Conference Paper

Spatial Autocorrelation Analysis of Tuberculosis Cases (2016-2018) In Kebumen

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Abstract

Tuberculosis (TB) is one of the tenth highest causes of death in Indonesia and even worldwide. Tuberculosis is an infectious disease caused by an infection of Mycobacterium tuberculosis bacterium. Kebumen is one of the districts with high tuberculosis cases and tends to increase every year. Based on the high case number, it is necessary to start research that examines patterns of spread. Spatial analysis is a very useful tool to evaluate the spreading pattern of the tuberculosis disease according to its geographical location. The study aimed to spatially analyze tuberculosis spread pattern from 2016 to 2018 using the spatial autocorrelation method through Moran Index and Local Indicator of Spatial Association (LISA). The study showed that the spatial autocorrelation in the spreading patterns of tuberculosis occurred in Kebumen and had a clustered pattern because of Moran Index is positive. The results of the LISA analysis in the High-High quadrant showed that the high tuberculosis cases correlated with areas that also had high tuberculosis cases. Sixteen villages were included in the High-High quadrant.

Keywords: lisa, moran index, spatial analysis, spatial autocorrelation, tuberculosis

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1. Introduction

Based on the WHO report, tuberculosis represents a disease that is ranked as the tenth highest cause of death in the world in 2016 [1, 2]. TB is still the top priority in the world and one of the goals in the SDGs (Sustainable Development Goals). Base on WHO that has released Global TB Report 2018, tuberculosis in Indonesia is estimated to reach 842 000 cases with a mortality rate of 107 000 cases [3]. It makes Indonesia as the third highest for TB cases after India and China that means Indonesia has a major problem in dealing with tuberculosis.

Kebumen is one of the districts that has high morbidity value compared to other districts in Central Java. Kebumen has coastal and mountain areas so that existing various diseases, such as tuberculosis, HIV/AIDS, diarrhea, leprosy, dengue fever and malaria [4, 5]. In 2017 occurred 1 844 cases, the case increased compared to the previous

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year [4]. Tuberculosis is an infectious disease caused by an infection of bacterium Mycobacterium tuberculosis [6]. The disease can be transmitted through droplets of people who have been infected with tuberculosis bacillus.

The high number of tuberculosis cases in the Kebumen Regency necessary to research for determining the spatial distribution patterns by using spatial statistics. Spatial statistics generally use the concept of spatial autocorrelation. Spatial autocorrelation is a value of consideration between variables [7]. In simple terms, spatial autocorrelation means the value of the similarity of objects in a space. In spatial autocorrelation, variable data can show spatial patterns [8].

This study aims to spatially analyze the tuberculosis's spreading pattern from 2016 to 2018 by using the spatial autocorrelation method through the Moran Index and Local Indicator of Spatial Association (LISA). The Moran index is a global index used to determine whether there is a spatial relationship in disease spreading. Whereas LISA is used to evaluate the tendency for spatial grouping locally and to show some forms of spatial relations.

2. Methodology

The following section will describe and discuss the methodology used in this study, including the study area, the data processing, and the method used.

2.1. Study Area

Kebumen is one of the districts that has a high morbidity value compared to other districts in Central Java. Geographically, Kebumen has coastal and mountain areas, so the existing diseases vary. Pulmonary tuberculosis is still a serious health problem in Kebumen because the number of cases increasing every year

2.2. Materials and Methods

The data used are tuberculosis cases in the Kebumen area in 2016, 2017, and 2018. The spatial analysis method used is the Moran Index and Local Indicator of Spatial Association (LISA).

2.2.1. Data Collection

This research used data on the distribution of tuberculosis cases that is obtained from the Kebumen Health Office with a range of years from 2016 to 2018 with the smallest spatial unit is village. The data obtained is from the spreadsheet data in.xlsx file format. Other data used are the administrative boundaries of Kebumen obtained from the Geographic Information Agency (BIG). Also, both data are combined in the in the shapefile data format.

2.2.2. Moran Index

Moran's Index is the most commonly used method to measure global spatial autocorrelation and quantify the similarity of outcome variables between regions defined as spatially related[9,10]. It can be applied to detect the beginning of spatial randomness. The beginning of spatial randomness indicates spatial patterns such as grouping or forming trends towards space. The value generated in the Moran Index calculation ranges from -1 to 1. The value of the zero value index is not grouped, the positive Moran's Index value indicates positive spatial autocorrelation which means that adjacent locations have similar and grouped values, and the Moran's Index value the negative indicates negative spatial autocorrelation which means that adjacent locations have different values [11]. According to Lee and Wong, the value of Moran Index is obtained through equation (1) [7].

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} \left(x_i - \overline{x}\right) \left(x_j - \overline{x}\right)}{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2} \tag{1}$$

Then hypothesis testing of parameter I is carried out as follows:

H0: there is no spatial autocorrelation

H1: there is positive autocorrelation (Moran Index is positive) or H1: there is negative autocorrelation (Moran's I index is negative).

After that, determine the critical value with a certain level of significance. Determination of the test values with the Z-score is used equation (2)

$$Z(I) = \frac{I - E(I)}{\sqrt{Var(I)}} \tag{2}$$

Where,

$$E(I) = \frac{-1}{(n-1)} \tag{3}$$

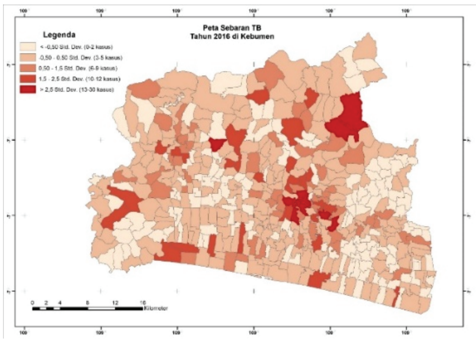
After the Z-score value is obtained from equations (2) and (3), then a critical value is tested. This test will reject the initial hypothesis if the value $|Z(I)| > Z(\alpha)$.

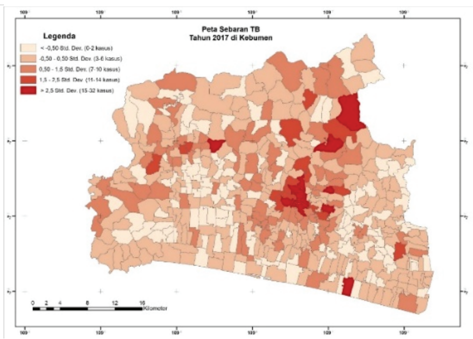
2.2.3. Local Indicator of Spatial Association

In this case, the spatial autocorrelation is that Moran Index does not provide information on spatial patterns in certain regions so that LISA analysis is needed. LISA can present spatial autocorrelation in each region on a variable, which can measure spatial relation for each location or correlation with each adjacent value [12].

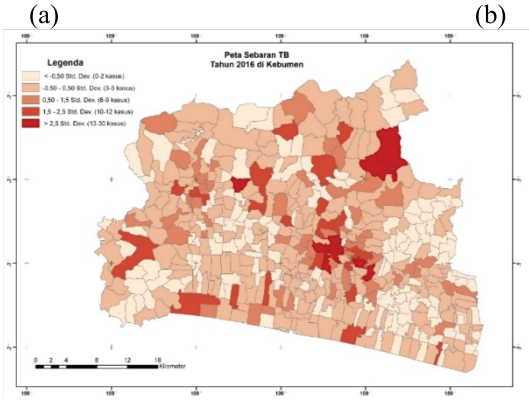
3. Result and Discussion

Data on the distribution of tuberculosis that have been obtained from the Kebumen District Health Office is then merged with the administrative boundaries of Kebumen Regency. Data on the distribution of tuberculosis range from 2016 to 2018 with the smallest spatial unit, namely the village shown in Figure 1.





(a) (b)



(c)

Figure 1: The map of tuberculosis distribution (a) 2016; (b) 2017; (c) 2018.

The data distribution is shown in Figure 1. The distribution of cases from the picture is shown by gradual color (value); dark red indicates the number of frequencies cases that occur more and the pink color near white shows a slight case. Result in 2016 shown by Figure 1. (a), Figure 1. (b) in 2017 and Figure 1. (c) in 2018.

Statistically, tuberculosis distribution data is shown in table 1.

TABLE 1: Descriptive statistics on tuberculosis distribution data from each village.

	2018	2017	2016
MIN	0	0	0
MAX	31	32	30
MEAN	3.83	3.88	3.45
MEDIAN	3	3	3
STANDEV	3.77	4.06	3.63
TOTAL CASES	1618	1638	1455

From Table 1. In 2018, there were a total of 1618 cases of pulmonary tuberculosis with the highest cases in one village totaling 31 cases, namely in Panjer Village and the lowest was 0 cases, while the average value was 3.83 ≈ 4 cases. In 2017 there were a total of 1638 cases of pulmonary tuberculosis with the highest cases in one village totaling 32 cases, namely in Tamanwinangun Village and the lowest was 0 cases, while the average value was 3.88 ≈ 4 cases. Whereas in 2016 there were a total of 1455 cases of pulmonary tuberculosis with the highest cases in one village totaling 30 cases, namely in Panjer Village and the lowest was 0 cases, while the average value was 3.45 ≈ 4 cases.

Based on Figure 1. the spatial pattern graphically is not too visible, even the distribution pattern is random, or it does not show a significant spatial pattern. Further testing is needed to be able to ascertain whether there is a spatial pattern, in this case spatial autocorrelation.

The results of processing spatial autocorrelation are used by Moran's Index method. This analysis uses attribute data of pulmonary tuberculosis distribution in 2018 (TB 1), 2017 (TB 2) and 2016 (TB 3) in Kebumen region. Moran Index value ranges from 1 to -1 with Moran Index value (I) > 0 indicating that spatial autocorrelation is considered positive and has a cluster pattern 13. If Moran Index global value (I) = 0, then the data does not occur spatial autocorrelation, while the Moran Index (I) < 0 autocorrelation value is negative that related to dispersed patterns. Process analysis using the help of ArcGIS and Geoda software to obtain the results of the Moran's Index (I) and Z-score. The results obtained were made by making hypotheses and statistical tests used in testing spatial autocorrelation. Calculation of values based on comparison (1) and Z-score obtained by equation (2). The results of the Moran's Index and Z-score are shown in Table 2.

Based on the results of Table 2. in 2018, Moran Index value is positive which is equal to 0.336319 which means that it has a group data pattern. In 2017, the value of Moran

Table 2: Moran's Index.

No	Year	Moran's I	Z-score	*Variance*	*p-value*
1	2018	0.336319	19.168345	0.000312	0.000000
2	2017	0.329776	18.817987	0.000311	0.000000
3	2016	0.281968	16.099922	0.000311	0.000000

Index was 0.329776 which means it entered into a group pattern, whereas in 2016 it also had a group pattern with the value of Moran Index of 0.281968.

To ascertain whether there is spatial autocorrelation or the significance test cannot be used as follows.

Null hypothesis (H0): I = 0 (there is no spatial autocorrelation)

Alternate hypothesis (H1): $I \neq 0$ (there is spatial autocorrelation)

The level of significance: Z (α) is 0.05, which is 1.64

Determination of critical values: H0 rejected if value I Z (I) I > Z (α)

Determination of test value: calculation of Z (I) 1 = 19.168345, Z (I) 2 = 18.817987, Z (I) 3 = 16.099922.

Draw conclusions: Rejected because of Z (I) 1, Z (I) 2 and Z (I) 3> Z (α) so that it can be concluded that spatial autocorrelation occurs.

The value of spatial autocorrelation cannot display spatial pattern information in a particular area so that a visual display of the tendency for spatial relationships is needed by using the Local Indicator of Spatial Association (LISA). The LISA value can be used to display a grouping of significant spatial relationships. The LISA value is divided into 4 categories namely high-high (H-H), low-low (L-L), high-low (H-L) and low-high (L-H). The LISA results in 2016, 2017 and 2018 show a pattern in Figure 2.

High-High Area (HH) shows areas that have high observation values surrounded by areas that have high observation values. In 2016 there were 26 villages included in this area. The Low-Low Area (LL) indicates an area that has low observation value surrounded by an area that has low observation value. In 2016 there were 37 villages. In 2017, the HH area numbered 35 villages and LL areas numbered 29 villages. Whereas in 2018, the HH area was 29 villages and also LL was 47 villages. In 2016 until 2018, there were 16 villages included in the HH area continuously, that are Murtirejo, Murtirejo, Jatisari, Muktisari, Tamanwinangun, Kalirejo, Selang, Panjer, Kebumen, Bumirejo, Kutosari, Gemeksekti, Karangsari, Kedawung, Pejagoan, Kuwayuhan and Semondo. While for LL area there are 4 villages, namely Kradenan Village, Sugihwaras, Tepakyang and Sidamukti

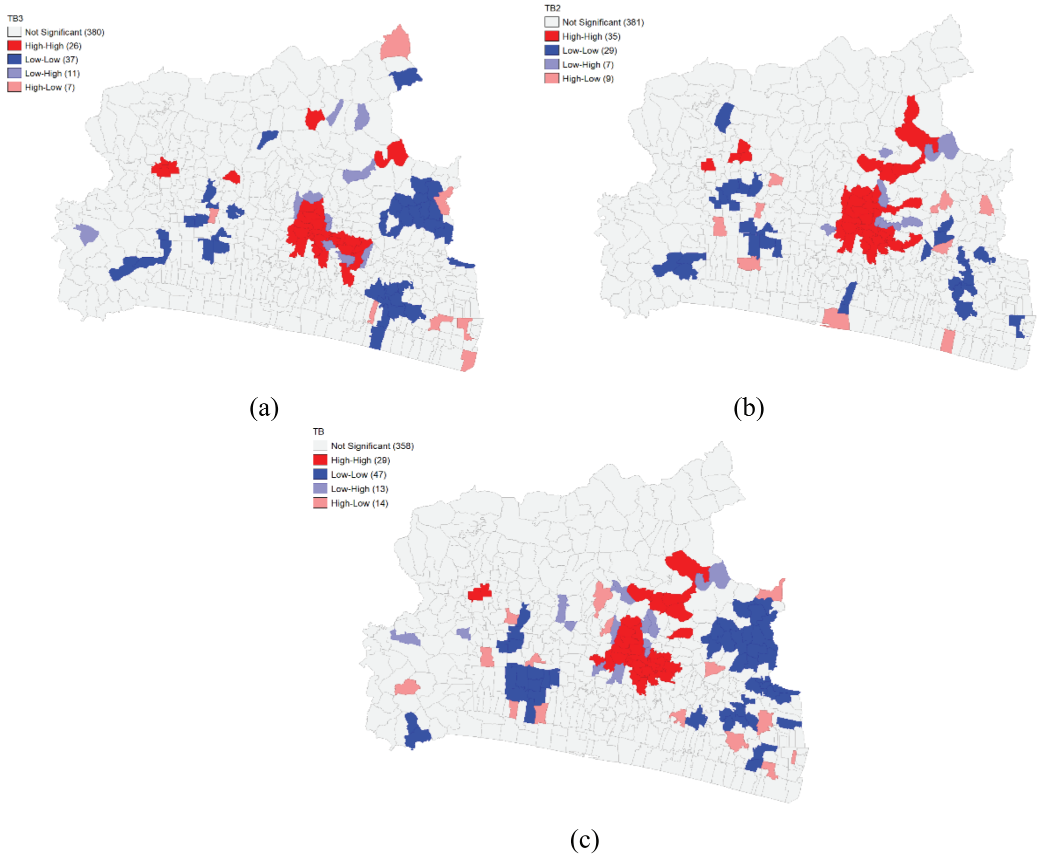


Figure 2: LISA result (a) 2016; (b) 2017; (c) 2018.

4. Conclusion

The conclusion of this study is that spatial analysis using the spatial autocorrelation method is very useful to determine the spreading pattern of the tuberculosis. The calculation of the value of Moran Index in 2018 is equal to 0.336319, in 2017 is 0.329776 and in 2016 is 0.281968. Three Moran Index show positive values which means they are included in a group pattern. The statistical test of the Moran Index is done with a value of Z (α) of 0.05 resulting in the conclusion that there is spatial autocorrelation in the data. The LISA analysis results show a tendency for spatial grouping. The villages included in the HH area continuously in 2016 to 2018 are 16, namely Murtirejo, Jatisari, Muktisari, Tamanwinangun, Kalirejo, Selang, Panjer, Kebumen, Bumirejo, Kutosari, Gemeksekti, Karangsari, Kedawung, Pejagoan, Kuwayuhan and Semondo. While for LL area there are 4 villages, namely Kradenan Village, Sugihwaras, Tepakyang and Sidamukti

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