

**USING THE KULLDORF'S SCAN STATISTICS TO IDENTIFY CLUSTERS OF TUBERCULOSIS INCIDENCE IN MUARO JAMBI REGENCY INDONESIA****Muhammad Syukri\*, Rizalia Wardiah**

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**ABSTRACT**

There was a significant increase in tuberculosis cases from 2016 to 2019 in Muaro Jambi Regency. Many studies on TB risk factors have been carried out, but spatial cluster analysis has never been carried out in Muaro Jambi Regency. This study aimed to identify the spatial clusters of TB in Muaro Jambi Regency in 2020 using the statistical Kulldorf's scan method. Data on all TB cases at sub-district level in 2020 were obtained from the Integrated Tuberculosis Information System (SITB) of the Jambi Provincial Health Office. Sub-district office coordinate data were obtained with the help of the Google Earth Pro application. Data were analyzed using Kulldorf's poisson spatial scan statistics based on population data and monthly number of TB cases using the free application SaTScan 10.0. Statistical scan spatial analysis found one most likely to cluster and two secondary clusters. The most likely cluster occurs in Jambi Kecil Sub-district. The first secondary cluster was found in Kasang Pudak Sub-district, and the second secondary cluster was found in Sembubuk Sub-district. The results of this study are expected to assist policy makers in increasing efforts to control and prevent TB cases by focusing on high-risk areas.

**Keywords:** kulldorf's scan statistics; muaro jambi regency; tuberculosis

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**INTRODUCTION**

Tuberculosis (TB) is a disease caused by tuberculosis mycobacteria which were discovered 150 million years ago. TB generally infects the lungs so lung problems are a common sign of tuberculosis (Adigun & Singh, 2022; Barberis et al., 2017). Until now, tuberculosis (TB) is still a public health problem at the local and global levels (Fukunaga et al., 2021). The World Health Organization (WHO) in its report in 2022 at the global level of TB cases is estimated that there are 10.6 million people suffering from TB, an increase compared to the previous year which amounted to 10.1 million cases. Southeast Asia is the second largest contributor of TB cases in the world after Africa (World Health Organization, 2022). Indonesia is included in the seven countries in the Southeast Asia region with a high TB caseload which puts Indonesia in the 2nd position with the highest number of TB cases in the world after India (WHO, 2022).

The number of TB sufferers in Indonesia in 2021 has increased compared to 2020. In 2020, the notification rate was 301 per 100,000 population, increasing in 2021 to 354 per 100,000. The death rate from TB has also increased from 34 per 100,000 population in 2020 to 54 per 100,000 in 2021 (Kementerian Kesehatan RI, 2022). Jambi is one of the provinces in

Indonesia with a low TB case notification rate, but has a low TB treatment coverage (TC) rate. The treatment coverage rate describes how many TB cases the program reaches (Kemenkes RI, 2022). This indicates that the number of TB cases in Jambi Province is far higher than the reported data (Dinas Kesehatan Provinsi Jambi, 2021). The Jambi Provincial Health Office in its 2022 annual report displays the districts/cities with the highest TB cases occupied by Jambi City. Muaro Jambi Regency occupies the 4th position. There was a significant increase in TB cases from 2016 to 2019 in Muaro Jambi Regency (Dinas Kesehatan Provinsi Jambi., 2021).

TB is an environment-based disease. Environmental conditions have a major role in the development of TB disease and are an important component of the TB disease epidemiology triangle (Kanchan et al., 2015). Another thing to pay attention to is social determinants. Social determinants is a term that refers to the level of education, type of work, income level, ethnicity and race, and social class which causes stratification in society. This stratification in society ultimately causes clusters of TB sufferers (Wardani et al., 2013). TB transmission clusters can occur both in place and time (Dowdy et al., 2014). Disease cluster analysis can help detect significant hotspots and high-risk groups in space and time that can help develop those policies and programs to prevent and treat TB infection. (Ratovonirina et al., 2017).

Spatial analysis and space-time clustering have been applied in many studies on TB disease (Asemahagn et al., 2021; Ge et al., 2016; Kiani et al., 2021). Research on TB risk factors has been carried out in Jambi Province (Devi et al., 2020; Erris, 2015; Nasution & Halim, 2021; Ruth Rahayuning Asih Budi et al., 2021; susilawati et al., 2018; Syaripi et al., 2022). Spatial studies have also been carried out to look at TB case hotspots using the Getis Ord  $G^*$  method, but there has been no research specifically looking at case clustering using the statistical scan method developed by an epidemiologist from America named Kulldorf. This study aims to identify clusters of TB cases in Muaro Jambi Regency in 2019 using the Statistical Scan method.

## **METHOD**

### **Study Area**

Geographically, Muaro Jambi Regency is located between 1°15'-2°20' Latitude and between 103°10'-104°20' Longitude. Muaro Jambi Regency is one of 11 regencies/cities in Jambi Province with an area of 532,600 Ha (5,326 km<sup>2</sup>) and is located at an altitude of 0-38 meters above sea level (BPS Kabupaten Muaro Jambi, 2021). Muaro Jambi Regency has a tropical climate where the climatic conditions are almost the same as Jambi City as the main district/city of Jambi Province. Observations from the Muaro Jambi Station show that the average humidity per month ranges from 80% -87% and rainfall ranges from 15.2 to 516.5 mm per month. (BPS, 2021). The Muaro Jambi district map can be seen in the figure 1.

### **Data Analysis**

The unit of analysis in this study were 155 villages and sub-districts in Muaro Jambi Regency. All TB data is processed into the Microsoft Excel application by loading the variables needed in the analysis such as TB case data, population, and village and sub-district office coordinates that represent the study area. The thematic maps aim to show the distribution of the proportion of TB cases per village and sub-district. Kuuldroff's space-time scan statistical analysis with the poison model is used to identify areas of villages and sub-districts with a high risk of TB with the help of the open-source application SaTScan 10.0. Statistical scan analysis has the goal of finding TB cluster areas. Spatial clustering or clusters can be defined as spatial aggregations of disease events or risk factors that are unlikely to occur by chance,

especially after it is known that the risk factors influencing the spatial distribution have been taken into account (Lessler et al., 2017).

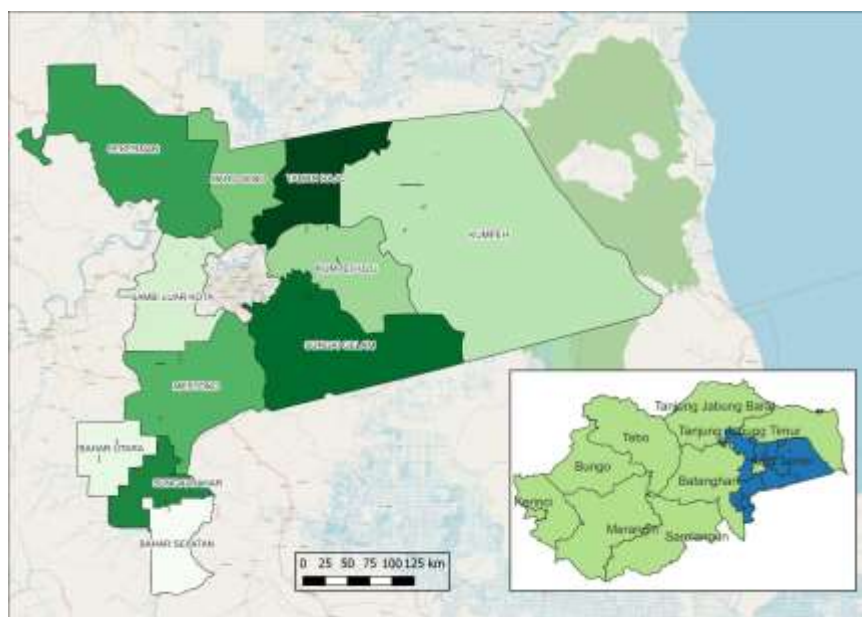


Figure 1. Administrative Map of Muaro Jambi Regency

### Data sources

The data analyzed in this study were 260 TB cases recorded in TB case reports in 155 villages and sub-districts obtained from the Tuberculosis Information System (SITB) of the Jambi Provincial Health Office from 1 January to 31 December 2020. The TB cases used in this study were all cases were either bacteriologically confirmed or clinically diagnosed.

### RESULTS

Description of the distribution of TB cases per 100,000 population

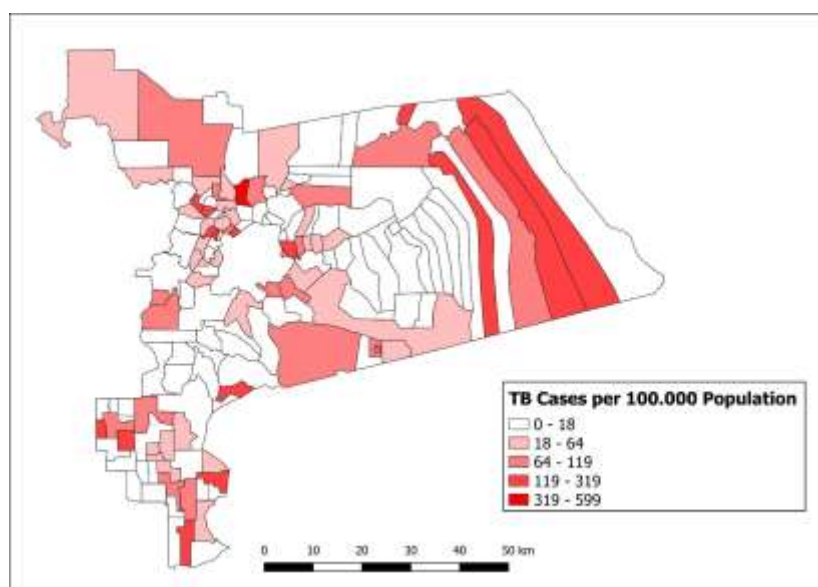


Figure 2. Distribution of TB Cases per 100.000 Population

In Figure 2 is the notification rate which is calculated by dividing all cases by sub-district by the number of population in the same area then multiplied by 100,000. From the figure, the lowest notification rate is 0-18 per 100,000 population and the highest is 319-599 per 100,000 population.

### Space-time analysis

The results of the statistical scan spatial analysis for TB cases in Muaro Jambi Regency in 2020. Details can be seen in the table and figure below:

Table 1.

TB clusters based on statistical scan spatial analysis in Muaro Jambi Regency in 2020

Cluster Type	Coordinates (latitude, longitude)	Radius (km)	Cases (n)	Expected Case (n)	RR	LLR	P value
Most Likely Cluster	1.500123 S 103.585198 E	0	16	1.33	13.0	25.6	<0,001
1 <sup>st</sup> Secondary Cluster	1.594256 S 103.670230 E	0	26	9.19	3.10	10.99	0.001
2 <sup>nd</sup> Secondary cluster	1.567180 S 103.544743 E	2.21	18	6.27	3.05	7.60	0.033

The analysis found three clusters with the most likely clusters occurring in an area not far from Jambi Municipality, namely in Jambi Kecil Sub-district which is at coordinates 1.500123 S and 103.585198 E with a radius of 0 km with a relative risk (RR) of 13.0, which means that these clusters are statistically significant. The RR value of 13 indicates that residents living in Jambi Kecil Village have a 13.0 times chance of contracting TB compared to residents outside the village. First secondary cluster analysis found there were 26 cases in 2020 spread across Kasang Pudak Sub-district with center coordinates 1.594256 S, 103.670230 E, radius 0 km with a relative risk value of 3.10. This explains that if someone lives in Kasang Pudak Sub-district, they will have a 3.10 times greater chance of contracting tuberculosis. The second secondary cluster of cases is in Sembubuk Sub-district, with center coordinates 1.567180 S, 103.544743 E, radius of 2.21 km, with a p-value of 0.033 (<0.05), Relative Risk of 3.05 which means that this cluster is statistically significant. This explains that if there are residents who live within a radius of 2.21 km from the coordinate point, they will have a 3.05 times greater chance of contracting tuberculosis. The map of the cluster area is shown in the figure below with the area markers around the black ring:

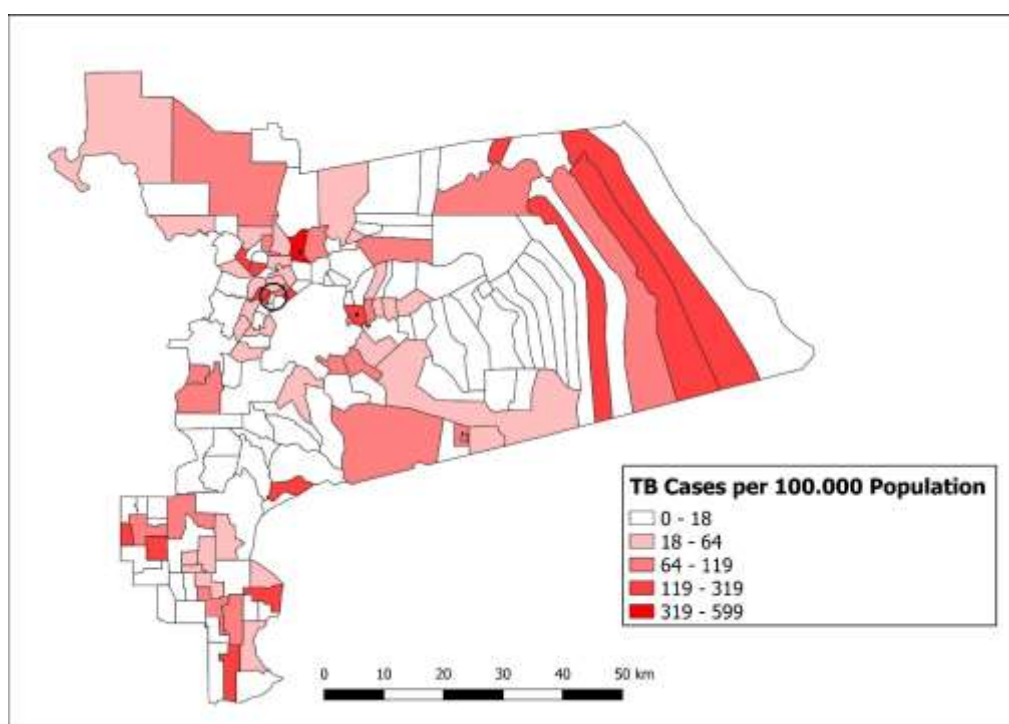


Figure 3. Retrospective Poisson Spatial Cluster of TB in Muaro Jambi Regency

## DISCUSSION

This study found that there were three significant clusters of TB cases in Muaro Jambi Regency in 2020. One most likely cluster and two secondary clusters. The three clusters occur in areas with a fairly high number of cases with a range of 319-599 cases per 100,000 population. The most likely cluster is found in Jambi Kecil Village with a cluster radius of 0 km, as well as the first secondary cluster area found in Kasang Puduk Village also with a radius of 0 km. The radius of 0 km in the two cluster areas indicates local transmission in the area. One of the characteristics that has become the focus of cases in this area is the relatively high population compared to other regions. Regions with a higher population have a tendency for more cases, because a high population will result in a higher population density. Jambi Kecil, Kasang Puduk, and Sembubuk sub-districts are areas with a fairly high population (BPS Kabupaten Muaro Jambi, 2021). The areas bordering Jambi Municipality are also areas with an increasing population and a fairly rapid rate of development. The lack of land in Jambi Municipality has made many residents choose to live in suburban areas which are not too far from the city center (OkeFinance, 2016).

Population density is a term that indicates the number of people living in a certain area. Population density is an indicator of pressure on natural resources and human activities in a certain area (Schowalter, 2016). Several studies have found a relationship between population density and TB incidence (Soares et al., 2022; X. Wang et al., 2019). High population density will reduce the distance between individuals. While it is known that mycobacterium tuberculosis is transmitted through droplets. Therefore, when the distance between individuals is getting closer, if there are bacterial particles in the air, it will be easier for them to spread between individuals in at-risk populations. In some areas, the high prevalence of TB is related to underdeveloped areas with poor environment, inadequate resources, problems with road transportation, and inadequate distribution of health services (Shang et al., 2022). This is supported by research conducted by Wardani et al. who stated that in Bandar Lampung there are 2 TB clusters which are significant in areas with a high number of cases and are densely populated, centered in Labuhan Ratu District (Wardani & Wahono, 2020). Another study conducted in India found significant clusters identified in 7 areas of Dahrudin City, India. The same study by Wang et al in Linyi, China, stated that there are cluster groupings in areas with a high incidence of TB (Tiwari et al., 2010; T. Wang et al., 2012).

TB is an infectious disease with many risk factors (Bhat et al., 2017). Apart from population density, there are several other factors that contribute to an increase in the number of TB cases in areas with a high risk of TB which indicate factors such as climate (air temperature, length of sunlight, wind speed and wind direction), socioeconomic status, nutritional status, age, Gender and other social factors can affect someone's exposure to TB disease (Hiswani, 2009). The sub-district of Jambi Kecil, Kasang Puduk and Sembubuk are villages bordering Jambi Municipality which is the center of TB cases in Jambi Province. Generally, residents in the area are used to going in and out of Jambi Municipality to buy shopping, recreation, and other social and economic activities. High mobility of the population to enter and leave endemic areas increases the risk of TB infection (*Tuberculosis and Vulnerable Populations*, n.d.). Based on the results of this study, it is necessary for health authorities to improve prevention programs through case finding in TB cluster areas, especially those with a high number of TB cases and to conduct case mapping periodically to maximize disease prevention and monitoring activities, especially TB disease. This study has limitations because the coordinates taken are sub-district offices, the results will be better if the coordinates collected and analyzed are addresses of TB sufferers. Another limitation in this study is that the data used is notification data, so it can potentially be biased because not everyone who has TB

comes for treatment at health facilities, so that the impact on the data being analyzed does not represent the actual number of cases in the field.

## CONCLUSION

This study found three spatial clusters of TB cases in the area bordering Jambi Municipality as the center of TB cases in Jambi Province. The most likely cluster is found in Jambi Kecil Sub-District. The first secondary cluster is in Kasang Pudak Sub-district, and the Second Secondary cluster is in Sembubuk Sub-district. These results can help health authorities to take preventive action, especially in the cluster areas found.

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