education levels generally possess broader knowledge and awareness regarding the disease and its prevention. However, this correlation is not absolute—greater knowledge does not necessarily translate into practical action. Conversely, individuals with lower educational levels may lack understanding or exhibit apathy toward dengue prevention, thereby placing themselves at a heightened risk of infection.

Occupational Factors in Dengue Fever Incidence

Individual mobility is a key factor influencing the risk of contracting Dengue Hemorrhagic Fever (DHF). This mobility is often closely associated with daily occupational activities, which in turn relate to household income and purchasing power. Increased mobility typically correlates with greater exposure to environments where dengue vectors are present, thus elevating the risk of infection. Moreover, individuals with higher income levels are generally better equipped to access prevention tools and healthcare services, thereby reducing their vulnerability to disease. In this study, "work" is defined as routine activities—such as employment or education—that require individuals to leave their homes. The results revealed that a majority of respondents diagnosed with DHF were either working or attending school, accounting for 71.8% at the Lambunga Health Center and 57.1% at the Waiwerang Health Center. Statistical analysis using the Chi-square test produced a p-value of 0.000 (<0.005) at the Lambunga Health Center, indicating a statistically significant relationship between occupational status and DHF incidence. The Odds Ratio (OR) for the work variable was 0.112, suggesting that individuals who work or attend school are significantly less at risk (OR = 0.112) compared to those who do not. However, this result may be counterintuitive and should be interpreted with consideration of contextual factors.

Occupational activities, particularly those requiring individuals to be outdoors during the daytime—when the *Aedes aegypti* mosquito is most active—can increase the risk of exposure to DHF vectors. Supporting this, a study conducted in Taiwan found that travelers were at increased risk of dengue virus infection while spending time outdoors (20), emphasizing the heightened risk of transmission in open environments. Findings from this study align with earlier research by Utami (2012), which demonstrated a significant relationship between work and DHF incidence (p-value = 0.011; OR = 2.788), indicating that individuals engaged in work were 2.788 times more likely to contract DHF than non-working individuals (21). Similarly,

Ramadani *et al.*, (2023) also reported a correlation between various occupations and DHF risk. These studies are consistent with the current findings at the Lambunga Health Center (22).

Conversely, a study by Umaya (2012) reported no significant relationship between occupational status and DHF incidence (p-value = 0.216) (14), a finding that corresponds with the results observed at the Waiwerang Health Center. According to the researchers, the absence of a relationship at Waiwerang may be attributed to the nature of respondents' occupations, which are predominantly in agriculture or small-scale entrepreneurship—activities typically conducted in environments similar to their homes. Additionally, the widespread distribution of dengue vectors across both indoor and outdoor settings may result in a similar level of risk regardless of occupational status. In summary, the association between work and DHF incidence appears to be context-dependent. At the Lambunga Health Center, the nature of daily activities—particularly those conducted during peak mosquito activity hours in open areas—likely contributes to increased risk. In contrast, at the Waiwerang Health Center, the homogeneity of occupational and residential environments may mitigate any significant variation in DHF risk across different work statuses.

Knowledge Factors in Dengue Fever Incidence

Knowledge is the outcome of cognitive processes that arise following sensory perception of external stimuli, which occurs through the five human senses—namely sight, hearing, smell, taste, and touch. According to Notoadmojo (2003), the majority of human knowledge is acquired through the senses of sight and hearing. In the context of this study, knowledge refers specifically to respondents' understanding of the symptoms, causes, and preventive measures related to dengue fever transmission.

The findings indicate that among dengue fever patients at the Lambunga Health Center, 57.3% demonstrated good knowledge regarding DHF, while the proportion of respondents with poor knowledge was also notable, at 50%. Despite this, the Chi-square test yielded a p-value of 0.123, which exceeds the 0.05 significance threshold. This suggests that there is no statistically significant relationship between the level of knowledge and the incidence of dengue fever at the Lambunga Health Center. These findings are consistent with the study conducted by Novitasari (2018), which similarly reported no correlation between knowledge levels and DHF incidence (23). However, other studies present contrasting results. Otherwise, Yuniar *et al*., (2024), found a significant association between low knowledge and increased DHF risk, noting that individuals with limited knowledge were 2.472 times more likely to contract DHF than those with adequate knowledge (24).

According to the researchers, the absence of a significant relationship at the Lambunga Health Center may be attributed to a discrepancy between knowledge and action. That is, although some respondents possess adequate knowledge about dengue prevention, this knowledge may not be translated into practical behavior. Apathy or failure to implement preventive measures leaves individuals vulnerable to infection, particularly if they reside in environments conducive to mosquito breeding and virus transmission. In contrast, a significant relationship between knowledge and DHF incidence was observed at the Waiwerang Health Center, where respondents with poor knowledge were more frequently affected by DHF. This supports the assertion that knowledge plays a critical role in influencing health behaviors and preventing disease transmission. Supporting this, Damanik, Indri Astuti and Kamsul, (2023) found that poor knowledge was associated with an 8.523 times higher risk of engaging in inadequate DHF prevention behaviors (25). In summary, while knowledge is a vital factor in disease prevention, its effectiveness is dependent on how well it is applied in everyday life. Possessing accurate information without corresponding behavioral action may not be sufficient to reduce the risk of DHF infection, especially in high-risk environments.

Presence of Mosquito Larvae Factors in Dengue Fever Incidence

The presence of *Aedes aegypti* larvae in a particular area serves as a critical indicator of the local *Ae. aegypti* mosquito population, which is the primary vector responsible for transmitting Dengue Hemorrhagic Fever (DHF). In this study, findings revealed that 62.7% of households at the Lambunga Health Center reported the presence of mosquito larvae, while 57.1% of households at the Waiwerang Health Center reported the absence of larvae.

Statistical analysis using the Chi-square test yielded a p-value of 0.000 at the Lambunga Health Center and 0.011 at the Waiwerang Health Center, both of which are below the 0.05 significance level. This suggests a statistically significant correlation between the amount of mosquito larvae and the incidence of DHF at both locations. Furthermore, the Odds Ratio (OR) for the presence of larvae at the Lambunga Health Center was calculated at 11.102, implying that individuals residing in homes with larvae were 11.102 times the likelihood to get DHF than those without larvae present. These findings are consistent with previous research by, also identified a significant association between the presence of mosquito larvae and DHF incidence (p-value = 0.005) (26). Similarly, reported that the presence of mosquito larvae posed a 6.578 times greater risk for dengue infection compared to homes without larvae (27).

According to the researchers, the strong association between larvae presence and DHF incidence may be attributed to insufficient public knowledge regarding vector control, particularly the Eradication of Mosquito Breeding Sites (PSN DBD). Lack of awareness or ineffective implementation of these preventive measures facilitates the proliferation of *Ae. aegypti*

breeding grounds, thus elevating the potential for dengue virus transmission. The detection of larvae within a household or community is therefore not only a marker of current vector activity but also a predictor of increased dengue fever risk within that area.

Habit of Using Mosquito Nets Factors in Dengue Fever Incidence

The use of mosquito nets during sleep is one of the effective preventive measures against bites from *Aedes aegypti*, the primary vector of Dengue Hemorrhagic Fever (DHF). The results of this study revealed that at the Lambunga Health Center, a significant proportion of respondents (63.6%) did not habitually use mosquito nets. At the Waiwerang Health Center, the proportions of those who did and did not use mosquito nets were equal, at 50% each.

Statistical analysis using the Chi-square test at the Lambunga Health Center produced a p-value of 0.000 (<0.05), indicating a statistically significant association between mosquito net use and the incidence of DHF. The Odds Ratio (OR) for this variable was calculated at 13.222, suggesting that individuals who did not use mosquito nets were 13.222 times more likely to contract DHF compared to those who did. These results are consistent with research conducted by Fitriani, Harokan and Zaman in Palembang, which also demonstrated a significant association between mosquito net use and DHF incidence, with an OR of 2.619 (7). However, this is in contrast to findings by Jumiati, who reported no significant relationship between mosquito net use and DHF (p = 1.000), as well as, whose study yielded a p-value of 0.164, also indicating no statistically significant association (28)(29). These latter findings are consistent with results obtained at the Waiwerang Health Center.

From the analysis conducted at the Lambunga Health Center, it can be inferred that the habitual use of mosquito nets is associated with a lower risk of DHF, underlining the importance of promoting this behavior as a protective measure. However, according to researchers, the use of mosquito nets may be perceived by the community as less practical in contemporary settings. As a result, individuals increasingly prefer alternative preventive methods such as mosquito electric rackets, insect screens, or mosquito-repellent lotions, which are considered more convenient for daily use.

Housing Density in Dengue Fever Incidence

A high concentration of individuals in a specific area facilitates the transmission of dengue fever, as it enhances the likelihood and speed of viral spread through the *Aedes aegypti* mosquito vector (30). Increased population density is typically accompanied by high housing density, which contributes to this elevated risk. The study's findings indicated that 67.3% of respondents at the Lambunga Health Center resided in densely populated areas, while at the Waiwerang Health Center, the proportion was 57.1%. The Chi-square test yielded a p-value of 0.000 (<0.05) at the Lambunga Health Center, demonstrating a statistically significant relationship between residential density and the incidence of dengue fever in that area. Furthermore, the Odds Ratio (OR) was calculated at 7.648, suggesting that individuals living in high-density housing were 7.648 times the risk of getting dengue fever compared to those in lower-density environments.

These findings are consistent with previous research by DBD Kaeng, Warouw and Sumampouw, both of which confirmed a significant association between residential density and dengue incidence (31)(32). Similarly, previous research found that densely populated housing areas have a 3.000-fold increased risk of dengue infection compared to less crowded areas (33). These results corroborate the findings observed at the Lambunga Health Center. Conversely, a study conducted by Harahap, (2021) found no significant relationship between residential density and dengue fever incidence (p = 0.605) (34), aligning with the findings from the Waiwerang Health Center, where no statistically significant association was observed. According to the researchers, increased population and housing density can elevate the risk of dengue fever transmission, particularly when not accompanied by effective mosquito control measures and vector management strategies to curb the proliferation of *Aedes aegypti*.

Housing Condition Factors in Dengue Fever Incidence

Damp residential environments, characterized by poor lighting and inadequate drainage systems, are conducive to the breeding of mosquitoes that transmit dengue fever, thereby increasing the risk of infection. The study revealed that the majority of respondents at both the Lambunga and Waiwerang Health Centers—57.3%—lived in permanent housing. Based on the results of the Chi-square test, the p-value at the Lambunga Health Center was 0.054 (p > 0.05), indicating no statistically significant relationship between housing condition and the incidence of dengue fever in that area. These findings are consistent with previous research by Sofia, Suhartono dan Wahyuningsih, which similarly found no significant association between housing conditions and dengue incidence, reporting a p-value of 1.000 (p > 0.05) (35). This suggests that the structural status of respondents' homes does not significantly impact their risk of contracting dengue fever. According to the researchers, the absence of a significant relationship may be attributed to the fact that both permanent and non-permanent dwellings in the study area share similar environmental and structural characteristics. Furthermore, the study assessed housing based solely on its classification as permanent or non-permanent, without a comprehensive evaluation of all physical elements typically required for a healthy home environment—such as ventilation, lighting, humidity levels, and sanitation infrastructure.

5. CONCLUSION

Occupational status, mosquito larvae presence, mosquito net usage, housing density, and non-permanent housing collectively account for 99% of DHF incidence at the Lambunga Health Center, with mosquito net usage being the most influential factor (OR = 21.154). The East Flores District Health Office and Lambunga Health Center should strengthen early case detection and promptly disrupt DHF transmission through targeted fogging within a 100–200 meter radius of at least three related cases, conducted in two cycles and supported by mass abate distribution. Community education on mosquito breeding site eradication (PSN) and engagement—such as the "One House, One Larvae Inspector" program—must be intensified. Monthly entomological surveillance is vital to track key indicators (HI, CI, BI, ABJ), and risk maps should guide vector control efforts. Health promotion (PROMKES) should focus on practical prevention through public outreach, discussions, and culturally tailored videos. Cross-sector coordination is essential for effective and sustainable DHF control.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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