BKM Public Health & Community Medicine
(Berita Kedokteran Masyarakat)

Volume 39 **Number** 2, 2023, **Pages** e6659
DOI: 10.22146/bkm.v39i02.6659

Spatial analysis of pediatric pulmonary tuberculosis cases aged 0-14 years in West Java Province

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Submitted:
January 5th, 2023
Accepted:
February 19th, 2023
Published:
February 28th, 2023

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Abstract

Purpose: Infectious diseases, including tuberculosis (TB), remain a major public health concern worldwide, causing significant morbidity and mortality rates. Despite advances in medical science, the spread of infectious diseases such as TB is not limited by geography or age, and children are particularly vulnerable. As such, this study aims to investigate the global and local spatial effects of pediatric pulmonary TB cases in West Java Province, contributing to understanding TB transmission dynamics and informing effective disease control strategies. **Methods:** This ecological study employed aggregated data from the 2020 health profile of West Java Province, utilizing all 27 districts and cities. Natural breaks were utilized to classify cases, and data analysis was conducted using GeoDA and QGIS applications. Specifically, GeoDa was employed to conduct Moran's Index and Local Indicators of Spatial Association (LISA) spatial autocorrelation tests, while QGIS was used to generate distribution maps. **Results:** The study reveals the presence of positive autocorrelation with clustered relationship patterns globally based on the incidence of pediatric pulmonary TB cases (Moran's I: 0.225; P-value: 0.04). The LISA test identifies six districts with significant correlation (Bandung, West Bandung, Cimahi, Ciamis, Majalengka, and Tasikmalaya). **Conclusion:** The study findings reveal that cases of childhood pulmonary tuberculosis occur in clusters, emphasizing the importance of targeted interventions in areas with high observation values to prevent the spread of the disease to areas with low observation values. Prioritizing program interventions in high-risk areas can help reduce the incidence of children's pulmonary TB cases more effectively.

Keywords: spatial analysis; tuberculosis; TB in pediatrics; Moran’s index

INTRODUCTION

Spatial statistics is a statistical method for analyzing spatial data. Spatial data is data that contains information about the variables being measured as well as the location of the data [1]. Infectious diseases, one of which is tuberculosis (TB), are currently one of the biggest health issues in the world due to their high morbidity and mortality rates. This infectious disease affects people of all ages, including children, and its spread is unaffected by regional or geographic factors.

Tuberculosis is a disease spread directly by TB germs (Mycobacterium tuberculosis). Most of these germs attack the lungs but can also attack other organs. It can be transmitted to susceptible individuals among tuberculosis patients via droplets. These droplets can also last for several hours in a dark and humid state, and if they are not exposed to sunlight, they will merge with the dust, and those that suck the dust will be infected [2].

Children's tuberculosis is an important disease that needs further study because 40-50% of cases come from developing countries, with a total of 500 thousand cases of childhood tuberculosis each year [3]. In 2020, the number of pediatric TB cases in Indonesia was 32,816. West Java Province has the most tuberculosis cases in children, with 11,465 cases, followed by Central Java with 4,011 cases and East Java with 2,734 cases [4].

The target of the 2015-2019 National Medium Term Development Term for TB cases in Indonesia is to reduce the prevalence of TB to 245 per 100,000 population. In West Java Province itself in 2020, the number of case notifications was 161/100,000 residents, with the four highest cases: Cirebon (372), Sukabumi (369), Bandung City (329), and Cimahi (277). The four cities are in the top 5 with the highest population in West Java [4]. Population density is one factor that influences the high number of TB cases. Previous research in Yogyakarta stated that a high population density followed the highest TB cases [14].

TB poses a risk of transmission to others, particularly in vulnerable groups with low immunity, such as children aged 0-14 years [5]. The goal of eradicating childhood tuberculosis is to protect the community, particularly children, from TB-related deaths. We also understand the factors that influence tuberculosis in children. A weak immune system, poverty, population density, a large family, malnutrition, exclusive breastfeeding, and environmental cleanliness contribute to TB in children. Furthermore, the source of disease transmission, age, non-immunization, virulence, and the number of germs all play a role in pulmonary tuberculosis [6]. Another influential factor is the utilization of health services, such as the number of health workers, access to health facilities, and health insurance ownership.

Infectious diseases are closely related to territoriality. In line with this study, Yang et al., [7] found that the high rate influences the high prevalence of pulmonary TB in surrounding areas. Given the high risk of pulmonary tuberculosis cases being transmitted between regions, appropriate analytical methods are required to assess and evaluate the disease's risk to implement appropriate and effective control measures. As a result, this study aims to examine the global and local spatial effects of pediatric pulmonary tuberculosis cases in West Java Province.

METHODS

This ecological study used secondary data to obtain information on the number of pulmonary tuberculosis cases in children aged 0-14 years, specifically data from the 2020 West Java Province health profile. The research was carried out in 27 regencies/cities throughout West Java province. As analysis units, all regencies/cities in West Java are used. To create a map of the distribution of pediatric pulmonary TB cases reported in 27 districts or cities, the data is classified using the "natural breaks" method, which seeks cases with minimum and maximum differences between each variable [8]. The GeoDa and QGIS applications were used to analyze the data. GeoDa is used to perform Moran's Index and Local Indicators of Spatial Association spatial autocorrelation tests (LISA). QGIS is used to generate distribution maps.

RESULTS

Figure 1 shows the distribution map of the number of child TB cases in West Java province in 2020 is grouped by district and classified into 3 categories using the “natural breaks” method based on the number of occurrences.

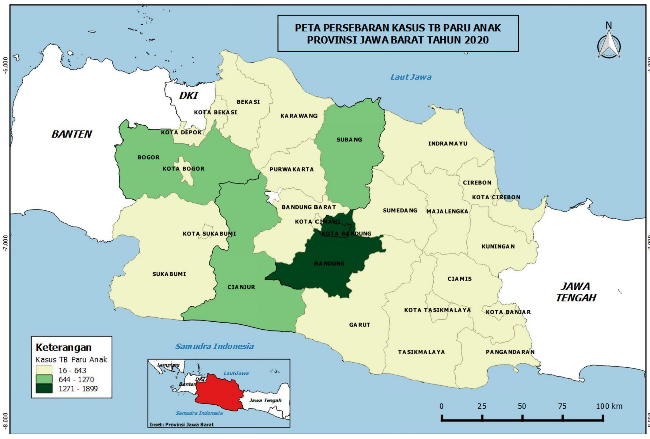

Figure 1. Map of the distribution of child TB cases in West Java Province

Natural breaks method is a data classification method designed to optimize the arrangement of a set of values into "natural" classes. Bandung and Bandung City have the highest rates and are classified in the third category. Twenty-two regencies/cities, Banjar, Pangandaran, Tasikmalaya, Tasikmalaya, Kuningan, Cirebon, Sumedang, Bogor, West Bandung, Sukabumi, Ciamis, Majalengka, Cirebon, Indramayu, Karawang, Cimahi, Depok, Purwakarta, Sukabumi, Bekasi, Garut, and Bekasi are categorized into the first category, with the lowest score being in Banjar. Meanwhile, 3 regencies, Subang, Cianjur, and Bogor, are categorized into the second category.

Table 1 shows the results of the global autocorrelation test using the Moran index on TB variables in children aged 0–14 years. From the results of the Moran test globally, it is known that Moran's I value is 0.22 and the p-value is 0.04. These results can be interpreted as $\alpha < 0.05$, meaning there is a significant autocorrelation between locations based on the number of cases of childhood pulmonary TB. Moran's I value of 0.22 indicates a greater value than the E(I) value of -0.04, indicating a clustered distribution pattern based on the number of pulmonary TB cases.

Table 1. Moran's I global tuberculosis pulmonary of pediatric in West Java Province in 2020

Variable	Moran's I	E(I)	z-value	Sig
Cases of pediatric's Pulmonary TB	0,22	-0,04	2,02	0,04

Figure 2 shows the results of the Moran scatterplot of the number of pulmonary TB cases in West Java province.

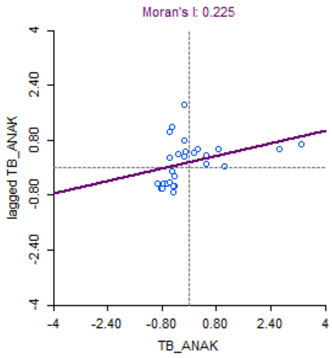

Figure 2. Morran scatterplot number of tuberculosis cases of children in West Java Province

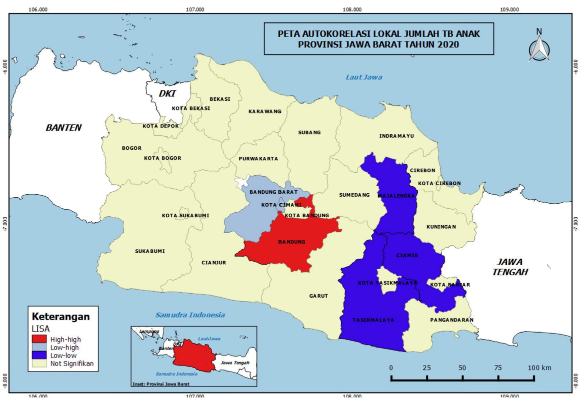

Figure 3. Moran's cluster map number of tuberculosis cases of children

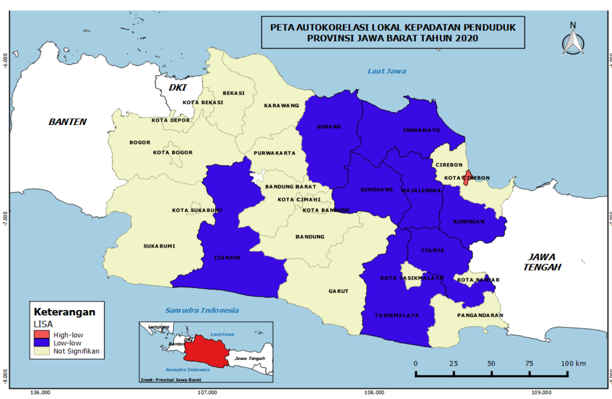

Figure 4. Moran's cluster map population density

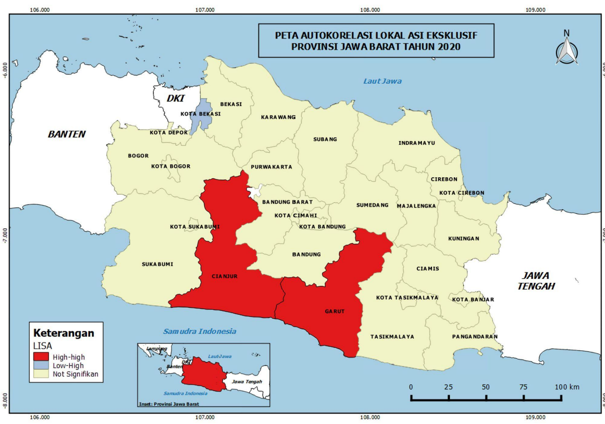

Figure 5. Moran's cluster map ASI exclusive

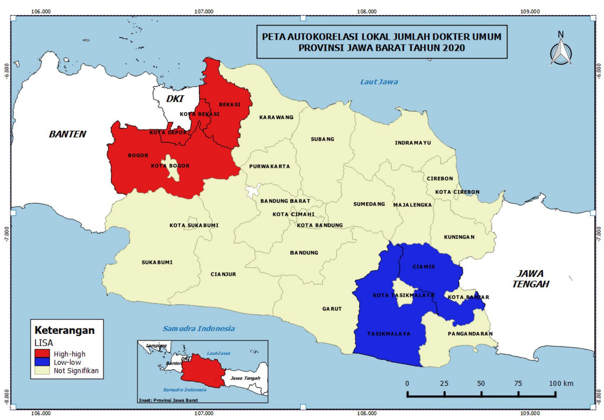

Figure 6. Moran's cluster map number of doctor

Based on the number of child tuberculosis cases in West Java province after LISA autocorrelation from 27 regencies/cities, there were 21 with no spatial interaction. Only six regencies/cities have spatial autocorrelation: Bandung, West Bandung, Cimahi, Ciamis, Majalengka, and Tasikmalaya. Bandung is a regency in quadrant I (high-high). West Bandung and Cimahi are in quadrant II (low-high). Quadrant III includes Ciamis, Majalengka, and Tasikmalaya (low-low). Figure 3 shows the cluster map of regions included in the high-high, low-high, and low-low.

Factors affecting children's pulmonary tuberculosis include population density, exclusive breastfeeding, and the number of general practitioners for areas classified as high-high, low-high, low-low, and high-low. It can be seen in figures 4, 5, and 6. At an insignificant population density of 18 regencies/cities. Eight regencies/cities (Cianjur, Tasikmalaya, Ciamis, Kuningan, Majalengka, Sumedang, Indramayu, and Subang) are in quadrant III (low-low). While Cirebon is located quadrant IV (high-low).

The exclusive breastfeeding factor reveals that there are only three significant regencies/cities, while the remaining 24 are insignificant. Cianjur and Garut are located at quadrant I (high-high). Bekasi City is located at quadrant II (low-high). The significance of regencies/cities based on the number of health workers is 6. Bekasi Regency, Bekasi City, Bogor Regency, and Depok are in quadrant I (high-high), also called hotspot areas. Meanwhile, Tasikmalaya and Ciamis regencies are in quadrant III (low-low), also called the coldspot area.

DISCUSSION

Based on the significant value of the Moran index, it can be concluded that there is a significant spatial autocorrelation between different regions in West Java Province with respect to the incidence of children's pulmonary TB. This indicates that the incidence of children's pulmonary TB in one region is related to the nearby areas. Spatial autocorrelation is a statistical method used to evaluate the level of correlation or dependence between the observation values of neighboring regions [9]. Fotheringham and Rogerson (2009) have defined spatial autocorrelation as a tool to determine the similarity of measurable data that varies with the distance between locations and is influenced by distance [10]. The Moran scatter plot is an important tool for evaluating how similar one location's attribute is to its neighboring locations [9].

The results of the Moran scatter plot in this study showed a positive relationship pattern, which means a clustered pattern based on the incidence of children's pulmonary TB. This is consistent with Tobler's Law "*everything is related to everything else, but near things are more related than distant things*" [9]. According to Alene et al. (2017)'s research in Ethiopia, there is a distribution pattern with a Moran index value 0.14 and p-value 0.007 based on the incidence of childhood pulmonary TB [11]. The same study related to TB in children under 15 years old conducted by Mendes (2021) stated a positive spatial autocorrelation in Paraiba, Brazil with a Moran index value of 0.59 and a p-value of 0.010 [12]. In line with research conducted by Wardani and Wahono (2020), it is stated that tuberculosis is a disease that tends to have a spatial correlation. The diversity of social factors in the community causes differences in both the number and location of TB cases that will tend to form TB clusters [13].

In addition to testing autocorrelation globally, this study tests autocorrelation locally using LISA which aims to determine the location and strength of spatial autocorrelation [9]. Based on the results of the analysis test, it is classified into four quadrants: quadrant I (high-high), quadrant II (low-high), quadrant III (low-low), and quadrant IV (high-low). Quadrant I (high-high) indicates locations with positive autocorrelation, which means that the observed value at that location is high and surrounded by other high locations, also called "hotspots." Quadrant II (low-high) shows negative autocorrelation due to the observation value being at a low location and surrounded by a high location. Quadrant III (low-low) indicates positive autocorrelation where the observation value of the location is low, and another low location surrounds it, also called a "coldspot." Quadrant IV (high-low) is a region with negative autocorrelation because the observation value of the location is high and low-value locations surround it.

In this study, hotspots based on the incidence of childhood pulmonary TB were identified in one regency, namely Bandung, indicating that Bandung regency had a high number of cases. The cluster map for West Bandung and Cimahi districts shows low-high areas, indicating that the area has a low value but is surrounded by areas with high cases. This must be taken into consideration because it allows for transmission to low-value areas, increasing the number of child TB cases.

CONCLUSION

This study examines global and local spatial correlations and reveals that pediatric pulmonary tuberculosis cases occur in clusters. Consequently, it is imperative to prioritize program interventions in areas with high observation values to prevent the spread to regions with low observation values. This approach can help reduce the incidence of children's pulmonary TB cases more effectively.

REFERENCES

1. Yuriantari NP, Hayati MN, Wahyuningsih S. Analisis autokorelasi spasial titik panas Di Kalimantan Timur menggunakan indeks moran dan local indicator of spatial autocorrelation (LISA). Eksponensial. 2017;8(1):63–70.
2. Kemenkes RI. Petunjuk teknis manajemen dan tatalaksana TB anak. Ministry of Health of the Republic of Indonesia. 2016. p. 3. Available from: [Website]
3. Wijaya MSD, Mantik MFJ, Rampengan NH. Faktor

risiko tuberkulosis pada anak. e-CliniC. 2021; 9(1):124–33.
4. Dinkes Jawa Barat. Profil kesehatan Jawa Barat tahun 2020. Dinas Kesehatan Provinsi Jawa Barat. 2020;
5. Hendri M, Rasyid R, Suryadi DH. Analisis Upaya Penemuan kasus tuberkulosis anak di Kabupaten Lima Puluh Kota tahun 2019. Human Care Journal. 2021;6(1):182–91.
6. Yustikarini K, Sidhartani M. Faktor risiko sakit tuberkulosis pada anak yang terinfeksi myco-bacterium tuberculosis. Sari Pediatri. 2016;17 (2):136.
7. Yang DL, Li W, Pan MH, Su HX, Li YN, Tang MY, et al. Spatial analysis and influencing factors of pulmonary tuberculosis among students in Nanning, during 2012–2018. PLoS One. 2022;17(5 May):1–14.
8. Gentleman R, Hornik K, Parmigiani G. Applied Spatial data analysis with R. Appl Spat Data Anal with R. 2008;21–54.
9. Grekousis G. Spatial analysis methods and practice. Cambridge: Cambridge University Press. 2020.
10. Fortheringham, A. Stewart & Rogerson PA. Spatial Analysis. SAGE Publications Inc. 2455 Teller Road Thousand Oaks, California 91320; 2009.
11. Alene KA, Viney K, McBryde ES, Clements ACA. Spatiotemporal transmission and socio-climatic factors related to paediatric tuberculosis in North-Western Ethiopia. Geospatial Health. 2017;12(2):342–50.
12. da Silveira Mendes M, de Oliveira ALS, Pimentel LMLM, de Figueiredo TMRM, Schindler HC. Spatial analysis of tuberculosis in children under 15 years of age and socioeconomic risk: an ecological study in Paraíba, Brazil, 2007-2016*. Epidemiologia de Servicos of Saude. 2021;30(3):1–8.
13. Wulan Sumekar Rengganis Wardani D, Prasetyo Wahono E. Spatial analysis of childhood tubercu-losis and social determinants in Bandar Lampung. E3S Web Conferences. 2020;202:1–6.
14. Rohman H. Pola spasial persebaran kasus tuberku-losis paru terhadap kepadatan penduduk. Jurnal Kesehatan Masyarakat. 2017;(978-602-6363-47–3): 8–16.