ISSN-0976-0245 (Print) • ISSN-0976-5506 (Electronic)

Volume 10 | Number 6 | June 2019

Indian Journal of Public Health Research & Development

An International Journal

SCOPUS IJPHRD CITATION SCORE

Indian Journal of Public Health Research and Development Scopus coverage years: from 2010 to 2018 Publisher: R.K. Sharma, Institute of Medico-Legal Publications ISSN:0976-0245E-ISSN: 0976-5506 Subject area: Medicine: Public Health, Environmental and Occupational Health

Cite Score 2017- 0.03

SJR 2017- 0.108

SNIP 2017- 0.047

Covered by Scopus

EMBASE

Approved by MCI

Website:

www.ijphrd.com

DOI Number: 10.5958/0976-5506.2019.01305.6

Modeling the Number of Cases of Tuberculosis Sensitive Drugs (TBSD) in East Java using Geographically Weighted Poisson Regression (*GWPR*)

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ABSTRACT

Tuberculosis lungs attacked the most productive age group (15-50 years), social economy is weak and low education. Estimated a patient TB adult will lose the average time it works 3-4 months. This resulted in the loss of annual revenue run their house around 20-30%. In addition to harm economically, TB also provides other negative impact socially, even excluded by the community. In this research will be discussed about the factors that were supposed to affect many cases for TBSD which occurred in East Java with Poisson regression. But because they found the existence of the case of overdispersi so that need to pay attention to the factors location from the point of observation and used GWPR. From the results of the analysis and discussion, obtained the result that GWPR model more appropriate to analyze the patients TBSD in East Java because it has smaller AIC value . The dominant factor in influencing TBSD in all districts in East Java is the percentage of poor families (X_1), except in Ngawi district and Magetan. For BTA^+ (X_2), the number of HIV/AIDS (X_3), numbers genesis diabetes mellitus (X_4), the percentage of the population density (X_5) and rasio health workers (X_6) affect TBSD patients in 7 groups of districts in East Java.

Keywords: *TBSD, Poisson Regression, GWPR*

Introduction

The Disease TB lungs is the cause of the death of three number after cardiovascular disease and respiratory disease in all age groups and the number one from the infectious diseases. Roughly estimated each 100,000 inhabitants of Indonesia there are 115 new patients TB positive lung. The Disease TB lungs attacked the most productive age group (15-50 years), social economy is weak and low education[1]. Estimated a patient TB adult will lose the average time it works 3-4 months. This resulted in the loss of annual revenue run their house around 20-30%. In addition to harm economically, TB also provides other negative impact socially, even excluded by the community. The main cause of increasing the burden of the problem of TB among others is poverty on various community groups such as in the countries of developing, changes it conveys demographics due to the rising world population and changes in the structure of the age of population; the impact of the HIV pandemic.

The problem of treatment TB become an important public health problem and need to be solved soon. The incidence of drug resistance increased since the introduction of the treatment of TB that first time in 1943. Tuberculosis Case Sensitive drugs continues to increase. Mok, et all[2] write that from 378 respondents with TB of Internally throughout the year 2010 with 2014 on 7 Hospital Education in Korea, obtained 57.1% patients with TB of primary SD. Clinical managements TB uses drugs anti-TB lini I and II causing the problem of tolerance and side effects. Patients with TB that have undergone treatment for the first time, feel himself back healthy, they really very infeksius until they assigned no longer as patients through a number of test.

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The results of research done in West Nusa Tenggara (NTB) by Erawatyningsih, [3] et all, The type of the work of patients with TBSD that on the move, make the desperate patients continued treatment, which impact with the prolonged especially more resistensinya against *Mycobacterium tuberculosis* so that patients become very infeksius source.

The status of the economy very closely also with contracting TB, because the small income make people could not live worthy to meet the conditions of health. Patients with TB of internally with low economic level, find difficulties in the requirements of healthy house or balanced nutrition, this is in line with the research[4], Who wrote as much as 34.4 percent of respondents with BTA^+ and resistant to Drugs Anti Tuberculosis, is derived from the economic level below.

Kizito, et all[5] in The Journal of Tuberculosis and Lung Disease, wrote in Kampala, Uganda, there are patients with TB of Internally that "*limits been notified and waiting treatment*" in 2013 as much as 100 people who are all located living in a shantytown and densely populated with personal hygiene bad, which is the source of infection Mycobacterium *tuberculosis*.

Patients with HIV/AIDS vulnerable to continued for 2 nd shot TB of the Lung directly in stages TB of Internally supported this research[6]multi-drug resistant tuberculosis (MDR. Similarly with Diabetes Mellitus, backer DM will experience of the weakness of the immune system that is causing the sufferers have the possibility of 3 times higher to suffer TB, this written by Laurentia, et all[7], Which in the period of ten years obtained screening result DM (*Diabetes Mellitus*) in patients with TB shows a high prevalence of around 5.4 % - 44.0 %, instead of diabetes mellitus as a risk factor makes TB resistant (OR:1.5 - 8.9). So that patients with HIV-AIDS and disabilities DM if to patients with TB is very infeksius. So in this research, want to obtained the relationship between the number of cases of patients with TB of internally in East Java with the variables predictors which allegedly influence with how to get the best relationship model using poisson regression analysis.

Material and Method

This research using secondary data obtained from the profile data the health of the province of East Java 2015 and Reporting Data P2TB East Java Provincial Health Office 2015. The variable data is examined in the form of the address and the date the enactment of respondents as patients with TB of internally in East Java Province. The variables used in this research consists of one response variable (Y) , the number of patients with TBSD and 6 predictors variables, 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) and the layout of the latitude south (ui) and East longitude layout (vi)

The steps done in the analysis of the data to achieve the goal of research covers

1. Do multikolinieritas detection against the variables predictors
2. Get the best model Poisson Regression on the number of patients with TBSD modeling **in East Java**
3. Get the best model GWPR on the modeling the number of patients with TBSD in East Java with some analysis phase

Results

Before done multiple regression analysis which contains more than 1 free variable test needs to be done in the variable multikolinearitas predictors. Multicolinearity check on this research based on based on the correlation between and the value of VIF each of which is shown in table 1

Table 1: Matrix of the correlation between the variables Predictors

Correlation coefficient (P-value)alue)	TBSD	X_1	X_2	X_3	X_4	X_5	X_6
X_1	-0.005	*	*	*	*	*	*
	0.978	*	*	*	*	*	*
X_2	0.965	0.016	*	*	*	*	*
	0.000	0.923	*	*	*	*	*
X_3	0.782	-0.369	0.785	*	*	*	*
	0.000	0.023	0.000	*	*	*	*
X_4	0.656	0.233	0.629	0.507	*	*	*
	0.000	0.159	0.000	0.001	*	*	*

Conted…

X_5	0.834	0.057	0.833	0.730	0.791	*	*
	0.000	0.736	0.000	0.000	0.000	*	*
X_6	-0.389	-0.404	-0.404	-0.139	-0.471	-0.572	*
	0.016	0.012	0.012	0.404	0.003	0.000	*

Other criteria that can be seen is the value of VIF multikolinearitas cases. To view this condition multikolinearitas then can use VIF value (Variance Inflation Factor). VIF values in each of the variables predictors can be seen in the table 2

Table 2: The value of the *Variance Inflation Factor* on TBSD

The variables	VIF
The percentage of poor families (X_1)	2,002
$BTA^+(X_2)$	4.684
Number of HIV/AIDS (X_3)	5.183
The number of Diabetes Mellitus (X_4)	3.028
The percentage of the population density of (X_5)	7.721
The ratio of health workers (X_6)	2.112

The results of the parameter estimation value reached convergence after iteration 4. Next, test is done simultaneously parameters to know is whether or not the influence of the independent variables against the dependent variables with the hypothesis as follows:

H0 : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

H1 : most no one $\beta_j \neq 0, J = 1, 2, 3, 4, 5, 6$

The value of the *deviance* on this analysis of 3023.5 and $\chi^2_{(31;\ 0,\ 05)} = 44.9853$, Then reject H_0 because $D(\hat{\beta})_{hitung} > \chi^2(v;\ \alpha)$ So it can be concluded that there are at least one independent variables that affect the significant impact on the dependent variables. Then the test is done partially parameters to know the influence of each independent variables.

H0 : $\beta_i = 0$ (Variables to-*I* do not affect significant)

H_1 : $\beta_i \neq 0$ (Variables to-*i* give significant influence)

Using the MLE method obtained the estimation of parameters as follows:

Table 3: Partial test Poisson Regression Parameters on TBSD

The Parameters	The estimation	Standard Error	Z	P-value
β_0	595.600	0.0325900	182.736	0.000
β_1	0.00247	0.0016940	1.459	0.144
β_2	0.00080	0.0000222	35.912	0.000
β_3	-0.00057	0.0000634	-8.936	0.000
β_4	0.00008	0.0000067	11.210	0.000
β_5	0.04966	0.0086770	5.723	0.000
β_6	-0.00125	0.0002716	-4.595	0.000

Table 3. Show that $|Z_{hitung}| > Z_{(\alpha/2)}$, Where $Z_{(0,025)}$ By 1.96, so that on a significant level 5 percent decline H_0 which means a variable BTA^+, the number of HIV/AIDS, numbers Genesis Diabetes Mellitus, the percentage of the population density and the ratio of health workers influential significant on the number of patients with TB of contraction 2015. While for the variable the percentage of poor families is not significant in affecting the number of patients with TBSD 2015, because the value of Z smaller than 1.96 or p-value = 0.144 greater than 0.05, in get the poisson regression model obtained is as follows:

$$\hat{\mu} = \exp(5.956 + 0{,}00247\ X_1 + 0{,}0008X_2 - 0{,}00057\ X_3 + 0.00008\ X_4 + 0.04966\ X_5 - 0.00125\ X_6)$$

Increase or decrease the number of patients with TB contraction each district in East Java 2015 depending of the value of the coefficient of each variable

that influence. Furthermore done overdispersi case examination on poisson regression model is Value of Deviance 3023.5, Db 31, is 97.532 greater than 1 so that it can be concluded on poisson regression model number of patients with TBSD each district in East Java 2015 happened *overdispersi*.

The analysis using the GWPR method aims to know the variables that affect the prevalence of TB Disease occurrence in each of the location of the observation in Regency/City of East Java Province. Following the modeling the number of patients with TB using GWPR method.

The first step is done to get GWPR model is to determine the coordinates of the point latitude and longitude on each location to count the distance *euclidean*, and determine the optimum bandwidth values based on the criteria *AICc*. The next step is to determine the matrix pembobot with kernel function.

The matrix weights obtained for each location and then used to form a model, so that obtained the model vary in each location of observation. The estimation of model parameters GWPR served in table 4 below

Table 4: The estimation of Model Parameters GWPR

The Parameters	Minimum	Maximum
β_1	48.571	105.096
β_2	-12.877	21.924
β_3	-22.601	66.571
β_4	-55.040	39.825
β_5	-58.488	172.953
β_6	-158.257	79.939

Modeling the number of patients with TB in Regency/City of the province of East Java using *Geographically Weighted Poisson Regression* approach to while is a model that better if compared with the poisson regression model.

Testing the hypothesis GWPR model consists of two test, namely suitability test GWPR model and test the significance of the parameters GWPR model. The following is the results of the hypothesis testing GWPR model:

$H_0 : \beta_k(u_i, v_i) = \beta_k$; K = 1, 2, ..., 12 (there is no significant difference between the poisson regression model (global) and GWPR model)

H_1 : There is at least one $\beta_k(u_i, v_i) \neq \beta_k$ (no difference between significant poisson regression model (global) and GWPR model)

Table 5: Test the suitability of the GWPR Model Deviance table with Adaptive Gaussian

Source	Deviance	DOF	Deviance/ DOF
The Model Global	3.023.533	31	97.533
Model GWR	5.035	0.067	75.344
Difference	3.018.497	30.933	97.581

Table 5 shows that the value of the *deviance*/d0f difference of 97.533 and , Then Reject H_0 because $\hat{B}(\beta)_{hitung} > \chi^2(v; \alpha)$so it can be concluded that on the model of the number of patients with TB of Internally each district in East Java 2015 is GWPR

The next step is testing the significance of model parameters GWPR partially to know any parameters that affect the number of patients with TB in each location of observation. The hypothesis that is used is as follows:

$H0 : \beta_k(u_i, v_i) = 0$

$H1 : \beta_k(u_i, v_i) \neq 0$; $I = 1, 2, ..., 31$; $k = 1.2, ..., 12$

With equal significance (α) of 5%, value $t_{(0,025;32)}$ = 2,037. The following variables predictors which affect significantly on each observation location that is served on the table 6

Table 6: The value of T-statistic on the variables in each District Using Adaptive Guassian

Regency/City	The value of T Statistic					
	X_1	X_2	X_3	X_4	X_5	X_6
1"Pati. Pacitan"	-54.447	223.337	-38.801	-24.748	56.666	52.772
2"Pati. Ponorogo"	-27.904	218.396	18.701	77.947	87.791	86.750
3"Pati. Trenggalek"	-36.326	-39.968	-46.947	-59.740	75.701	66.345

Conted…

4”Pati. Tulungagung”	32.974	52.204	42.849	36.585	-23.475	-16.899
5”Pati. Blitar”	82.888	43.730	85.544	17.946	17.547	17.390
6”Pati. Kediri”	46.568	106.314	95.013	76.590	-54.054	-29.119
7”Pati. Malang”	-0.1104	78.893	28.740	73.180	-97.396	32.795
8”Pati. Lumajang”	96.700	-86.655	120.370	-134.223	138.343	112.805
9”Pati. Jember”	29.281	47.748	-29.973	59.742	88.590	129.906
10”Pati. Banyuwangi”	43.475	56.232	-76.513	-0.0264	117.505	109.826
11”Pati. Bondowoso”	34.774	56.502	-72.980	-0.0968	115.730	108.796
12”Pati. Situbondo”	74.222	-11.049	22.423	49.315	-11.294	-18.388
13”Pati. Pasuruan”	95.406	-68.808	85.331	-90.812	109.879	105.022
14”Pati. Probolinggo”	-106.145	173.646	54.790	205.069	-202.954	-225.150
15”Pati. Sidoarjo”	171.795	-59.767	-78.479	-79.053	120.578	129.208
16”Pati. Mojokerto”	229.918	183.576	-244.911	-17.923	186.133	235.483
17”Pati. Jombang”	86.042	150.312	33.690	88.222	-89.108	-66.703
18”Pati. Nganjuk”	-30.979	59.343	37.827	-0.2297	-54.149	-33.304
19”Pati. Madiun”	56.514	-82.479	-122.755	86.478	100.275	124.180
20”Pati. Magetan”	72.870	93.327	76.619	-69.419	-63.106	-38.097
21”Pati. Ngawi”	58.407	-85.240	-121.735	75.876	103.949	114.212
22”Pati. Bojonegoro”	-0.7205	69.335	-23.719	-0.3748	-47.912	-14.244
23”Pati. Tuban”	-23.838	305.446	-31.315	42.787	-21.117	25.397
24”Pati. Lamongan”	-16.649	235.913	-148.762	23.086	-11.165	52.992
25”Pati. Gresik”	119.483	-73.714	15.814	-125.506	175.732	124.129
26”Pati. Bangkalan”	115.961	-69.106	13.133	-112.746	161.554	104.654
27”Pati. Sampang”	-14.329	37.483	-47.588	15.548	86.688	43.456
28”Pati. Pamekasan”	-50.710	225.124	-30.726	-12.807	53.635	48.859
29”Pati. Sumenep”	42.327	-14.720	15.877	-36.080	124.987	49.093
30”Kediri City”	41.334	105.730	92.832	74.423	-51.047	-26.880
31”City of Blitar”	86.603	60.815	93.222	23.204	12.966	15.168
32”Malang city”	-90.807	147.730	-70.845	91.504	-113.062	-56.199
33”Probolinggo town”	0.7149	107.769	43.488	87.139	-48.394	53.889
34”Pasuruan”	165.061	-89.103	107.585	-35.915	46.409	107.178
35”City Mojokerto”	62.252	140.166	-188.084	-140.801	157.770	155.373
36”Madiun”	46.913	-76.313	-116.243	95.820	99.838	122.282
37”Surabaya City”	206.871	-22.225	-69.377	-180.011	230.246	125.808
38”Batu”	-19.297	158.293	27.918	100.190	-128.011	-74.148

Discussion

There are several variables that indicate the relationship of almost no correlation that meets the requirements of poisson regression and 2 predictor variables assessing VIFs over 10 percentage of poor people in each district in East Java and the average of school population variables in each district in East Java.

Based on table 6, with bandwidth size = 9 it can be seen that all observation locations identify variables that significantly influence in all districts in East Java province to group 7. Being the reference of handling pulmonary tuberculosis disease.

Conclusions

Based on the results of the analysis and discussion, can be concluded that the model of the GWPR more appropriate to analyze the patients TBSD in East Java because it has smaller AIC value. The dominant factor in influencing TBSD in all districts in East Java is the percentage of poor families, except in Ngawi district and Magetan for BTA^{+}, the number of HIV/AIDS, numbers genesis diabetes mellitus, the percentage of the population density and rasio health workers affect TBSD patients in 7 groups of districts in East Java.

Conflict of Interest: There is no conflict of interest for authors.

Source of Funding: This research funded by the authors themselves. No other financial support received.

Ethical Clearance: Ethical reviewed has been done at the ethical standards of the Health Research Ethics Committee Faculty of Public Health Airlangga University.

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