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Spatio of Lungs Tuberculosis (*Tb Lungs*) in East Java Using Geographically Weighted Poisson Regression (GWPR)

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ABSTRACT

Pulmonary tuberculosis patients lose nearly 40% of their productive time. This results in reduced productivity if he is the head of the family or productive. In addition, pulmonary tuberculosis patients become highly dangerous transmitters if they do not pay attention to handling the correct cough and being in a location with a high sexual percentage. Likewise, people who are hurt, will have great information, contracting, if any, and very experienced. This study aims to map the grouping of tuberculosis patients and who are at risk of contracting by time rather than looking at the factors that influence it by using poisson regression that address the presence of GWPR over dispersion. The results obtained there are 5 grouping of areas, with the most significant factors of the district plus the ratio of Trenggalek basic health facilities (Z_2) and the percentage of school (Z_4) and poor population (X_1), BTA + (X_2), HIV / AIDS incidence rate (X_3) incidence of diabetes mellitus (X_4), population density (X_5) and ratio of health personnel (X_6).

Keywords: *TB Lungs, Poisson Regression, GWPR*

Introduction

Tuberculosis sucks the attention of developing and world governments, as the treatment of pulmonary TB patients takes a lot of money, energy and time. A pulmonary tuberculosis patient requires substantial funds to complete treatment and involves field workers who monitor and take 8 (eight) months treatment even more. This has a negative impact on developing countries that should require funding to advance education, technology and community prosperity[1]. The economic status is very closely related to TB transmission, since small income makes people unable to live by meeting health requirements. Pulmonary tuberculosis patients with low economic levels find difficulty in meeting the requirements of healthy homes or balanced nutrition, this is in line with the Rosiana[2] study, which lists 34.4% of respondents with smear + and resistant to Anti-Tuberculosis (OAT) drugs, derived from economic level below. Kizito et al (2014, p.300) in the Journal of Tuberculosis and Lung Diseases[3], wrote in Kampala, Uganda, that there were 100,000 people who had been notified and waiting treatment in 2013 who all lived in slum and densely populated with bad personal hygiene, which is the source of transmission of Mycobacterium tuberculosis. People with HIV / AIDS (Human Immunodeficiency Virus / Acquired Immuno Deficiency Syndrome) are susceptible to contracting pulmonary tuberculosis, this is supported by Mesfin, et al[4]multi-drug resistant tuberculosis (MDR. Likewise with Diabetes Mellitus, people with DM will experience weakness of the immune system, causing the sufferer to have 3 times more likely to suffer from TB, this is written by Laurentia M, et al[5], which within 10 years obtained the results of

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DM screening (Diabetes Mellitus) in patients with TB showed a high prevalence of about 5.4% - 44.0%, and otherwise diabetes mellitus as a risk factor to make TB resistant (OR: 1,5 - 8,9). So people with HIV-AIDS and people with DM if they become patients with pulmonary tuberculosis, are highly infectious transmitters.

Bera, dkk[3] writes with low house sanitation in a slum neighborhood in Maharashtra India, making children susceptible to contracting Mycobacterium Tuberculosis. The same thing was written in Fatimah, dkk[6] on the result of his research getting the lighting (OR = 3,286), humidity (OR = 3,202), ventilation (OR = 4,144). Home sanitation contributes to the survival of the Mycobacterium Tuberculosis germ, which is then a source of contagion. Kuruc V., et al. (2014) as well as Grant M (2014) writes in The International Journal of Tuberculosis and Lung Disease[3], in Cape Town South Africa the difficulty of reaching basic health facilities is one factor that makes a person slow to be detected as a tuberculosis patient.

Jacob, dkk[3] writes that the most dominant risk factor is education. To support the global tuberculosis control program, early introduction of pulmonary tuberculosis in primary schools and the use of information media needs to be improved in order to decrease cases and deaths from pulmonary tuberculosis especially in the productive age.

Based on the above explanation, this research would like to see the grouping of regions around Tuberculosis sufferers in East Java Province along with predictor variables that are likely to influence and see good relationship model by using poisson regression analysis.

Material and Method

This study uses secondary data from East Java Province Health Profile Year 2015 and P2TB Report Year 2015 East Java Provincial Health Office. The first dependent variable was the pulmonary tuberculosis sufferer who was first confirmed as the first patient (Y_1) with 6 predictor variables of the percentage of poor families (X_1), BTA + (X_2), the number of HIV / AIDS (X_3), numbers Genesis Diabetes Mellitus (X_4), the percentage of the population density of (X_5) and the ratio of health workers (X_6). Y_2 is a patient with pulmonary tuberculosis determined 3 months later, with 4 predictor variables of healthy house (Z_1), ratio of basic health facility (Z_2), percentage of household PHBS (Z_3), percentage of school population (Z_4) and the layout of the latitude South (ui) and East longitude layout (vi).

Data analysis using the following steps:

1. Detecting the presence of multicollinearity on the predictor data Y1 and Y2
2. Looking for the best model of poisson regression from transmitted and infected tuberculosis patient in East Java Province
3. Certainty of overdispersion
4. Looking for the best model from GWPR by looking at the smallest AICc number

Results

The detection result of non-occurrence of multicollinearity in each predictor of each dependent variable can be seen in table 1

Table 1: Data Multicolastic Detection

Transmitters TB (Y_1)		Infected TB (Y_2)	
Variable	**VIF**	**Variable**	**VIF**
Percentage of Poor Family (X_1)	2.002	Percentage of Healthy House (Z_1)	1.747
$BTA^+(X_2)$	4.684	Basic Health Facility Ratio (Z_2)	1.202
Number of Occurrences of HIV/AIDS (X_3)	5.183	Percentage of Households with PHBS (Z_3)	1.702
Genesis of Diabetes Mellitus (X_4)	3.028	Percentage of School Population (Z_4)	1.114
Percentage of Population Density (X_5)	7.721		
Ratio of Health Personnel (X_6)	2.112		

The result of the parameter estimation value reach convergent after the 5th iteration. Furthermore, the simultaneous parameter testing to determine whether there is influence of independent variables to the dependent variable with the following hypothesis :

$H_0 : \gamma_1^* = \gamma_2^* = \gamma_3^* = \gamma_4^* = \gamma_5^* = 0$

H_1 : most no one $\gamma_j^* \neq 0, j = 1, 2, 3, 4,5$

The deviance value in this analysis is 1660.2 and c _ ((32,0,0)) ^ 2 = 46.1943, then reject H_0 because D($\hat{\beta}$)$_{arithmetic}$ > $\chi^2(v; \alpha)$ so it can be concluded that there is at least one independent variable that has a significant effect on the dependent variable. Partial parameters are then tested to determine the effect of each independent variable.

$H_0 : \gamma_j = 0$ (the i-th variable has no significant effect)

$H_1 : \gamma_j \neq 0$, (the i-th variable gives significant influence) $j = 1, 2, 3, 4,5$

By using MLE method obtained the following parameter estimation:

Table 2: Partial Test Parameters Poisson Regression In pulmonary tuberculosis contracted with pulmonary tuberculosis source prediction

Parameters	Estimated	Standard Error	Z	P-value
γ_0	6.05500	0.0425600	142.249	0.000
γ_1	-0.00663	0.0003728	-17.789	0.000
γ_2	0.00359	0.0003666	9.778	0.048
γ_3	0.00117	0.0005919	1.975	0.002
γ_4	-0.00131	0.0004171	-3.143	0.018
	0.0008563	0.0000083	103.708	0.000

Table 2 shows that $|Z_{arithmetic}| > Z_{(\alpha/2)}$ where equal to 1.96, so at a significant level 5% reject H0 which means variable percentage of healthy homes (Z_1), ratio of basic health facilities (Z_2), percentage of households with PHBS (Z_3), percentage of school population (Z_4) and prediction Y_1 ($\hat{Y}_1$) has a significant effect on the number of people with pulmonary TB infected in 2015. So the poisson regression model obtained is as follows:

$\hat{\mu}$ = exp(6,055 – 0,007Z_1 – 0,004Z_2 + 0,001Z_3 – 0,001Z_4 + 0,0009($\hat{Y}_1$)

The increase and decrease of the number of lung tuberculosis patients infected with $\hat{Y}_1$ per district/city in East Java Year 2015 depends on the coefficient value of each influencing variable. Further examination of overdispersion cases in the Poisson regression model presented in table 3

Table 3: Overdispersion Inspection

Criteria	Value	db	Value/db
Deviance	1660.2	32	51.88

Table 3 shows that the deviance/db value of 51.88 is greater than 1 so it can be concluded in the poisson regression model the number of infected pulmonary tuberculosis patients with $\hat{Y}_1$ per district/city in East Java 2015 overdispersed.

The next step to get the GPR model is to determine the point of coordinates of latitude and longitude at each location, calculate the euclidean distance, and determine the optimum bandwidth value based on Cross Validation (CV) criteria. The next step is to determine the weighting matrix with the kernel function.

The weighted matrix obtained for each location is then used to form the model, so that different models are obtained at each observation location. Estimation of GWPR model parameters is presented in table 4 below:

Table 4: Parameter Model Estimation of GWPR

Parameters	Minimum	Maximum
γ_1	6.35866	6.93825
γ_2	-0.79574	0.12149
γ_3	0.00171	0.35332
γ_4	-0.16109	0.36839
γ_5	-0.38866	0.48457

Modeling the number of pulmonary tuberculosis patients infected with in the District / City of East Java Province using the Geographically Weighted Poisson Regression (GWPR) approach is temporarily a better model when compared to the Poisson regression model.

The hypothesis testing of the GWPR model consists of two tests, namely the GWPR model conformity test and the parameter significance test of the GWPR model. Here are the results of hypothesis testing GWPR model:

$H_0 : \gamma_k(u_i, v_i) = \gamma_k$; $k = 1, 2, \ldots, 38$ (There is no significant difference between the poisson regression model (global) and the GWPR model)

H_1 : There is at least one $\gamma_k(u_i, v_i) \neq \gamma_k$ (There is a significant difference between the poisson regression model (global) and the GWPR model)

Table 5: Table of Conformity Testing of GWPR Model with Adaptive Gaussian Weighing

Source	Deviance	DOF	Deviance/DOF
Global model	1.660.164	32.000	51.880
GWR model	281.060	6.661	42.192
Difference	1.379.104	25.339	54.427

Table 5 shows that the deviance/d0f difference of 54.427 and $\chi^2_{(26;\ 0.05)} = 38.8851$, then reject H_0 because it can be concluded that in the model the number of pulmonary tuberculosis patients is infected with $\hat{Y}_1$ per district/city East Java The year 2015 is GWPR

Next is the partial test of GWPR model parameter significance to find out which parameters significantly influence the number of infected pulmonary tuberculosis patients with $\hat{Y}_1$ in each observation location. The hypothesis used is as follows:

$$H_0 : \gamma_k(u_i, v_i) = 0$$

$$H_1 : \gamma_k(u_i, v_i) \neq 0;\ i = 1, 2, \ldots, 38;\ k = 1, 2, \ldots, 5$$

With a significance level (α) of 5%, $t_{(0,025;26)} = 2.055$. Predictor variables that influence significantly on each location of observation with bandwidth size = 3 can be seen that all observation locations identified variables that significantly affect all districts/municipalities in East Java Province.

Discussion

There are several variables that indicate the relationship of almost no correlation that meets the poisson regression requirements. Percentage of poor and average of school population variable in each district in East Java.

Predictor variables that significantly influence each location of observation with bandwidth size = 3, it can be seen that all observation locations significantly identify the variables that affect in all districts in East Java province grouping 5 areas. Being a reference for the treatment of pulmonary tuberculosis.

Conclusions

Based on the results of the analysis and discussion, it can be concluded that the GWPR model is more appropriate to analyze pulmonary TB patients in East Java because it has a smaller AIC value. The dominant factor in influencing pulmonary tuberculosis in all districts in East Java is the most significant factor except Trenggalek district ratio of basic health facilities and percentage of school population and poor families, BTA +, HIV/AIDS incidence rate, incidence of diabetes mellitus, population density and power ratio health. Influencing pulmonary tuberculosis patients in 5 districts/cities in East Java.

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