International Journal of Statistics and Applications 2013, 3(4): 97-105
DOI: 10.5923/j.statistics.20130304.02

Characteristics of Dengue Haemorrhagic Fever and Factors Affecting Dengue Haemorrhagic Fever in Bogor, West Java Indonesia

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Abstract This study aimed to identify characteristics of DHF and factors cause the percentage of patients with Dengue Haemorrhagic Fever (DHF) in each village. The secondary data was used. Data obtained from Cipto Mangunkosumo Hospital (RSCM) in Jakarta and Bogor City Health Office, and the Regional Development Planning Board (Bappeda) Bogor in 2008. To indentify characteristic of DHF we used Latent Cluster and to identify factors affecting DHF, was used Spatial Logistic Regression. Latent cluster shows that symptoms of dengue fever begins with non-specific clinical symptoms such as weakness, back pain, bones, joint sand head that lasts between 2-7 days then droplysis. Other symptoms of this disease are bleeding, and red spots around the body. The manifestations of bleeding and red spots usuall appear in 2-3 days of fever and lasts for 3-6 days. Fatigue is another common clinical symptom experienced by patients. However, diarrhea, abdominal painkind are not so much occurring in patients. Haemoglobin indicates the DHF with Increasing of levels of hematocrit. The last indicator is seen in the determination of these patients are positive for DHF is the low number of leukocytes in the body. Spatial logistic regression model showed that model has Classification Correct Rate (CCR) of 78.6%. Variables that affect the percentage of patients of DHF in each village in Bogor are the distance to the nearest centre of health village (poskesdes) (km) and the average number of dengue patients in around the village.

Keywords Latent Cluster, Dengue Haemorrhagic Fever(DHF), Spatial Logistic Regression Model, CCR

1. Introduction

1.1. Background

Bogor city is an area known as the city of rain. The advent of the rainy season could lead to dengue hemorrhagic fever (DHF). Dengue fever is a disease caused by the dengue virus and transmitted by the Aedes aegypti mosquito from patient to another via the bite.

DHF is an acute viral disease-febrile, possibly an acute febrile illness with two or more of the following manifestations: headache, retro-orbital pain (pain around the neck), myalgia (aches), arthralgia (joint pain bone), rash, bleeding manifestations, leucopenia (WHO 1997)[15].

Dengue Hemorrhagic Fever (DHF) is characterized by a major clinical manifestations (WHO 1997)[15]. Major clinical manifestations are Fever or history of acute fever for lasting 2-7 days, occasionally biphasic. Bleeding tendency, evidenced by at least one of the following: positive tourniket test, petechiae, ecchymoses or purpura, bleeding from mucosa, gastrointestinal tract, injection pattem or other locations, hematemesis or melena. The existence of plasma seepage due to increased vascular permeability, manifested by at least the following: an increase in hematocrit equal to or greater than 20% above the average age, gender, and population; decreased hematocrit after volume replacement action is equal to or greater than 20% basic data; plasma seepage signs such as pleural effusion, ascites, and hipoproteinemia. One importance is to identify characteristic of DHF by using mutivariate analysis such as Latent Cluster Model. That model will be easier for a medical doctor to identify this symptom. (Anonymous 2008)[3,5]

Mahtumah (2010)[7] did spatial analysis of dengue fever by using spatial logistic regression. This study concluded spatial factors proved significant in the spread of dengue fever in the city of Bogor in 2008. In the study it is said that the model is good enough to suspect the spread of dengue fever in the city of Bogor in 2008 is a logistic regression model with spatial effects at lag 1.

This study try to cluster DHF Symptoms of DHF and to investigate the variables that affect the number of dengue patients in the city of Bogor in 2008 by using spatial logistic regression. In addition to regression, the study also uses spatial lag dependence to determine the effects of the influence of spatial and distance weighting to the formation

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of spatial weighting matrix.

1.2. Purposes

There are two objectives of this study. They are:

- Identify cluster of DHF symptoms by using Latent Cluster
- Identify the variables of spatial and non spatial effect on the number of dengue fever patients using logistic regression analysis of the spatial approach.

2. Methods

2.1. Data

The data used in this study is secondary data. There are two sources of data,

a) medical records of patients suspected of having a DHF from Cipto Mangunkusumo Hospital (RSCM) in Jakarta in 2008. Data as patients studied 252 patients who had positive DHF, which collected in April-May 2008. Variables observed in this study are headache (headache), aches (myalgia), joint pain bone (altralgia), rumple leed , rash (petechiae), nosebleeds (epitaksis), waste water big black (melena), under normal leukocytes (leukopenia), changes in hematocrit levels (delta hematocrit) and the lowest platelet levels (thrombocytopenia) in the blood.

b) Secondary data come from two sources, namely Bogor City Health Office and the Regional Development Planning Board (Bappeda) Bogor in 2008. Data from Bogor City Health Office is used as response variables. Response variable in this study was the percentage of patients with Dengue Hemorrhagic Fever (DHF) in each village in Bogor City. Bogor City contains 68 villages. Data Bogor City in Figures 2008 from the Regional Development Planning Board (Bappeda) Bogor was used as explanatory variables. Explanatory variables used in this study are nine variables. List of explanatory variables are shown in Table 1.

Table 1. List of explanatory variables used in the study

Explanatory Variables	Explanatory Variables Name
X_1	Population density (number people/km^2)
X_2	Percentage of population mobility
X_3	percentage of households living in slums
X_4	Percentage of primary school
X5	distance to the clinic / clinic nearest (miles)
X_6	Distance to the nearest sub-health center (km)
X_7	Distance to the nearest centre of health village(poskesdes) (km)
X_8	distance to specialty shops herbal / medicinal nearest (miles)
Wy	Mean number of patients with Dengue Hemorrhagic Fever (DHF) in each village

2.2. Method

2.2.1. Method for Clustering by using Latent Classes

Steps being taken in performing clustering using Latent Cluster are as follows:

- Data was divided two clusters randomly, π_1 and π_2 values came from this equation :

$$f(y_h|\alpha_k) = \sum_{k=1}^{K} \pi_k g(y_h|\alpha_k),$$
$$\pi_k = \frac{n_k}{N}$$

Where

$g(y_h|\alpha_k)$ =Distribution of y_h came from model parameter, α

π_k=First Probability of Latent Class or k-th groups at y

α_k=Probability of a object go into k-th group

K =Number of groups (k=1, 2, …, K), where $\sum_{k=1}^{K} \alpha_k = 1$ and $k=1K\pi k=1$

n_k =Number of data at k-th group

N =Total number of data.

(Pujiati and Suherman 2008)[12]

$G(y_i|\alpha_i)$ was computed from

$$f(y_h|\alpha_k) = \sum_{k=1}^{K} \pi_k g(y_i|\alpha_k) = \sum_{k=1}^{K} \pi_k \prod_{i=1}^{P} \prod_{s=1}^{S_p} (\alpha_{k(is)})^{y_{h(is)}}$$

for categorical variables which two categories, yes and no, and

$$f(y_h|\mu_k,\sigma_i^2) = \sum_{k=1}^{K} \pi_k g(y_i|\mu_k,\sigma_i^2)$$
$$= \sum_{k=1}^{K} \pi_k \frac{1}{2\pi^{p/2} \prod_{i=1}^{p} \sigma_i} exp\left[-\frac{1}{2}\sum_{i=1}^{p} \frac{(y_i-\mu_{ik})^2}{\sigma_i^2}\right]$$

(Mclachlan and Bastford 1988)[8]

For continue variables. $G(y_i|\alpha_i)$ function as a input for this equation

$$f(y_h|\alpha_k) = \sum_{k=1}^{K} \pi_k \prod_{i=1}^{I} g(y_{hi}|\alpha_{ik})$$

(Vermunt et.al 2002)[9,10]

- To evaluate i-th object as a member of k-th cluster, we used Bayesian model. The Bayesian model is followed

$$\frac{\pi_k \prod_{i=1}^{I} g(y_{hi}|\alpha_{ik})}{f(y_h|\alpha_k)} = \frac{\pi_k \prod_{i=1}^{I} g(y_{hi}|\alpha_{ik})}{\sum_{k=1}^{K} \pi_k \prod_{i=1}^{I} g(y_{hi}|\alpha_{ik})}$$

If the value of that equation close to 1 if k=K, then that object is as member of k-th cluster (Snellman, 2008)[13].

2.2.2. Method for Spatial Logistic Regression

Spatial logistic regression is mathematical modeling approaches that can be used to describe the relationship of explanatory variables are continuous variables and categories that are response categories. In logistic regression that modeled is the probability of a particular category so that the interpretation obtained is the relationship between the response variable yi opportunities with explanatory variables xi. According to Ward and Christians (2008)[14] and Agusta (2009)[2] form spatial logistic model in general are as follows:

$$g(\boldsymbol{x}) = \log\left(\frac{\pi(\boldsymbol{x})}{1-\pi(\boldsymbol{x})}\right) + \rho\psi + \varepsilon$$

Where

$$\log\left(\frac{\pi(\boldsymbol{x})}{1-\pi(\boldsymbol{x})}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_i x_i$$

(Hosmer and Lemeshows 2000)[6]

β: regression coefficient.

ρ: coefficient of spatial autoregresion

ψ: weighted average of the number of events within a region to - i consisting of k neighbors.

In general the process of estimation, hypothesis testing, drawing conclusions and interpretations follow the classical logistic regression.

Model Significance Test

Testing sigifikansi spatial logistic regression models done in two ways. The first phase of Likelihood Ratio test for the significance of the coefficient parameters simultaneously. The decision will reject H0 if the test statistic G > $\chi^2_{p(\alpha)}$, with p degrees of freedom, meaning that this model is significant because at least there is one value of the parameter coefficients are not equal to zero. G test statistic formula as follows:

$$G = -2\log\left[\frac{l_0}{l_1}\right]$$

Description:

l_0 a maximum value of likelihood function of a model without explanatory variables

l_1 is the maximum value of the model with explanatory variables

While testing the hypothesis was formulated as follows:

H_0: β1 = ... = βk = 0 (the model can not explain)

H_1: At least one βi ≠ 0 (the model can explain)

The second phase Wald test for the significance of each parameter coefficient. The decision will reject H0 if the test statistic ||W| > $\chi^2_{p(\alpha)}$, where k is the degrees of freedom, which in this test is 1 so that the independent degrees $\chi^2_{p(\alpha)} = \chi^2_{1(\alpha)}$.. When H_0 is rejected means the explanatory variables xi significant effect on the response variable y. W test statistic formula as follows:

$$W = \left[\frac{\beta_i - \beta_0}{SE(\beta_i)}\right]^2$$

(Hosmer and Lemeshows 2000)[6]

Description:

βi is the alleged value of the i-th parameter of the maximum likelihood method. SE(βi) the standard deviation of the ith parameter estimators.

While testing the hypothesis was formulated as follows:

H0: βi = 0 (the i-th explanatory variable has no effect real)

H1: βi ≠ 0 (the explanatory variable of the i-th real effect) (Agresti 1998)[1]

Interpretation of Coefficients

Interpretation of coefficients for the logistic regression model with one dichotomous explanatory variables can be done by looking at the ratio odds. Value odds (the ratio between the percentage of patients with disease of Dengue Hemorrhagic Fever> mean of y, then categorized y = 1 and the percentage of patients with Dengue Hemorrhagic Fever disease <mean of y then categorized y = 0 for x = 1) is $\left[\frac{\pi(1)}{1-\pi(1)}\right]$, while for x = 0 is $\left[\frac{\pi(0)}{1-\pi(0)}\right]$. Log odds of these two values are defined as g (1) and g (0).

The odds ratio is defined as the ratio of the odds for x = 1 with x = 0, ie

$$Rasio\ odds = \frac{\left[\frac{\pi(1)}{1-\pi(1)}\right]}{\left[\frac{\pi(0)}{1-\pi(0)}\right]} = \exp\ (\beta_1)$$

(Hosmer and Lemeshows 2000)[6]

If an explanatory variable has a positive coefficient sign, then the value odds ratio will be greater than one, but if the sign of the coefficient ratio odds negative then the value will be smaller than one.

Suitability Model Autologistic Spatial

Compliance is seen from the value model autologistic Clasification Correct Rate (CCR). CCR can be calculated by the equation below

$$\text{CCR} = \frac{\text{banyaknya dugaan yang benar}}{\text{banyaknya pengamatan}} \text{x} 100\%$$

The greater the percentage of CCR produced a model, then the level of accuracy produced a model of the higher, making it the better model to use in suspect.

Stages of analysis used to achieve the objectives of this study are as follows:

● Creating spatial weighting matrix (W).

Determining value weighting matrix using distance matrices.

● Creating a new independent variable derived from spatial effects.

X_spatial = W Y

● X_spatial is the average number of patients with Dengue Hemorrhagic Fever (DHF) in each village

● Selecting explanatory variables to be included in a logistic regression analysis with spatial Pearson correlation test.

● Creating a logistic regression model for the spread of dengue fever

Interpretation of logistic models

a. Simultaneous test with Likelihood ratio test. Decision of Reject H0 made if jika $G > \chi^2_{p(\alpha)}$.. If H_0 is rejected, it can be concluded that the model can be used to predict the spread of dengue fever.

b. Identify significant explanatory variables for the response variables to obtain the spatial logistic regression models of dengue fever in the city of Bogor

c. Partial test Wald test. Decision of Reject H0 made if $|W| > \chi^2_{p(\alpha)}$.. If H0 is rejected, it can be concluded that the explanatory variables have a significant contribution to the response variable

● Seeing the suitability of spatial logistic regression model of the value of Correct Classification Rate (CCR)

3. Result and Discussions

3.1. Discussion for First Objective

Estimation of many clusters of dengue fever patient data with 8 variables and 127 patients, performed using software LatentGOLD 4.0 (Vermunt et.al 2002)[11] (Anonymous 2003)[4]. The first step of the selection of the best model suggested five clusters selected based on the smallest value of BIC(*Bayes Information Criterion*).. Figure 1 shows the values for the five models. Model 3 shows the lowest BIC value that is equal to 3731,064 compared to four other models, and even tends to increase the value of BIC for models 4 and 5.

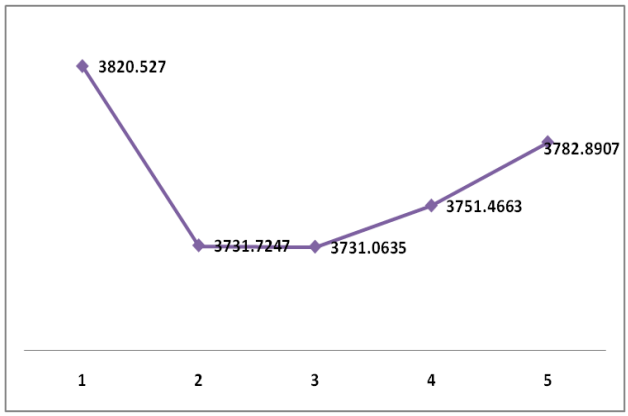

Figure 1. BIC values for each model

BVR *(Bivariate Residual)* large value indicates this assumption of local independence is not there. This model has a value of BVR with range 0.0006 - 2.8753, then it can be concluded (it is lower than 3.84) the distribution of data is local independence

Table 2. The classification of objects into clusters that are formed

Cluster	n	Posterior Probability
1	78	0.62
2	39	0.28
3	10	0.10
Total	127	1.00

This model shows approximately 78 patients as in fiirst cluster, 39 patients as in second cluster and the remaining 10 patients included in third cluster (Table 2). Probability of each cluster are 0.6177, 0.2812 and 0.1012 respectively.

The largest value of R^2 are hematocrit and platelets. Those are 38.68% and 37.28% respectively. While the smallest R^2 value is abdominal at 0.26%. This is because symptoms such as hemoglobin, hematocrit, platelets, and leokosit larger role in diagnosing the patient. While symptoms such as fever, rash, aches, and abdominal pain are symptoms that are commonly experienced by patients with DHF. Overall this model is good enough to use, visible from p-value less than 0.05 is equal to 1.9x10-5. EM algorithm and Newton iteration Rhapson showed that log-likelihoodnya maximum value at the time of the EM algorithm iterations to 21 and then followed by newton rhapson, finally obtained the final value of the log-likelihood of -1773.4922.

3.1.1. Latent Cluster for Nominal Variables

Symptoms of dengue fever begins with non-specific clinical symptoms such as weakness, back pain, bones, joints and head for 2-7 days then drop lysis. Figure 2 shows the majority of patients in all three clusters have a fever with a fever period between 2-7 days. Cluster 2 and 3 even show throughout the patient have a fever. This is consistent with a fever probability, that showed a great value for three clusters, ie 0.8859, 0.9993 and 0.9980 for first, second and third cluster, respectively.

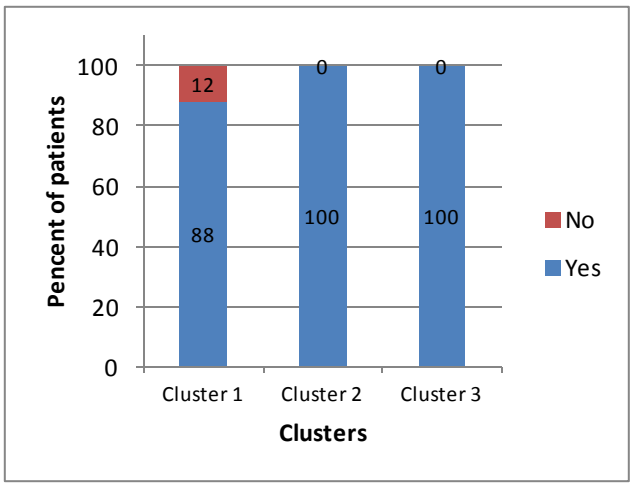

Figure 2. The number of yes and no criteria for variable fever (Fever)

Other symptoms of this disease is bleeding manifestations usually appear in 2-3 days of fever. One of the common red spots around the body, this manifestation usually lasts for 3-6 days. Figure 3 shows three clusters exhibit the same symptoms, nearly all patients were included into the cluster having three red spots. In term of probability, first cluster has greater value of probability with patient experience red spots on the body that is equal to 0.5629. While the other clusters show a much smaller probability of 0.2993.

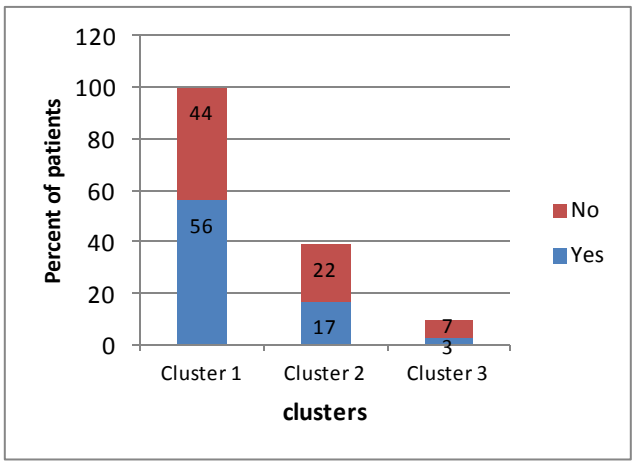

Figure 3. The number of yes and no criteria for variable red spots (Petechiae)

Fatigue is another common clinical experienced by patients. Patients experiencing these symptoms with showed sizable probablity of 0.6366, 0.8087 and 0.8707 for first,

second and third cluster respectively. Figure 4 shows the majority of patients in all three clusters experiencing these symptoms. However, in first cluster about 1/3 patients did not experience these symptoms. While second cluster and third only a few who do not experience these symptoms.

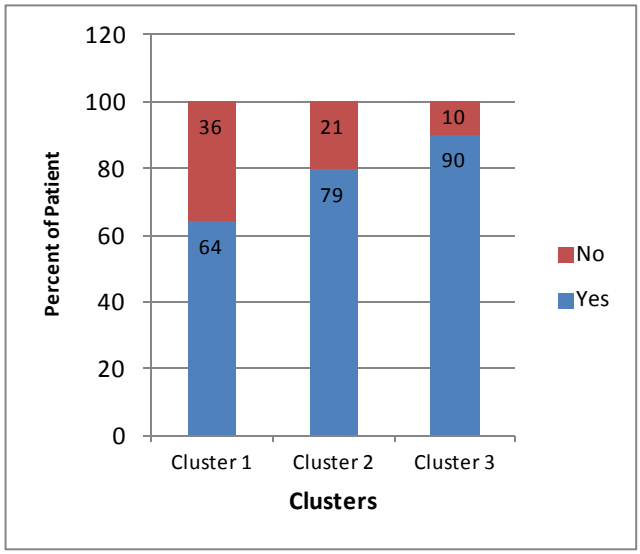

Figure 4. The number of yes and no criteria for variable aches (myalgia)

Clinical symptoms such as diarrhea, abdominal pain kind was classified by three clusters. Probabilty of these symptoms for each cluster showed is not so large, ie 0.1833, 0.208, and 0.2484. This is confirmed by Figure 5 which shows more patients do not experience these symptoms

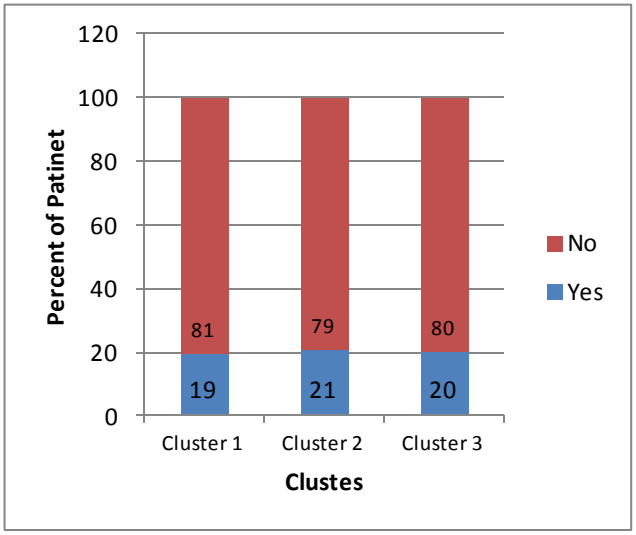

Figure 5. The number of yes and no criteria for variable abdominal pain (abdominal)

3.1.2. Latent Cluster for Continuous Variables

Concentration of hemoglobin is indication of dengue symptoms, Figure 6 shows the highest concentration hemoglobin is in second cluster with an average value of 15.8281. The second cluster is higher concentration of hemoglobin compare first and third clusters.

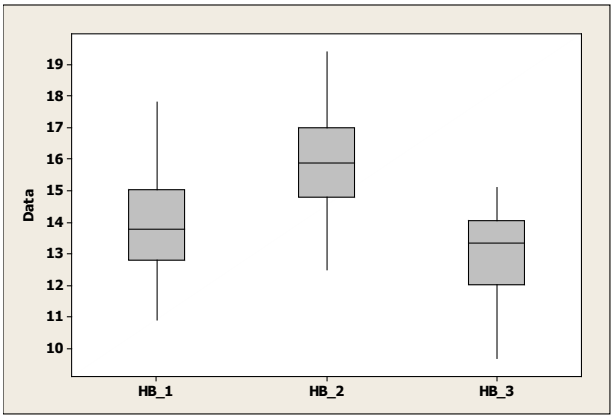

Figure 6. Boxplot for hemoglobin

The increasing hematocrit levels of patients is a sign for DHF. Third cluster has hematocrit levels of 31. While first, and second clusters show hematocrit levels less than third cluster.

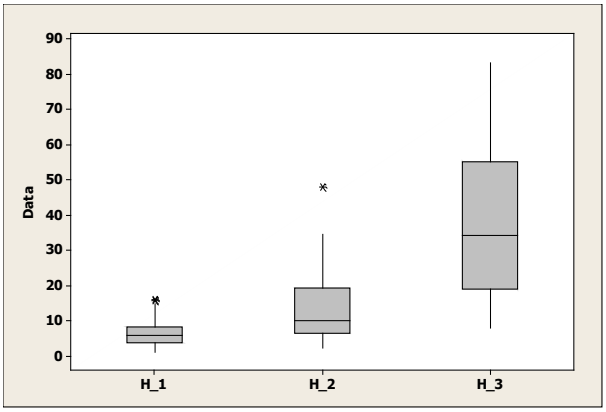

Figure 7. Boxplot for hematocrit

Platelets under 100.000/mm^3 usually found between day 3 to day 7. Second Cluster in Figure 8 shows the value of platelet levels lower than the other two clusters. The average of platelets level in second cluster only amounts to 15.000/mm^3. This amount is very small compared to the two other clusters with platelet level around 50.000/mm^3, however the numbers are still below 100.000/mm^3.

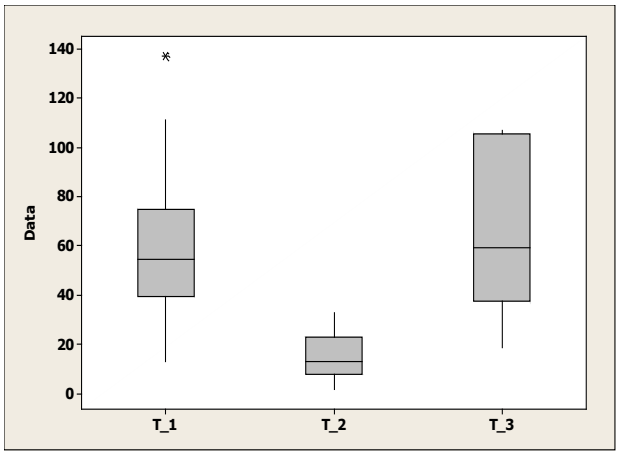

Figure 8. Boxplot for platelet

And the last indicator for positive of dengue fever is the number of leukocytes in the body. DHF patients usually have a low number of leukocytes. Figure 9 shows the average of the lowest number of leukocytes present in second cluster. Although number of leukocytes of second cluster is not different with first cluster, but range of the number of leukocytes of second cluster is smaller than first cluster.

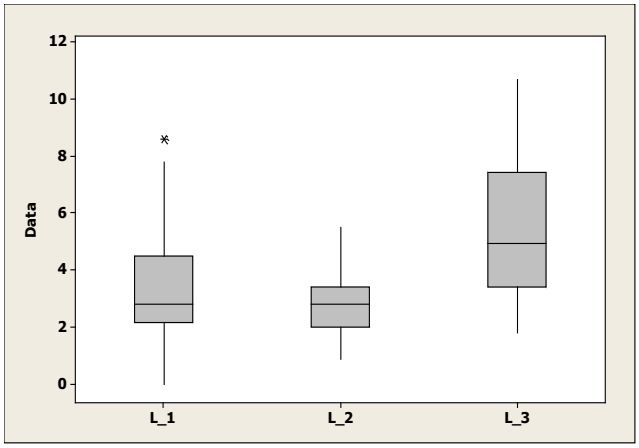

Figure 9. Boxplot for leukocyte

DHF symptoms of fever, aches, and abdominal pain of first cluster is more seldom compare second and third clusters. While the spots red body around quite a lot in this cluster. The first cluster has characteristics such patients do not experience fever, myalgia and abdominal, but there is petechiae with number of hemoglobin between 13.80-15.80, hematrokit number between 01.00-8.60, platelet count between 30.00-50.00 and the number leokosit between 2.10-2.60.

Second Cluster indicates positive dengue (DEN-3). Almost patients have a fever, and symptoms peacock spots, aches and abdominal pain. This cluster has a higher hemoglobin values compare the two other clusters, but not too high hematocrit, but platelets and leokosit are lower than the two other clusters. This cluster has characteristics such fever, myalgia and abdominal but not havingpetechiae with the amount of hemoglobin between 15.90-1940, hematrokit number between 8.90-83.33, 2.00-29.00 and platelet counts between leokosit number between 0:00 to 2:00 and 2.70-3.30.

The third cluster has the same symptoms as the two previous clusters, but this cluster has a lower amount of hemoglobin, but the number hematrokit, platelets and leokosit are higher compare first and second clusters.This cluster has a number of hemoglobin between 9.70-14.90, number of trombosit between 51.00-137.00,and leokosit number between 34.00-10.70.

3.2. Discussion for Second Objective

Bogor city has five districts, namely North Bogor District, East Bogor, West Bogor, South Bogor and Tanah Sareal. The number of villages of five districts namely 68. Ten villages which have the highest number of people in 2008 can be seen in Figure 10. Based on Figure 10 it is obtained that dengue fever, in the city of Bogor in 2008, most attack residents in the Bantarjati Village. DHF patients in village amounted to 91 people. The next highest number of patients with DHF were inTegalgundil and Baranangsiang Villages. DHF cases for each of these villages are 71 and 63 people respectively.

Distribution map of DHF patients in Bogor can be seen in Figure 11. Thematic maps were created by dividing the village into two groups. Village with the percentage of patients with DHFgreater than the average value is given red. Village with the percentage of patients with DHF less than the average value are colored yellow.

Thematic map in Figure11 shows that the group of villages has the same color has high spatial correlation.

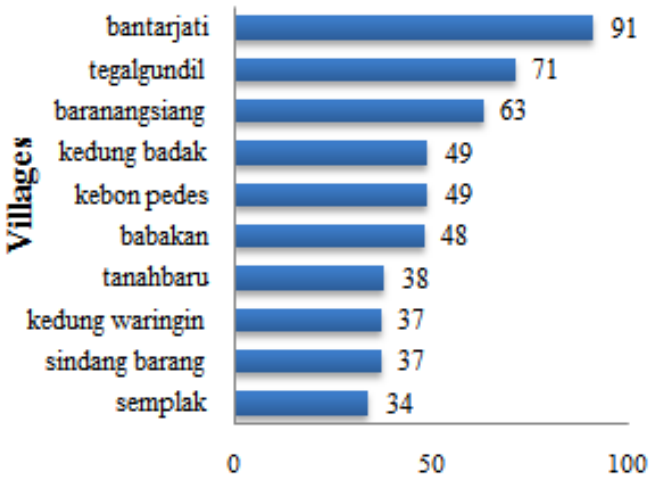

Figure 10. Ten villages in Bogor city with the largest number of dengue patients

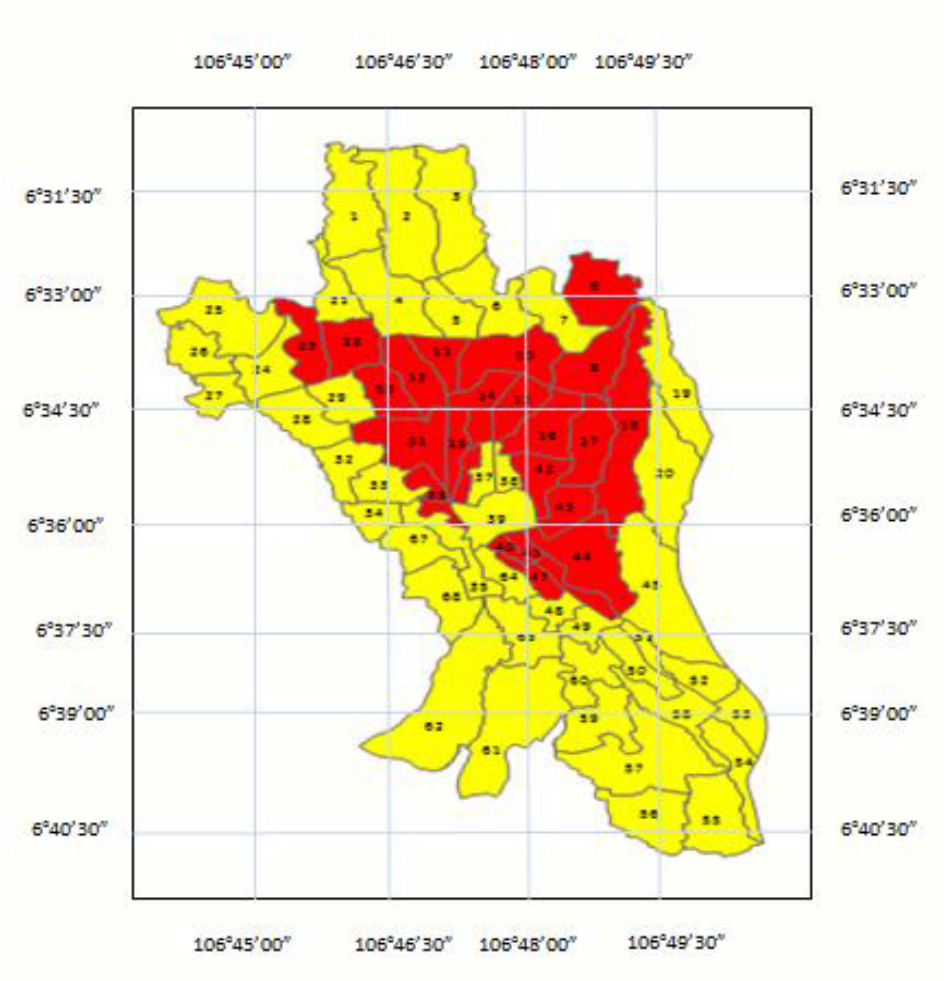

Figure 11. Distribution map of DHF patients in Bogor

3.2.1. Examination of Spatial Logistic Regression Model Assumptions

Table 3. The results of Pearson correlations between the explanatory variables

		X1	X2	X3	X4	X5	X6	X7	X8	Wy
X_1	Correlation	1.000								
	p-value									
X_2	Correlation	0.101	1.000							
	p-value	0.413								
X_3	Correlation	0.101	0.699*	1.000						
	p-value	0.414	0.000							
X_4	Correlation	0.013	-0.040	-0.066	1.000					
	p-value	0.916	0.748	0.594						
X_5	Correlation	-0.223	-0.078	0.087	0.183	1.000				
	p-value	0.068	0.529	0.481	0.136					
X_6	Correlation	0.031	0.106	-0.046	-0.104	0.014	1.000			
	p-value	0.801	0.389	0.710	0.397	0.907				
X_7	Correlation	0.320*	0.142	-0.173	-0.232	-0.320*	0.123	1.000		
	p-value	0.008	0.248	0.158	0.057	0.008	0.317			
X_8	Correlation	-0.173	0.021	0.078	0.183	0.269*	0.035	-0.161	1.000	
	p-value	0.158	0.865	0.529	0.135	0.026	0.776	0.189		
Wy	Correlation	-0.535*	-0.033	-0.077	0.030	0.319*	0.079	-0.236*	0.386*	1.000
	p-value	0.000	0.792	0.533	0.811	0.008	0.524	0.052	0.001	

*) Significant at $\alpha = 10\%$

Logistic regression model does not assume multicolinearity, the explanatory variables correlated. This is because the presence of multicolinearity will result in a standard error of the regression coefficients enlarge so that the Wald test results from each of the explanatory variables would be insignificant, and its significance not stable. The results of Pearson correlations between the explanatory variables are shown in Table 3.

These results demonstrate that some explanatory variables correlate. However, the correlation between the explanatory variables are correlated no more than 0.700. Therefore, it can be concluded that there is no multicollinearity in the data of this study and that the nine explanatory variables can be used in building the spatial logistic regression model.

3.2.2. Spatial Logistic Regression Model

The establishment of logistics model aims to determine the effect of explanatory variables simultaneously on response variables. Likelihood ratio test values generated at spatial logistic regression is 49,903. This value will give the decision to reject the null hypothesis (H0). This is because the value of Likelihood ratio tests> $\chi^2_{((0.05,9))}$ = 16,919, meaning logistic models can be used to predict the spread of dengue fever in the city of Bogor in 2008. The results of the spatial logistic regression model is shown in Table 4.

Table 4. The results of spatial logistic regression analysis

Predictor	Coeffisien	Standard Error	Wald	p-Value
Intercept	1.157	1.864	0.385	0.535
X_7	0.031	0.016	4.004	0.045*
Wy	**-0.034**	0.012	7.412	0.006*

*) Significant at α = 10%

Based on the wald test results obtained that two explanatory variables that significantly affect the real level of 10%, which is the distance to the nearest village health post (X7) and the average number of dengue patients in each village in Bogor (Wy). It can be seen from the resulting p-value of each variable of less than α = 10%.

3.2.3. Interpretation of Coefficient Odds Ratio

Interpretation of logistic regression models is done by looking at the value of each variable odds ratios that have been tested statistically. Odds ratio values for spatial logistic regression model are shown in Table 5.

Table 5. Odds ratio values for spatial logistic regression model

Predictor	Exp(B)	Confidence Interval 95%	
		Lower	Upper
Intercept	3.180		
X_7	1.032	1.001	1.064
Wy	0.967	0.944	0.991

Table 4 shows that for the variable average number of dengue patients in each village (Wy) had an odds ratio of 0.967. This value indicates that a unit increase in variable Wy, will cause an area alleged have a percentage of people with dengue fever greater than the value of average to be increased by 0.967 times. Based on the confidence interval, it can be said that at the level of 95%, an increase of one unit X_spatial 1 would lead to the possibility of a region having a larger percentage of DHF cases average values to be increased between 0.944 to 0.991 times.

Interpretation of the odds ratio for the distance to the nearest village health post (X7) in Table 5 had an odds ratio for 1032. This value indicates that the increase in the density of the distance to the nearest poskesdes of one square kilometer would lead to the possibility of a region of dengue fever patients having percentages greater than the value of average to be increased by 1032 times. Based on the confidence interval, it can be said that at the level of 95%, an increase in the distance to the nearest poskesdes of one square kilometer would lead to the possibility of an area have percentage of DHF cases greater than the value of average to be increased between 1.001 to 1.064 times.

3.2.4. Logistic Regression Model Evaluation

Evaluation of spatial logistic regression model can be seen from Correct Classification Rate (CCR). Spatial logistic regression models have a CCR value of 78.60%, so it can be stated that the spatial logistic regression model is good enough to suspect the spread of dengue fever in the city of Bogor in 2008.

4. Conclusions

- Symptoms of dengue fever begins suddenly with non-specific clinical symptoms such as weakness, back pain, bones, joints and head that lasts between 2-7 days then drop lysis. Other symptoms of this disease include bleeding manifestations usually appear in 2-3 days of fever. One of the common red spots around the body, this manifestation usually lasts for 3-6 days. Fatigue is another common clinical symptom experienced by patients. Clinical symptoms such as diarrhea, abdominal pain kind of look not so much occur in patients. Haemoglobin symptoms indicate that the higher the DHF. Increased levels of hematocrit is a sign of the patient suffering from dengue fever.The last indicator is seen in the determination of these patients were positive for dengue fever is the number of leukocytes in the body, DHF patients usually have a low number of leukocytes.
- Spatial factors proved significant in the spread of Dengue Hemorrhagic Fever (DHF) in the city of Bogor in 2008. Influence of spatial factors derived from the average number of dengue patients in each village. Another significant factor in the spread of dengue is poskesdes closest distance. Spatial logistic regression model is good enough to suspect the spread of dengue fever in the city of Bogor in 2008. It is seen from the CCR value of 78.60%.

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