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GEO-SPATIAL CLUSTER TUBERCULOSIS OF 2021-2023: STUDY IN A DISTRICT, INDONESIA

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ABSTRACT
Tuberculosis is an infectious disease that affects the respiratory organs and is still a health problem in Indonesia. The incidence of tuberculosis in Indonesia ranks second after India. Spatial analysis of tuberculosis has been conducted in Indonesia, but there has been no research on cluster distribution patterns in Sukoharjo District, Indonesia. Objective: This research aims to identify tuberculosis spatial clusters in Sukoharjo Regency in 2021-2023. Method: This research data was obtained from the Integrated Tuberculosis Information System of the Sukoharjo Regency Health Service for 2021-2023. Population and population density data were obtained from the Central Statistics Agency (BPS) of Sukoharjo Regency Data were analyzed using Poisson spatial scanning using the SaTScanTM v.10.0.1 application and area mapping using QGIS 3.34. Results: Based on the spatial scanning analysis that has been carried out, there is a cluster grouping of population and population density of tuberculosis cases in Sukoharjo Regency. In the 2021-20233 population cluster, there is 1 cluster grouping of 978 cases with a radius of 9,39 km. Meanwhile, in the 2021-2023 population density cluster, there are 7 cluster groupings, but there is a cluster with the largest radius 16,8 km with 1152 cases. Conclusions: This results of this research are expected to assist health authorities in increasing efforts to control and prevent tuberculosis cases by focusing in areas with high risk population.

Keywords: spatial cluster; sukoharjo district; tuberculosis

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INTRODUCTION

Tuberculosis is a chronic disease caused by Mycobacterium tuberculosis bacteria and can be transmitted through the air (CDC, 2022). WHO reports that the prevalence of tuberculosis in 2021 is 10.6 million cases, the figure is estimated to increase by around 600,000 cases in 2022. Indonesia is in 2nd position after India with the highest number of cases in the world according to WHO in the 2022 Global TBC Report (WHO, 2022). The Case Notification Rate in Central Java in 2015 increased by 55.99 per 100,000 population from the previous year. In 2015, the proportion of sufferers compared to all tuberculosis cases with BTA positive was only 63 cases out of 100 tuberculosis cases (Setiyadi et al., 2020). Based on the tuberculosis incidence rate of 969,000, the CNR for tuberculosis in 2021 is only 443,235 (53.8%) or there are still 46.2% who have not been notified, have not been reached, have not been detected or have not been reported. Even though there was a decrease in the death rate in 2000-2020, in 2020-2021 there was an increase in tuberculosis cases by 18% (Dirjen P2P, 2023).

In the last 3 years, the number of tuberculosis case discoveries in Sukoharjo Distict, Indonesia has shown a fluctuating trend with the highest case discovery in 2022. According to the

Sukoharjo Regency Health Profile for 2021-2023, the number of tuberculosis case discovery in 2021 is 708 from the target of 1,979 or around 35.8 % (Dinkes Sukoharjo, 2021). In 2022, there will be 1,260 tuberculosis cases discovered from the target of 1,878 or 67.1% (Dinkes Sukoharjo, 2022). Tuberculosis case finding in 2023 was 1,428 out of a target of 1,814 or 78.7%. The discovery of the tuberculosis case was the discovery of a case that had early symptoms of tuberculosis and had not been confirmed as BTA positive.

The historical decline before tuberculosis chemotherapy suggests the importance of socio-environmental factors. Measuring time sprent in crowded, poorly ventilated neighborhoods frequented by potentially infectious tuberculosis cases reflects socio-environmental risk. In high incidence areas, most tuberculosis ransmission does not only occur ini households, but also in the general community (Coleman et al., 2022). Environmental conditions play a major role in the development of tuberculosis disease and are an important component in the epidemiological triangle of tuberculosis disease (Srivastava et al., 2015). Other factors influence the rise and fall of tuberculosis cases, such as treatment compliance and tuberculosis recurrence (Setiyadi et al., 2019). Spatial analysis is one method of data collection that can be carried out as an environmental management effort and is part of area-based disease management. Spatial analysis is generally used to record disease geographically regarding population, distribution, environment, behavior, social, economic, and relationships between variables, especially the incidence of tuberculosis (Tiwari & Rushton, 2010).

Referring to Presidential Decree No. 67 of 2021, namely strengthening commitment and leadership between the central, provincial and Regency/city areas which is carried out through regionally based tuberculosis control activities (Presiden Republik Indonesia, 2021). Spatial analysis can be carried out as a method to obtain information related to tuberculosis in a particular area, but there has been no research in Sukoharjo District, Central Java, Indonesia specifically to look at the clustering of tuberculosis cases. This research aims to identify clusters of tuberculosis cases in Sukoharjo Regency in 2021-2023 using the Statistical Scan method.

METHOD

This study used was an ecological study design with a spatial analysis approach located in Sukoharjo District, Central Java, Indonesia. Spatial analysis is a Geographic Information System (GIS) for making environmental-based disease management decisions (Sunaryo, 2015). Spatial analysis can also be interpreted as a process between location, distance and area that is analyzed using geographical methods and techniques to produce patterns in a space (Grekousis, 2021). This research used tuberculosis case data based on the Integrated Tuberculosis Information System (SITB). Data for population and population density variables were obtained from the Central Statistics Agency of Sukoharjo District, Indonesia. Population dan population density data was downloaded from the website of Central Statistics Agency of Sukoharjo District, Indonesia then the data was formatted in Excel. The data was analyzed using SaTScanTM v.10.0.1. This application was used to identify tuberculosis clusterin in Sukoharjo District, Indonesia. Spatial clusterin analysis for 2021-2023 was identified using Poisson variance. The method was used not only to identify the most significant cluster, but also a number of secondary potential clusters that may form.

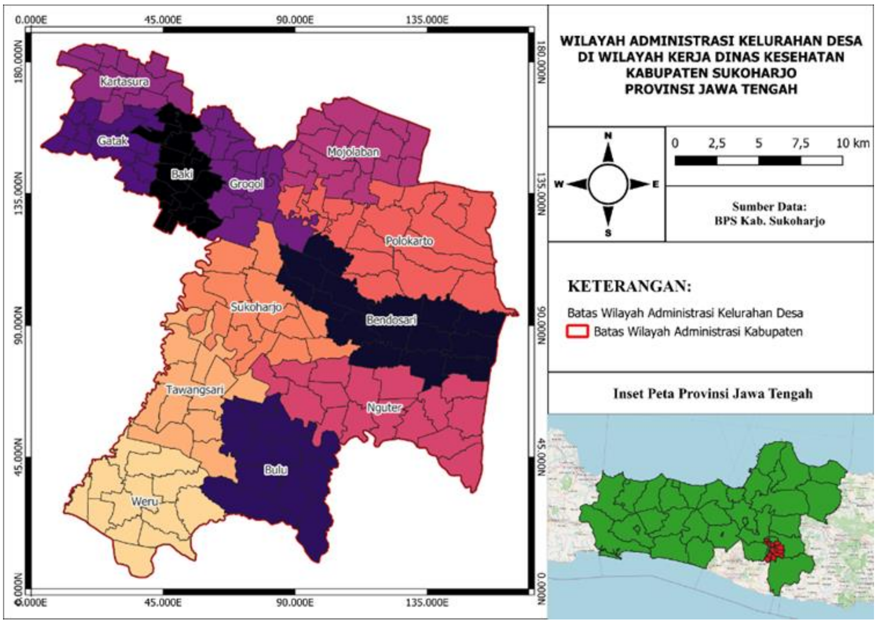


Figure 1 Administrative Map of Sukoharjo District

RESULTS

Case Distribution

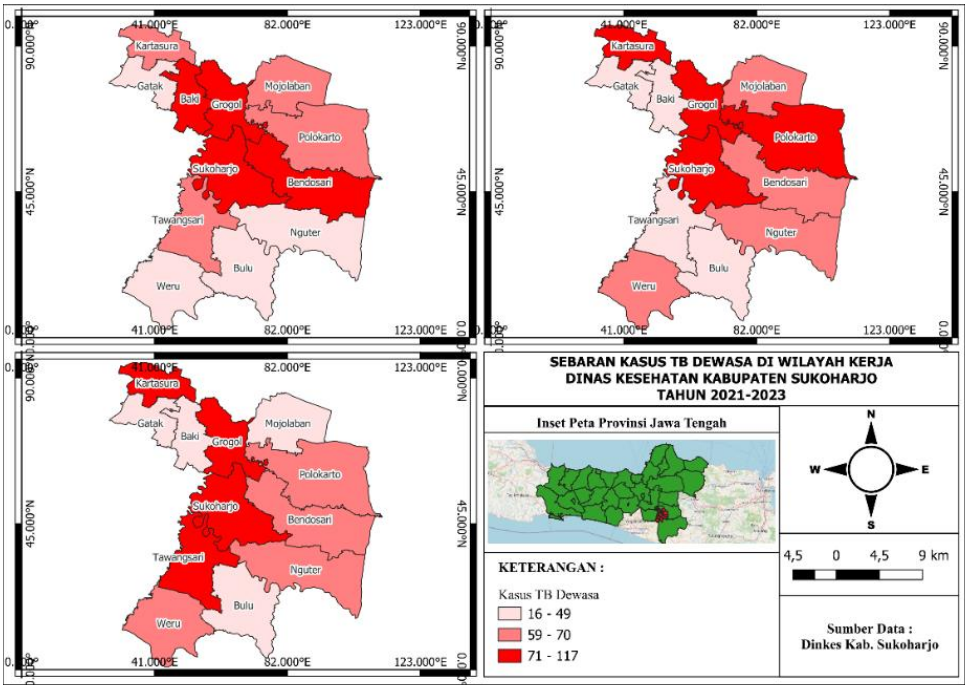


Figure 1 Case Distribution Map

Based on the picture, there was 2 areas with high cases of tuberculosis in 3 consecutive years, namely Grogol and Sukoharjo.

Population Cluster Analysis

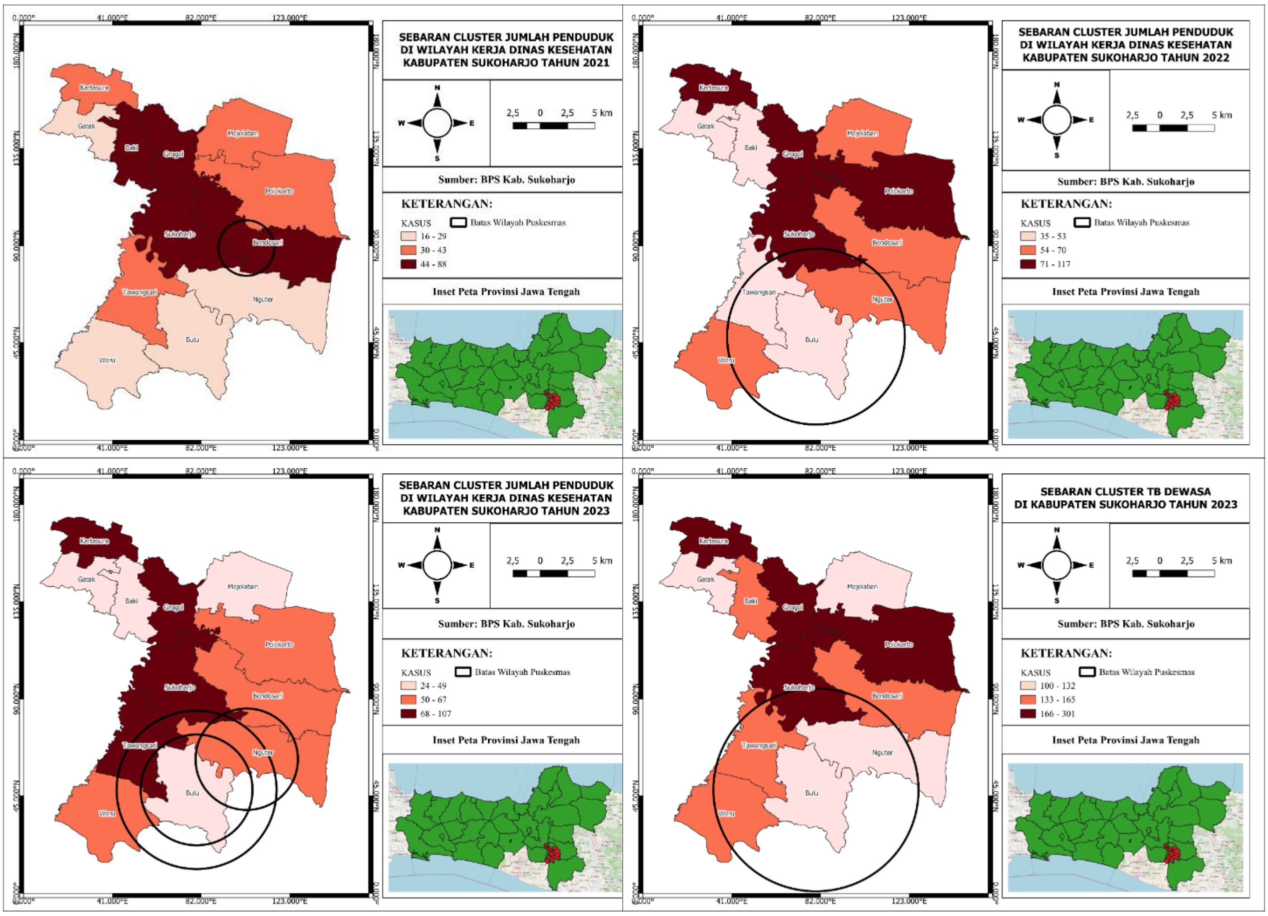


Figure 2 Population Clustering Analysis Maps

The figure shows that there is clustering of population against tuberculosis cases in 3 consecutive years. In 2021-2022 there was only 1 clustering of cases, but in 2023 there were 3 clustering of cases with the largest radius of 7.32 km.

Table 1.
A Population Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2021	Most Likey cluster	7.691533 S, 110.874214 E	1/1/2021-31/12/2021	2,57 km	132	83,35	158697	1,78	0,0046

Table 2.
B Population Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2022	Most Likey cluster	7.765317 S, 110.832718 E	1/1/2022-31/12/2022	8,1 km	307	261,11	294353	1,28	0,012

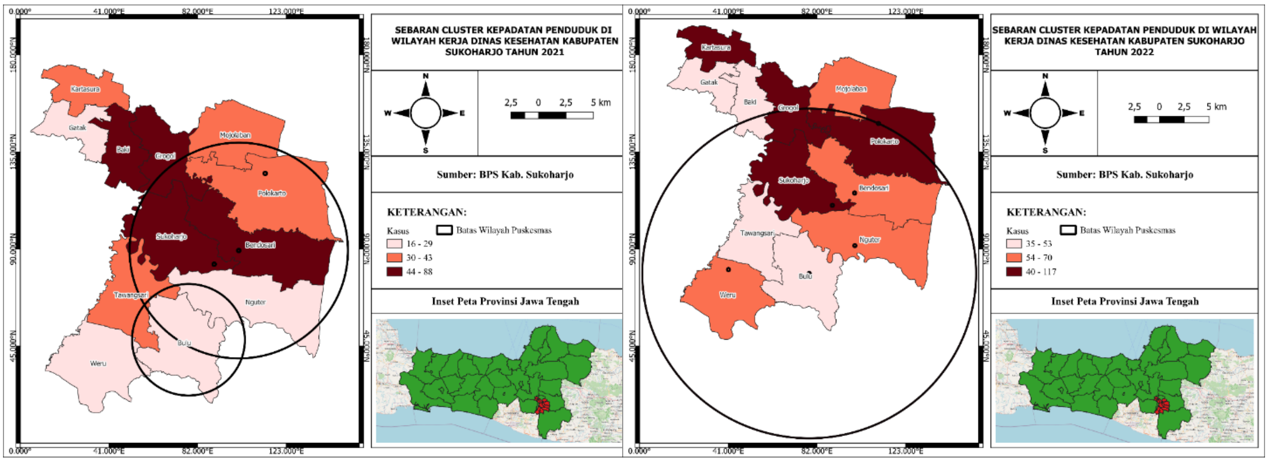
Table 3.
C Population Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2023	Most Likey cluster	7.765317 S, 110.832718 E	1/1/2023-31/12/2023	7,32 km	286	199,39	245336	1,7	0,0027
2023	1st Secondary	7.765317 S, 110.832718 E	1/1/2023-31/12/2023	5,12 km	123	73,18	90050	1,81	0,013
2023	2nd Secondary	7.739800 S, 110.8744335 E	1/1/2023-31/12/2023	4,69 km	163	126,2	155286	1,37	0,0012

Table 4.
D Population Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2021-2023	Most Likey cluster	7.765317 S, 110.832718 E	1/1/2021-31/12/2023	9,39 km	978	802,65	359283	1,42	0,001

Population Density Cluster Analysis



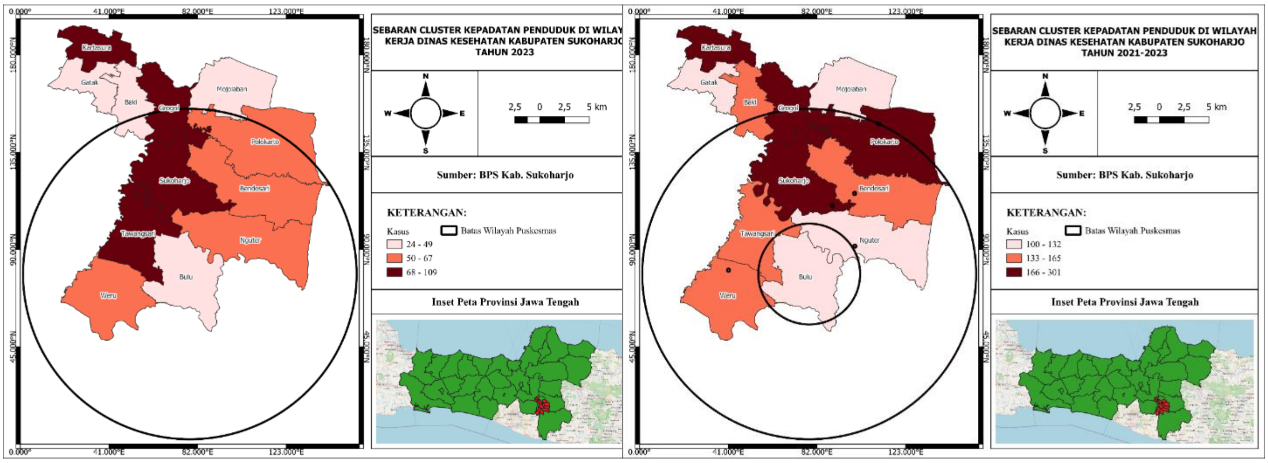


Figure 3 Population Density Clustering Analysis Maps

The figure shows that in 2021-2023, there is a clustering of population density on tuberculosis cases. Based on the figure, there was small points on the map, there indicating the center of a significant cluster. These clusters are areas with more concentrated tuberculosis cases compares to other areas.

Table 5.
A Population Density Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2021	Most Likey cluster	7.691533 S, 110.874214 E	1/1/2021-31/12/2021	9,92 km	250	133	7813	2,82	<0,001
2021	1st Secondary	7.702833 S, 110.853897 E	1/1/2021-31/12/2021	0 km	88	37,2	2186	2,67	0,0017
2021	2nd Secondary	7.691533 S, 110.874214 E	1/1/2021-31/12/2021	0 km	44	20	1175	2,32	0,0017
2021	3rd Secondary	7.765317 S, 110.832718 E	1/1/2021-31/12/2021	5,12 km	61	35,89	2108	1,8	0,007
2021	4th Secondary	7.627767 S, 110.896004 E	1/1/2021-31/12/2021	0 km	41	23,11	1357	1,85	0,012

Table 6.
B Population Density Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2022	Most Likey cluster	7.765317 S, 110.832718 E	1/1/2022-31/12/2022	16,8 km	433	260,74	9153	2,41	<0,001
2022	1st Secondary	7.702833 S, 110.853897 E	1/1/2022-31/12/2022	0 km	104	62,37	2190	1,77	0,0042
2022	2nd Secondary	7.739800 S, 110.874435 E	1/1/2022-31/12/2022	0 km	57	27,84	977	2,13	0,0071

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2022	3rd Secondary	7.627767 S, 110.896004 E	1/1/2022-31/12/2022	0 km	72	38,87	1365	1,93	0,0095
2022	4th Secondary	7.761750 S, 110.758919 E	1/1/2022-31/12/2022	0 km	66	37,49	1416	1,83	0,0017
2022	5th Secondary	7.765317 S, 110.832718 E	1/1/2022-31/12/2022	0 km	43	22,75	799	1,94	0,0014
2022	6th Secondary	7.691533 S, 110.874214 E	1/1/2022-31/12/2022	0 km	54	33,77	1185	1,64	0,018

Table 7.
C Population Density Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2023	Most Likey cluster	7.765317 S, 110.832718 E	1/1/2023-31/12/2023	16,8 km	450	249,06	8937	2,99	<0,001

Table 8.
D Population Density Clustering Analysis Result

Year	Cluster type	Coordinates (latitude, longtitude)	Period	Radius (km)	Cases (n)	Expected Case (n)	People at risk (n)	RR	p-value
2021-2023	Most Likey cluster	7.765317 S, 110.832718 E	1/1/2021-31/12/2023	16,8 km	1152	664,49	9072	2,67	<0,001
2021-2023	1st Secondary	7.702833 S, 110.853897 E	1/1/2021-31/12/2023	0 km	301	158,79	2168	2,05	<0,001
2021-2023	2nd Secondary	7.765317 S, 110.832718 E	1/1/2021-31/12/2023	5,12 km	264	155,74	2126	1,8	0,0011
2021-2023	3rd Secondary	7.627767 S, 110.896004 E	1/1/2021-31/12/2023	0 km	174	98,19	1341	1,84	0,002
2021-2023	4th Secondary	7.691533 S, 110.874214 E	1/1/2021-31/12/2023	0 km	151	85,93	1173	1,82	0,002
2021-2023	5th Secondary	7.739800 S, 110.874435 E	1/1/2021-31/12/2023	0 km	127	71,43	975	1,83	0,005
2021-2023	6th Secondary	7.761750 S, 110.758919 E	1/1/2021-31/12/2023	0 km	135	94,41	1289	1,46	0,0053

DISCUSSION

In a study that analyzed tuberculosis case data for 2021-2023 in Sukoharjo District, Indonesia, it was found that for 3 consecutive years there were 2 puskesmas working areas with an increasing number of cases, namely Grogol and Sukoharjo. In the Grogol health center working area, the population and population density are categorized as high. Population or household density is associated with higher interpersonal contact, which can increase the likelihood of transmission of tuberculosis bacteria. This is in line with the research of Abreu et al (2016) which found that the highest cases were strongly associated with higher population density but not with lower income (Abreu et al., 2016). It was also concluded by Uppal et al. (2021) that the overall parameter representing the relative risk of active disease development among individuals in dense and non-dense settlements is the most influential factor in the potential spread of disease (Uppal et al., 2021).

The zero kilometer point of Sukoharjo District, Indonesia is the Adipura Monument located at the Sukoharjo Proliman Intersection. Grogol sub-district is 11 km from the zero point of Sukoharjo district and Sukoharjo sub-district is 5.5 km from the zero point of Sukoharjo district. Sukoharjo Regency has 12 sub-districts and in each sub-district there is already 1 health center available. So that the surrounding community already has easy access to health. Research conducted in Nairobi, Kenya, found that residents there experienced access barriers in obtaining access to health. The study also stated that people living in the informal settlement sector were five times more vulnerable to death from tuberculosis because they came from low socioeconomic backgrounds (Gichuki & Mategula, 2021).

Figure 3 shows the results of the clustering analysis of population against tuberculosis cases. In 2021-2022, there was 1 clustering of cases, but in 2023 there were 3 clustering of cases with cluster 1 (p-value = 0,0027), cluster 2 (p-value = 0,013), and cluster 3 (p-value = 0,0012) which means that the clustering means that there is statistically significant clustering of cases. This study is also in line with Fitri (2020), where population is consistently positively correlated with the number of tuberculosis cases. Total population and population density are proven to have a spatial effect on the number of tuberculosis cases. (Fitri, 2022). This finding is also in line with previous findings conducted by Fahdhienie (2022) that the study results show that statistically significant fires and spatial clusters occur in sub-districts with high population (Fahdhienie & Sitepu, 2022). A higher population will lead to a higher level of population density, population problems are strongly correlated with health problems. The denser and faster the population growth of an area, the more likely it is to have health problems (Sihaloho et al., 2019).

Based on research that has been carried out, it is stated that population density forms a pattern of distribution of adult tuberculosis cases with a p-value <0.001, which means that there is a spatial relationship between adult tuberculosis cases and population density in Sukoharjo Regency. Research conducted in West Java is in line with this research which shows that there is positive autocorrelation which tends to be clustered (Lestari et al., 2023). Research conducted by Hikma (2016) shows that large population density figures have a significant impact on environmental conditions, especially environmental health. A crowded environment is easily polluted and dirty, making it easier for disease germs to spread. This also applies to the spread of the Mycobacterium tuberculosis bacteria which quickly spreads through the air in crowded and unhealthy environments (Hikma et al., 2016). The results of this research are not in line with Rahmawati (2020) who stated that there is no spatial autocorrelation so there is no spatial relationship between tuberculosis and population density (Rahmawati & Rahmaniati, 2020).

The results of the population density clustering analysis of TB cases are small dots in the analysis results for 2021, 2022 and 2021-2023. Research observed by Shaweno et al. (2018) stated that one of the reasons for TB clustering is the impact of population proximity and movement, which causes neighboring districts with high TB cases to be at greater risk (Shaweno et al., 2018). Another research conducted in China stated that clustering of cases occurs because areas/subdistricts are close to each other that have the same geographical characteristics associated with disease transmission and development, thus causing the same incidence (Alene et al., 2021).

CONCLUSION

Based on the research conducted, it showed that there are spatial clusters of tuberculosis in Sukoharjo District, Indonesia. There are 17 statistically significant tuberculosis clusters identified in the period 2021-2023. Most likely clusters were detected in Grogol sub-district of Sukoharjo and Sukoharjo sub-districtsin the period of three consecutive years. This study may assist health authorities to improve efforts to control and prevent tuberculosis cases by focusing on areas with high-risk populations.

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