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Epidemiological Determinants and Trend Analysis of Dengue Fever Disease

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ABSTRACT

Bandung City is an endemic area for dengue fever, with 4,424 cases and 14 deaths. This research aims to analyze the epidemiological determinants and see the trend analysis to forecast dengue hemorrhagic fever cases. This research used a case-control design. The case population was those who suffered from dengue hemorrhagic fever, while the control population was those who did not suffer from dengue hemorrhagic fever. A sample of 510 respondents was taken. Sampling using a purposive sampling technique. Epidemiological determinants were analyzed using the chi-square test and logistic regression, while disease trends used exponential smooth analysis. The related results were education (p=0.036), presence of mosquito larvae (p=0.000), container material (p=0.002), water container (p=0.025), mosquito wire (p=0.010), presence of solid waste (p=0.002), mosquito repellent plants (p=0.041), mobility (p=0.004). The most dominant epidemiological determinant was the presence of mosquito larvae (OR=3.2). The incidence trend of dengue fever is increasing over the next 5 years. The research concluded that the epidemiological determinants of dengue fever were education, the presence of mosquito larvae, container materials, water collection objects, mosquito wires, the presence of solid waste, and mosquito repellent plants. The presence of mosquito larvae was the dominant factor. There is an increase in dengue fever cases over the next 5 years. It is recommended to increase the larva-free rate by optimizing Jumantik cadres and conducting epidemiological surveillance.

Keywords : Dengue hemorrhagic fever; determinant epidemiology; host; agent; environment

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INTRODUCTION

Dengue hemorrhagic fever (DHF) is a tropical disease that remains an international public health problem. In recent decades, approximately 50 million dengue virus infections occurred, causing significant morbidity and mortality worldwide.[1] DHF is an infectious disease caused by the dengue virus through the bite of Aedes mosquitoes, especially Aedes aegypti.[2] It is also known as the fastest-growing disease in the world,[3] symptoms are usually high fever and bleeding, small spots appear on the skin, and can also cause shock, up to death.[4]

One modeling estimate suggests 390 million dengue virus infections per year. Additional studies on dengue prevalence estimate that 3.9 billion people are at risk of infection. Although there is a risk of infection in 129 countries, 70% of the actual burden is in Asia.[5] From 2015 to 2019, the cases of DHF in Southeast Asia increased up to 46% while the decreased by 2%. The current situation of high dengue caseload in the region is coupled with the absence of effective treatment, and lack of comprehensive sustainable vector control.[6]

In Indonesia, there were 138,127 cases in 2019. There was a significant increase in cases from the previous year, which amounted to 65,602 cases. In addition to the increase in incidence, there was also an increase in CFR from 0.65 to 0.94.[7] Meanwhile, until July 2020 the number of cases reached 71,633 cases. Various factors are responsible for the expansion and distribution of dengue mosquito vectors and viruses such as high population growth rates, inadequate water supply and poor storage practices, sewers, and waste management systems, increased global trade and tourism, global warming, changes in public health policies, and development of hyperendemicity in urban areas.[6] DHF prevention and control programs have been conducted by the Indonesian government through the Directorate General of Communicable Disease Control, Ministry of Health of the Republic of Indonesia since 1968.[8] The programs included fogging, mass larviciding, and public health education. Despite these control programs, DHF continues to grow both in several cases and geographically, and Indonesia is now a dengue-endemic country and a national health problem.[9]

Bandung City is one of the DHF-endemic cities. The number of cases continues to increase and always causes death, so DHF disease is one of the priorities in Bandung City. In 2018 the number of cases was 2,826 with 7 deaths. There was a significant increase in 2019 to 4,424 cases with 14 deaths. Reducing breeding sites is one of the effective methods at this time, by providing basic sanitation facilities. Another way to reduce breeding sites is through simultaneous mosquito nest eradication (PSN). In addition, better skills of health workers in detecting DHF symptoms and the availability of treatment at health facilities. Currently, guidelines for diagnosis, treatment, prevention, and control of DHF are available at all health centers (Puskesmas).[10] The research used a Poisson kriging model, the method was used to determine the risk level of Dengue Fever (DHF) incidence in the selected region, indicating that Bandung City is on DHF alert.[11] An overview of DHF cases and prevention attempts have been made, but what is missing from the literature is the epidemiological determinants and trend

analysis of DHF disease in Bandung City. The purpose of this study is to analyze the epidemiological determinants and trend analysis to project the number of DHF cases in Bandung City.

METHODS

Quantitative observational analytical research using a case-control design. This design was used to analyze the influence of epidemiological determinants on DHF incidence. The data used were primary and secondary data. Primary data is data obtained from epidemiological determinant data, while secondary data is data on the incidence of DHF from 2016-2020 taken from the Bandung City Health Office to determine the trend analysis of DHF disease. The location was selected based on the number of DHF cases in West Java, where Bandung City is the city/district with the highest number of cases in West Java.

The population in this research consists of a case population and a control population. The case population is those who suffered from DHF in 2020 and 2021 in Bandung City, while the control population is those who did not suffer from DHF. Determination of the minimum sample uses the two proportions difference hypothesis test formula so that a minimum sample of 255 respondents is obtained. In this study using the 1: 1 technique. So the number of control group samples was 255 respondents. Case sampling used a simple random sampling technique. While the control group is a neighbor of the case group. The sample criteria in this study were sampling with criteria: residing in Bandung City, the house they live in is their own house, allowing observation inside and outside the house. Sampling of cases and controls was carried out in 13 Puskesmas working areas in Bandung City which had the highest number of cases in 2020.

The instrument used in this research is an observation sheet. Two kinds of observation sheets were used. The first was an observation sheet for data collection of DHF cases at the Bandung City Health Office, which was used to record the number of cases for 5 years. The second observation sheet was used when conducting surveys at the respondents' houses. The components contained in the observation sheet were: respondent characteristics consisting of age, gender, education, occupation, and income. Furthermore, the presence of mosquito larvae, container materials, water collection objects, mosquito wires, dense waste, mosquito repellent plants, and mobility.

All the respondents who participated in this study have agreed to the research protocol and have been approved in written form. This research has been approved by the Ethics Committee of STIK Immanuel Bandung (054/KEPK/STIKI/VI/2021) and considers to the principles in the research process.

This research used three statistical tests. Firstly, the chi-square test was used to examine the relationship between characteristics of the host, agent, and environment with the incidence of DHF. Secondly, multiple logistic regression was used to determine the epidemiological determinants most associated with DHF incidence. Furthermore, exponential smooth analysis with Holt's linear trend model was conducted to forecast the development of DHF cases in Bandung City.

RESULTS

Epidemiological Determinants

This research examines epidemiological determinants consisting of the host, agent, and environment. The results of the research obtained a description of the characteristics presented in table 1, showing that almost all respondents with low-risk age groups, most female respondents, most respondents have high education, most respondents do not work, and more than half have low income.

Table 1. An Overview of Host Characteristics

Characteristics	n	%
Age		
High Risk	49	9,6
Low Risk	461	90,4
Genders		
Male	163	32,0
Female	347	68,0
Education		
Low	161	31,6
High	349	68,4
Occupation		
Not Employed	312	61,2
Employed	198	38,8
Income		
Low	287	56,3
High	223	43,7
Total	510	100,0

Table 2 below indicates that most of the respondents had mosquito larvae in their homes, most of the container materials were ceramic/plastic, more than half had water storage objects around the house, more than half had no mosquito wires, more than half of the respondents had no solid waste, most did not have mosquito repellent plants, and most of the respondents had low mobility.

Table 2. An Overview of Agent and Environment Factors

Variable	Total Amount	Percentages
Mosquito Larvae		
There are Larvae	196	38,4
No Larvae	314	61,6
Containers material		
Ceramic/Plastic	310	60,8
Cement/Soil	200	39,2
Water Reservoir Object		
Found	294	57,6
No Object	216	42,4
Mosquito Wire		
There are no object	87	50,3
There are object found	86	49,7
Presence of Solid Waste		
Found	217	42,5

Not found	293	57,5
Existence of mosquito repellent plants		
No repellent plants	333	65,3
There are repellent plants	177	34,7
Mobility		
Yes	123	24,1
No	387	75,9
Total	510	100,0

Table 3 below indicates that the variables associated with DHF incidence were education and the presence of mosquito larvae (p<0.005). While the variables of age, gender, occupation and income could not be proven.

Table 3. Chi Square Test of Host and Agent with Dengue Fever Incidence

Host and Agent	DHF Incidence				*P-Value*	OR 95% CI
	Case		Control			
	n	%	n	%		
Age						
High Risk	27	10,6	22	8,6	0,548	1,254 (0,694-2,267)
Low Risk	228	89,4	233	91,4		
Gender						
Male	86	33,7	77	30,2	0,447	1,176 (0,810-1,708)
Female	169	66,3	178	69,8		
Education						
Low	92	36,1	69	27,1	0,036	1,521 (1,044-2,217)
High	163	63,9	186	72,9		
Occupation						0,767
Not Employed	148	58,0	164	64,3	0,173	(0,537-1,097)
Employed	107	42,0	91	35,7		
Income						
Low	140	54,9	147	57,6	0,592	0,894 (0,630-1,269)
High	115	45,1	108	42,4		
Mosquito larvae						
Larvae present	133	52,2	63	24,7	0,000	3,322 (2,281-4,839)
Not larvae	122	47,8	192	75,3		

Table 4 below indicates that the environmental conditions associated with DHF incidence are container type, water reservoir, mosquito wire, presence of solid waste, presence of mosquito repellent plants, and population mobility (p<0.005).

Table 4. Chi-Square Test of Environment with Dengue Fever Incidence

Environment	DHF Incidence				*P-Value*	OR 95% CI
	Case		Control			
	n	%	n	%		
Container Materials						
Ceramic/Plastic	173	67,8	137	53,7	0,002	1,817 (1,268-2,605)
Cement/Soil	82	32,2	118	46,3		
Water reservoir object					0,025	1,521

Present	160	62,7	134	52,5		(1,068-2,165)
No	95	37,3	121	47,5		
Mosquito Wire						
No Wire	138	54,1	108	42,4	0,010	1,605 (1,132-2,278)
Wire Present	117	45,9	147	57,6		
Presence of solid waste						
Solid Waste Present	126	49,4	91	35,7	0,002	1,760 (1,234-2,510)
No Solid Waste	129	50,6	164	64,3		
Existence of mosquito repellent plants					0,041	1,491 (1,033-2,153)
No Repellent Plants	178	69,8	155	60,8		
Repellent Plants Present	77	30,2	100	39,2		
Mobility						1,879
Yes	76	29,8	47	18,4	0,004	(1,241-2,845)
No	179	70,2	208	81,6		

Table 5 below indicates the results of multiple logistic regression tests aimed at determining the dominant factors associated with DHF incidence, the results show that mosquito larvae are the most dominant epidemiological determinant of DHF incidence (OR=3.2).

Table 5. Final Logistic Regression Modelling of Epidemiological Determinants of DHF Incidence

Epidemiological Determinants	B	*P value*	OR	OR 95% CI	
Mosquito Larvae	1,163	0,000	3,201	2,153	4,760
Container Material	0,662	0,001	1,939	1,309	2,872
Water Reservoir Object	0,630	0,002	1,878	1,258	2,803
Mosquito Wire	0,450	0,020	1,568	1,074	2,289
Existence of Mosquito Repellant Plants	0,480	0,024	1,615	1,066	2,448
Mobility	0,680	0,005	1,974	1,232	3,162
Constant	-6,226	0,000	0,002		

Dengue Fever Disease Trend

The projection results in Table 6 and Figure 1 indicate an increase in DHF cases in 2021-2025. The 2021 projection result of 3,3063 is below the number of DHF cases in 2020 (base year) of 2790 cases. The projection result in 2025 is 3,189 cases. Hence, there is an increasing trend in dengue cases in Bandung City in the next 5 years.

Table 6. Trend Analysis of Dengue Fever Disease for the Period 2021-2025

		Forecast				
Models		2021	2022	2023	2024	2025
Number of	Forecast	3063	3094	3126	3157	3189
Cases	UCL	6966	7017	7067	7118	7169
Model_1	LCL	-840	-828	-816	-804	-791

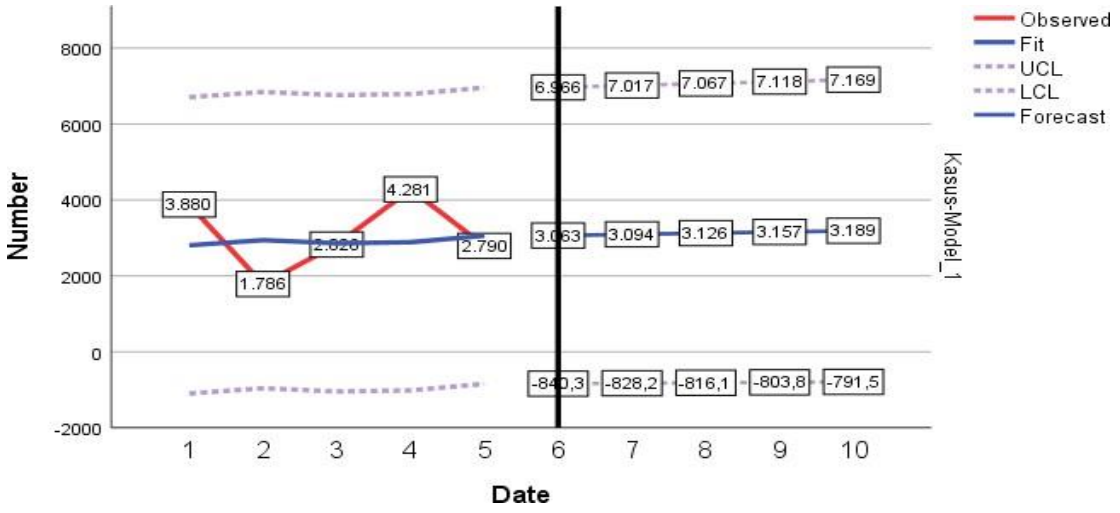

Figure 1. Projection Chart of the Number of DHF Incidences for the Period 2021-2025

DISCUSSION

Epidemiological Determinants

Host

The results showed that the host factor that is a risk factor for DHF incidence is education. Those with low education had a 1.5 times chance of contracting DHF. This result is in line with previous studies which stated that education is one of the risk factors for DHF.[12] Other studies have shown that the pattern of DHF transmission tends to be positive for age, education, occupation and population density.[13]

Education is the formal education that has been taken by respondents. In this research, the higher the level of education of the respondent, the greater the ability of a person to receive information obtained. Those with a high level of education tend to pay more attention to the health of their own and their family's health. In fact, during the observation, it was found that more people had high formal education, namely most of them graduated from high school and college. However, those who have experienced DHF are more likely to have low education than those who have not experienced DHF.

Education is strongly related to knowledge where it is expected that people with higher education, the wider their knowledge.[14] Lack of knowledge will lead to a lack of awareness of the importance of prevention and control of DHF.[15] person with low education can result in a lack of ability to seek information, low knowledge can result in a person not being able to prevent dengue fever.[16]

Agent

The agent factor studied in this research is the presence of mosquito larvae in water reservoirs (TPA). Observations were made in crocks, drums bathtubs, and buckets. No further identification was done to confirm whether the larvae found were Aedes aegypti larvae or not. The results showed that

the agent factor (presence of mosquito larvae) was associated with the incidence of DHF. This result is in line with previous studies which stated that the presence of mosquito larvae is one of the factors that can lead to DHF.[17,18]

Observation showed that the case group used more plastic buckets for landfill even though they had a bathtub. In the control group, almost all of them had implemented *PSN* so that the breeding place of Aedes aegypti was disrupted. Multiple logistic regression test showed that the presence of mosquito larvae was the most dominant factor with DHF incidence. Those who lived in a house with mosquito larvae in one of the places such as a crock, bathtub drum, or bucket had a 3.2 times chance of contracting DHF. Based on a survey of 510 houses in Bandung City, 314 houses did not have mosquito larvae. Therefore, the mosquito larvae free rate (ABJ) is 61.6%. *ABJ* is calculated by the formula (number of larvae negative houses/number of houses checked) x 100%.

Larvae-free rate is the percentage of houses or public places where no larvae are found during an Aedes aegypti mosquito larvae examination. This number is obtained from larval surveys conducted by the government, which aims to determine whether an area or region is free of larvae or not. DHF prevention efforts can be carried out by conducting larval surveys. Mosquito larvae are the forerunners that will one day become full-grown mosquitoes. The more mosquito larvae found in a house, the more full-grown mosquitoes will fly around the house, and the greater the risk of DHF.[19]

Reducing the risk of dengue transmission can be done by increasing the ABJ. The active role of the *jumantik* cadre in PSN is very necessary. In addition, health workers need to conduct systematic monitoring so that the presence of larvae is detected at an early stage.

Environment

In terms of the physical environment, container materials were associated with the incidence of DHF. In line with other studies, container material is one of the factors for the presence of aedes aegypti mosquito larvae.[20] Observation conducted by the researcher, many plastic buckets and ceramic bathtubs were found to be used as landfills in both the case and control groups. Water reservoirs are preferred by the aedes aegypti mosquito because usually the water in the landfill is clear water that is not exposed to direct sunlight. Aedes aegypti mosquitoes do not like water in direct contact with the ground. The type of landfill most favoured by the aedes aegypti mosquito is the bathtub, this is because the volume of water contained in the bathtub is relatively more, and it is located inside the house so it is very conducive to its development.[21]

This research did not measure the Container Index (CI), which is one of the indicators to determine the condition of DHF disease through larval surveys. Research in Jepara District showed that houses with a high-risk CI were 5 times more likely to have DHF than houses with a low-risk CI.[22]

This research also found that water containers are associated with DHF incidence. In line with previous studies, poor environmental conditions are a risk factor for DHF incidence. The breeding of the aedes aegypti mosquito is highly dependent on its environment. If the surrounding environment

creates a situation with conditions that the mosquito likes, such as the presence of objects that can hold water that allows it to be used as a resting place and breeding, then the mosquito will breed.[23]

The environment surrounding the house such as the garbage that can hold water including used cans, used tyres, buckets that can be used as a breeding site for the aedes aegypti mosquito. If the garbage is not managed properly and quickly, it can become a mosquito nest, so that the development of the aedes aegypti mosquito can be increased. Besides containers, the aedes aegypti mosquito also likes items that have water in them, such as plastic bottles filled with water, used cans filled with water, used tyres filled with water, shells filled with water, bamboo fences filled with water, coconut fronds/banana fronds filled with water, and others.[24]

This research found that mosquito wires are associated with DHF incidence. Several other studies have stated the same thing, that mosquito wires are a risk factor for DHF incidence.[25] This research found that mosquito wires are associated with DHF incidence. Several other studies have stated the same thing, that mosquito wires are a risk factor for DHF incidence. The results of field observations of the ventilation conditions in the respondents' houses, both the case group and the control group, mostly used wire mesh on the ventilation, but in the case group most of the wire mesh used was not mosquito wire mesh.

Ventilation can be utilized by DHF vectors to enter and exit the house. Installation of mesh on ventilation is one of the preventive measures for dengue disease transmission. The goal is to prevent the Aedes aegypti mosquito from entering the house through ventilation. Ventilation needs to be covered with mosquito wire mesh and not to leave doors or windows open so that mosquitoes cannot enter the house, so the chances of biting humans will be smaller.[25]

The occurrence of waste can be associated with the incidence of DHF. In this study, the presence of solid waste included whether there was a rubbish bin in the respondent's house and the frequency of solid waste disposal. Field observations showed that most of the control group already had a watertight rubbish bin, and they disposed of rubbish no more than once every 2 days. This study was conducted in an urban area, so temporary waste bins have been provided by the local government in various places, such as markets, residential complexes, and on the roadside, which aims to make it easier for people to dispose of waste.[26]

Breaching the chain of transmission through vector control is one of the effective ways to prevent dengue transmission so that the morbidity rate can be reduced. Environmental manipulation needs to be done to overcome the spread of DHF because the Aedes aegypti mosquito is found in places that are rarely cleaned and rarely monitored.[28]

Mosquito-repellent plants are associated with the incidence of DHF. In this research, the mosquito-repellent plants observed were lemongrass, basil seeds, lavender, geranium, and rosemary. The observation indicated that most of the mosquito-repellent plants owned by respondents were lemongrass and lavender. Planting mosquito-repellent plants is one of the PSN behaviors. Other studies have shown that PSN behavior is associated with the incidence of dengue fever.[29] The purpose

of the PSN program is to control the Aedes aegypti mosquito population so that it is unable to breed. This is the main program and can be directly carried out by the community according to local conditions and culture.[30]

Mobility is associated with DHF incidence. In line with research in Lampung, population mobility is one of the risk factors for DHF incidence.[31] Bandung City is one of the areas in Greater Bandung, and is directly adjacent to several surrounding cities such as Cimahi City, Bandung Regency, and West Bandung. Many people in Bandung also work in Jakarta, where they return home once a week. In this research, 29.8% of the respondents in the case group always went out of town to work every week, which is an opportunity for DHF transmission, which is likely to come from areas outside Bandung City.

Not only does high mobility have a positive impact, but it also has a negative impact with the spread of disease from one area to another due to population movement. Many previous researches have shown that population mobility is one of the factors of DHF transmission. The denser population and higher population mobility are the causes of the occurrence of extraordinary events (KLB) and the expansion of dengue-infected areas.

Dengue Hemorrhagic Fever Trend

Forecasting DHF cases in this research uses exponential smoothing. The use of this method is due to the limited data that can be accessed by researchers. This method is one of the most widely used methods to project the number of cases in the next few years. The total number of DHF cases in 2020 was 2,790 cases. Based on the forecasting results, there will be an increase in cases by 273 cases. Meanwhile, in 2025 it will be 3,189. By knowing the results of forecasting the number of cases, so that it can implement appropriate prevention of transmission of dengue disease. Another research that conducted a projection of the number of DHF incidents in East Java stated that the peak of DHF cases correlated with the rainy season.[33]

The impact of rainfall can affect the life of mosquitoes, leading to increased breeding sites for the Aedes aegypti mosquito.[34] The intensity of Aedes aegypti mosquito bites will increase and if that happens, the number of cases will certainly increase accordingly. This is due to the increase in breeding sites of the Aedes aegypti mosquito which are influenced by the rainy season.[33]

This case study was conducted to provide advice to stakeholders in the hope of assisting in the prevention and control of DHF in Bandung City. Activities that can be carried out to reduce the incidence of DHF by conducting DHF surveillance activities and always monitoring trends in DHF cases, in addition to the need for early vigilance there is a possibility of a DHF outbreak.

CONCLUSION AND SUGGESTION

Epidemiological determinants that were found to be associated with DHF incidence were education, presence of mosquito larvae, container materials, water-holding objects, mosquito wires,

presence of solid waste, and mosquito repellent plants. However, age, sex, occupation, and income were not proven. The presence of mosquito larvae was the dominant factor associated with dengue incidence. There is an increase in dengue fever cases over the next 5 years. It is necessary to increase the larva-free rate by optimising *jumantik* cadres and conducting systematic monitoring so that the presence of larvae is detected early. In addition, conducting epidemiological surveillance of dengue disease is necessary.

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