

MANUSKRIP_BAHASA INGGRIS

by Check Turnitin

Submission date: 12-Feb-2024 03:16AM (UTC-0500)

Submission ID: 2123636369

File name: MANUSKRIP_BAHASA_INGGRIS-1.pdf (1.38M)

Word count: 5243

Character count: 28097

Spatial and Epidemiological Analysis of Tuberculosis Incidence in Children in Palembang City in 2022

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"How to Cite"

Article Information

Article History (filled in by Editor):

Submission: month dd, yyyy

Revision: month dd, yyyy

Reception: month dd, yyyy

Keywords: *Epidemiology, Mapping, Spatial Analysis, Tuberculosis in Children*

ABSTRACT

Introduction: Tuberculosis does not affect only adults but also children, occurring between the ages of 0-14 years. According to WHO, in 2021, 1.2 million children will fall ill with tuberculosis globally. This study aims to conduct spatial analysis with the distribution of tuberculosis disease areas in children in Palembang City in 2022 and find out the epidemiological calculations. **Method:** This study used descriptive quantitative research with an ecological research study design approach. This study used secondary data, namely all tuberculosis cases in children in 2022 in Palembang City and the sample are all TB cases in children in 2022, totaling 1,036 cases. Data analysis uses spatial analysis. **Results:** The highest number of childhood tuberculosis cases occurred in hospitals, public health centers, clinics and health facilities in the Kemuning District area, namely 338 cases, and the lowest was in Gandus District and most often occurred in the Sekip, Sukarami and Merdeka Public Health Centers. The most cases came from the 0-4 years age group with 530 cases and were experienced by male with 547 cases and female with 489 cases and tend to be from moderate population density. Palembang City has achieved targets for treatment success with an average of 96.4% (90% achievement target) and case detection rate of children with 130%. **Conclusion:** The distribution of childhood tuberculosis cases can describe case findings in certain areas. Therefore, the importance of public awareness and the role of the health sector related to the prevention and control of tuberculosis in children.

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INTRODUCTION

Tuberculosis (TB) is a disease caused by *Mycobacterium tuberculosis* bacteria that can attack the lungs. *M. tuberculosis* bacteria cause respiratory problems, such as shortness of breath and chronic cough (Kementerian Kesehatan RI, 2022c). Tuberculosis is a type of infectious disease that is related to and affects public health, especially in developing countries around the world. The most commonly infected body organ is the lungs and can also occur in other body organs. Tuberculosis disease is a problem in eradicating the disease

in the treatment stage for each tuberculosis patient where the patient requires costs that are not affordable by the general public and a short time. This causes the treatment of pulmonary tuberculosis sufferers to decrease. Treatment that does not comply with guidelines affects drug resistance which increases the problem of tuberculosis. The number of new tuberculosis cases is caused by several factors, including HIV, malnutrition, smoking, and alcohol use (World Health Organization, 2022).

According to WHO, 1.6 million people died from TB in 2021. In the world, tuberculosis is the second infectious disease after Covid-19 above HIV/AIDS cases and the 13th cause of death. In 2021, there were 1.2 million children infected with tuberculosis worldwide. Tuberculosis in adolescents and children is often ignored by health providers and difficult to diagnose and treat. Based on WHO in the Global Tuberculosis Report 2022, geographically, it is estimated that 10.6 million people were affected by tuberculosis in 2021 and increased to 10.1 million (4.5%) in 2020 (World Health Organization, 2022).

An increase in tuberculosis case finding occurred in 2021, which amounted to 397,377 cases from 2020, which amounted to 351,936 cases (Kementerian Kesehatan RI, 2022b). Based on the South Sumatra Provincial Health Office in 2021 it shows that the discovery of new cases of pulmonary tuberculosis continues to increase with 9,382 cases in 2020, and 13,514 cases in 2021. The highest number of cases of tuberculosis (TB) is in Palembang City, namely 2,822 cases in 2020 and in 2021 an increase of 5,023 cases (Dinas Kesehatan Provinsi Sumatera Selatan, 2022).

Tuberculosis disease is not only suffered by adults, but also children. Tuberculosis can affect other organs such as the kidneys, lymph nodes, brain membranes, bones, intestines and skin. The incidence of tuberculosis in children is an important concern because pulmonary tuberculosis is the main cause of death among infectious diseases and the third cause of death at all ages (Kementerian Kesehatan RI, 2022a). Childhood tuberculosis is the incidence of tuberculosis infecting children aged 0 to 14 years. There is an estimated 5%-6% incidence of childhood tuberculosis per year. Children are at higher risk of contracting tuberculosis in areas with a high number of tuberculosis cases. Another factor affecting childhood tuberculosis is population density as it causes stronger interactions and influences the spread of mycobacterium tuberculosis (Martinez et al., 2020).

The prevalence of childhood tuberculosis disease in the age group under 1 year is 0.1%, 1 to 4 years is 0.3%, and 5 to 14 years is 0.2% (Riskasdas, 2018). Data from the Indonesian Ministry of Health in 2021 states that the number of tuberculosis patients in children aged 0-14 years is 38,663 cases (9.7%). Based on the provinces that have the highest number of cases are West Java, Central Java, DKI Jakarta, and East Java provinces (Kementerian Kesehatan RI, 2022b). Palembang City is the largest city in South Sumatra Province, with a population that is increasing every year. Based on the Palembang City Health Profile, Palembang experienced an increase in the number of childhood tuberculosis cases from 2019 to 2021. In 2020, the number of childhood tuberculosis cases was 125 cases and 205 cases in 2021.

Based on previous research that the risk factors for tuberculosis in children infected with *M. tuberculosis* showed a relationship between ventilation, housing density, nutritional status of children, house floor, exclusive breastfeeding, child age, LBW history, gender, BCG immunization status, maternal knowledge, family income, maternal education, smoking place, maternal employment status, presence of smokers, and contact history in children (Fitria & Rita, 2021).

Based on the description above, the purpose of this study is to determine and describe spatial analysis with an overview of the regional distribution of tuberculosis in Children in Palembang City in 2022 and find out the epidemiological calculations. Thus, it can find

efforts to achieve a decrease in the incidence of childhood tuberculosis and increase the participation of the community and health service facilities so as to improve the prevention and control of tuberculosis.

LITERATURE REVIEW

A tuberculosis is an infectious disease caused by *Mycobacterium tuberculosis* which attacks the lungs and other parts of the body. Pulmonary tuberculosis is one of the indicators in the MDG's (Kementerian Kesehatan RI, 2022b). Transmission of this disease can occur and can move through the blood to infect other parts of the body, such as the spine, brain, and kidneys (CDC, 2022a). Currently, the incidence of tuberculosis is still a major health problem nationally and globally, including the 10 main causes of death in the worldwide (Kementerian Kesehatan RI, 2022c).

Childhood tuberculosis is a disease that affects children under 15 years of age. This is still a very important issue to deal with in the public health sector because it is currently a factor in tuberculosis transmission. The group of children aged under 5 years old and adolescents over 10 years old have the highest number of cases in the childhood group. Symptoms of childhood tuberculosis include cough, fever, feeling sick and weak, weight loss, and night sweats (CDC, 2022b).

There are factors that can increase the risk of childhood tuberculosis include age, gender, contact investigation status, and BCG immunization status. A child's immune system is still weak because the child's immune system is not functioning properly, and will show an increase in resistance to tuberculosis with age. Children under 5 years of age are at higher risk of tuberculosis infection (Farsida & Kencana, 2020). In the 2018 Riskesdas, tuberculosis in male children was also found to be 1.3 times more than in female children (Riskesdas, 2018).

The distribution of tuberculosis cases was conducted to see the magnitude of the number of cases in a particular area. The analysis used is spatial analysis. Spatial data is useful to help describe through visualization of public health events. This map can be analyzed and will help convey public health information that is easy to understand and informative. The role of GIS in the health sector functions in the observation of a disease event based on time so that anticipatory actions such as countermeasures can be taken quickly if an outbreak occurs (Kementerian Kesehatan RI, 2015).

METHOD

This research uses descriptive quantitative research with an ecological research study design approach. This study uses secondary data in the form of aggregate population obtained from the Palembang City Health Office. The data contained the number of tuberculosis cases in children in each public health center and sub-district in 2022. The population in the study is all cases of childhood tuberculosis in 2022 that were recorded and reported by the Palembang City Health Office. The sample in this study was all cases of tuberculosis in children in 2022 that were recorded and reported by the Palembang City Health Office in 2022, namely 1,036 cases. In this study, the sampling technique used was *total sampling*. Samples were taken using the entire number of samples.

Data were obtained through recording and reporting of tuberculosis through the TB Information System (SITB) service application which had previously been recollectd by the P2PM section of the Palembang City Health Office. The data analysis used is spatial analysis. Spatial analysis is the analysis of data on patterns, locations, or relationships between systems of spatial data using geographic information systems (GIS). Data presentation will be made in the form of maps and tables along with their interpretation.

This study has received ethical approval from the Health Research Ethics Committee, Faculty of Public Health, Sriwijaya University with No. 386/UN9.FKM/TU.KKE/2023.

RESULT AND DISCUSSION

Distribution Map of Tuberculosis Cases in Children in Palembang City in 2022

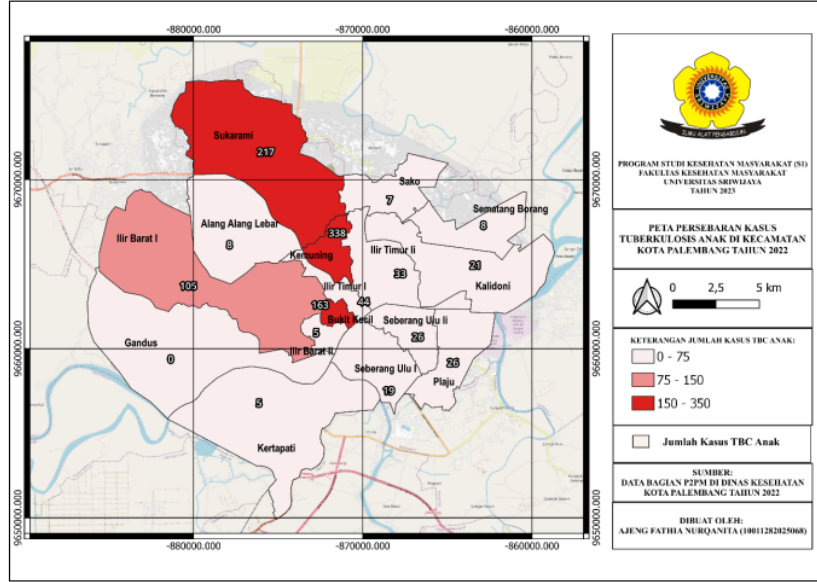


Figure 1. Mapping of Tuberculosis Cases in Children by Subdistrict in Palembang City in 2022

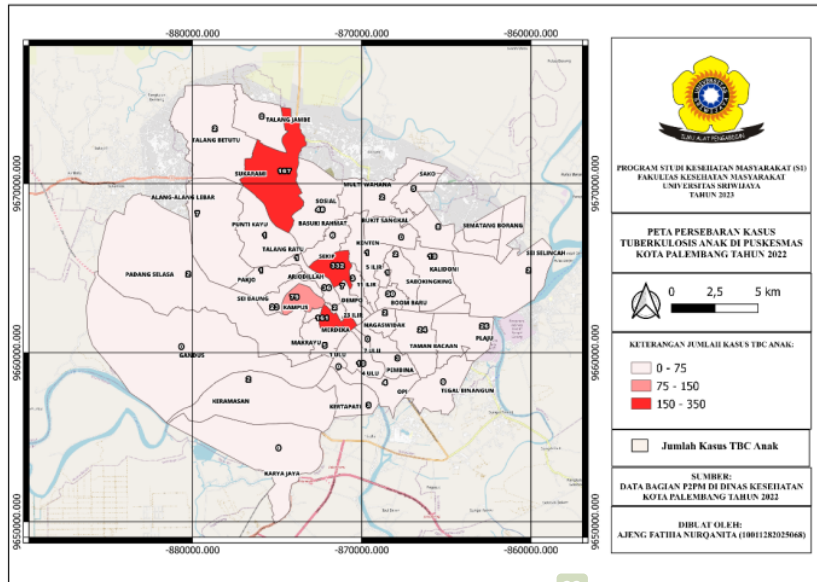


Figure 2. Mapping of Tuberculosis Cases in Children by Health Center in Palembang City in 2022

Based on the Figure 1. above, there are three different color categories of tuberculosis distribution areas. The deeper/darker color categories describes areas with the most cases found in hospitals, public health centers, clinics and health facilities in the sub-districts are, while the lighter/faded color categories describes areas with low case finding. The mapping above shows that the highest number of child tuberculosis cases in Palembang City in 2022 were found in hospitals, public health centers, clinics and health facilities in Kemuning Sub-district, with 338 cases, which is indicated by the solid red category. After that, below Kemuning Subdistrict are health facilities in Sukarami and Bukit Kecil Subdistricts with case findings between 150-350 cases marked with the same regional category. Furthermore, the second category with a slightly darker pink area color is Ilir Barat I Subdistrict, which has 105 cases with a category of 75-150 cases. Meanwhile, other sub-districts have low findings of child tuberculosis cases so they are included in the light pink area category. In 2022, the total number of tuberculosis in children cases recorded by the Palembang City Health Office is 1,036 cases.

The mapping results in Figure 2. above show that the most cases of childhood tuberculosis in Palembang City in 2022 were at the Sekip Health Center with 332 cases marked with the solid red area category. After that, under Sekip Health Center are Sukarami and Merdeka Health Center with the number of case findings between 150-350 cases marked with the same area category. Furthermore, the second category with a slightly dark pink area color is Kampus Health Center with 79 cases. Meanwhile, the other health centers are included in the light pink area category, which is the lowest case finding for childhood tuberculosis.

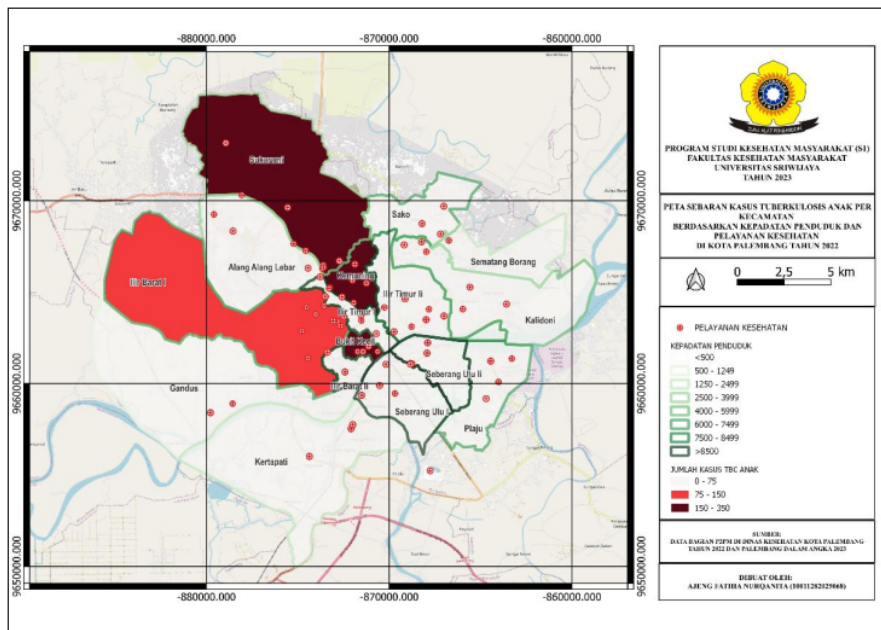


Figure 3. Mapping of Tuberculosis Cases in Children Based on Population Density and Health Services in Palembang City in 2022

The mapping results above show that the population density in Palembang City is in the dense category, namely Seberang Ulu I, Ilir Timur I, Ilir Barat II, Seberang Ulu II, Jakabaring and Kemuning Districts. This area has a density with an area of >8,500 inhabitants/km². The incidence of childhood tuberculosis is often found in the Sukarami, Kemuning and Bukit Kecil areas. In general, the results of the distribution of childhood tuberculosis cases in Palembang City are not influenced by the general population density in the area. Most cases were found only in the Kemuning District area with a high population density. Case findings in Palembang City tend to be in medium density areas, namely the Ilir Barat I, Sukarami and Bukit Kecil areas.

Epidemiological Indicators of Tuberculosis Cases in Children in Palembang City in 2022

Table 1. Incidence Rate and Case Notification Rate of Childhood Tuberculosis Cases in Palembang City in 2022

Number/Rate	Formula	Value	Rate per 100.000 population
<i>Incidence rate of child TB cases in Palembang City in 2022</i>	(Number of childhood TB cases : Total population at risk) × (100.000)	(1.036 : 348.073*) × (100.000)	298 cases per 100.000 population
<i>Case Notification Rate (CNR) of childhood TB cases in 2022</i>	(Number of childhood TB patients found : Total of child population) × (100.000)	(1.036 : 348.073*) × (100.000)	298 cases per 100.000 population

*) Total population by age group (BPS Palembang)

Source: P2PM Section of Palembang City Health Office and Palembang in Figures 2023 (BPS Palembang)

Table 2. Epidemiological Calculation of Childhood Tuberculosis Cases in Palembang City in 2022

Number/Rate	Formula	Value	Rate (%)
<i>Mortality Rate of childhood TB in 2022</i>	(Number of childhood TB deaths : Total of child population) × (100%)	(6 : 348.073*) × 100%	0,0017%
<i>Case Fatality Rate (CFR) of childhood TB cases in 2022</i>	(Number of childhood TB deaths : Number of childhood TB cases) × (100%)	(6 : 1.036) × 100%	0,58%
<i>Case Detection Rate (CDR) of childhood TB cases in 2022</i>	(Total number of childhood TB patients : Target number of childhood TB cases) × (100%)	(1.036 : 793) × 100%	130%

*) Total population by age group (BPS Palembang)

Source: P2PM Section of Palembang City Health Office and Palembang in Figures 2023 (BPS Palembang)

Based on the table above, it can show the results of epidemiological calculations of childhood tuberculosis cases in Palembang City in 2022, obtained an Incidence Rate of 1,036 cases of tuberculosis and an estimated 298 per 100,000 people and a Case Notification Rate (CNR) of 298 per 100,000 people. The table above shows that the Case Fatality Rate (CFR) of tuberculosis cases in children is 0.58%, the Mortality Rate is 0.0017%, and the Case Detection Rate (CDR) is 130%.

Overview of the Incidence of Childhood Tuberculosis Based on Characteristics

In Palembang City, the number of childhood tuberculosis cases from 2020 to 2022 was obtained from P2PM data from the Palembang City Health Office, where the incidence of childhood tuberculosis has increased. In 2020, the number of childhood tuberculosis cases was 140 cases, 383 cases in 2021, and 1,036 cases in 2022.

Table 3. Distribution of Childhood Tuberculosis Incidence Based on Characteristics in Palembang City in 2022

Variables	Frequency (n)	Percentage (%)
Age (year)		
0 - 4	530	51,2
5 - 14	506	48,8
Gender		
Male	547	52,8
Female	489	47,2
Patient Type		
New patient	951	91,8
Patient with unknown previous TB treatment history	79	7,6
Relapse patient	5	0,5
Patient with a history of TB treatment other than relapse	1	0,1
Contact Investigation Status		
Contact investigated	579	55,8
Unknown contact investigated	457	44,11
BCG Immunization Status		
BCG immunized	513	49,5
Unknown BCG immunized	523	50,5

Source: P2PM Section of Palembang City Health Office in 2022

Based on the table above, it shows that out of 1,036 cases of tuberculosis in children in 2022 in Palembang City, the most cases were in the age category of 0-4 years, namely 530 cases (51.2%), while the age of 5-14 years were 506 cases (48.8%). Based on the frequency distribution above, it is known that most cases of tuberculosis in children in Palembang City in 2022 were suffered by male children, namely 547 cases (52.8%), while female children were 489 cases (47.2%).

Most cases of childhood tuberculosis in Palembang City in 2022 were new patients, namely 951 cases (91.8%), 79 cases (7.6%) were patients with unknown previous TB treatment history, 5 cases (0.5%) were relapsed patients, and 1 case (0.1%) was patients with TB treatment history other than relapse. Most cases of childhood tuberculosis in Palembang City in 2022 had conducted contact investigations, namely 579 cases (55.8%) and the unknown status of contact investigations were 457 cases (44.11%). Then, most cases of childhood tuberculosis in 2022 in Palembang City had unknown BCG immunization status, namely 523 cases (50.5%), while children who had BCG immunization were 513 cases (49.5%).

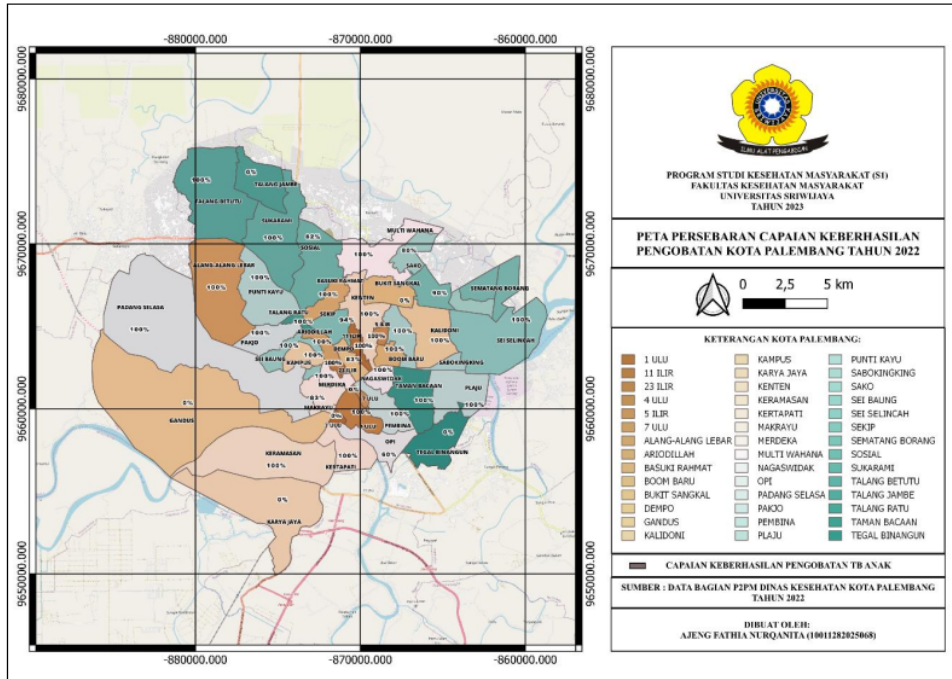


Figure 4. Distribution of Treatment Success Rate of Children by Health Center in Palembang City in 2022

Table 4. Treatment Success Rate of Children by Health Center in Palembang City in 2022

Public Health Center	Number of Cases	Treatment Success Rate (%)
Kertapati	3	100
Pakjo	1	100
Sekip	332	94
Taman Bacaan	24	100
Karya Jaya	0	-*
7 Ulu	0	-*
Talang Betutu	2	100
Kenten	1	100
Sako	5	80
Padang Selasa	2	100
Kampus	79	100
Nagaswidak	2	100
Dempo	7	83
Talang Ratu	1	100
Gandus	0	-*
Punti Kayu	1	100
Tegal Binangun	0	-*
Kalidoni	19	100
Keramasan	2	100
Makrayu	5	83
Multi Wahana	2	100

Boom Baru	30	100
Plaju	26	100
Alang-Alang Lebar	7	100
11 Ilir	3	100
Sei Baung	23	100
Pembina	3	100
1 Ulu	0	-*
Sukarami	167	100
Sei Selincah	2	100
Ariodillah	36	100
5 Ilir	1	100
Bukit Sangkal	0	-*
Basuki Rahmat	6	100
Sabokingking	2	100
Sematang Borang	8	90
23 Ilir	2	100
Sosial	48	82
4 Ulu	19	100
Talang Jambe	0	-*
Opi	4	60
Merdeka	161	100
Total	1.036	96,4

*) There is no patient finding in that health center

Source: P2PM Section of Palembang City Health Office in 2022

Based on the distribution of Treatment Success Rate achievements above, of the 42 health centers in Palembang City, most health centers have achieved the target of 90% successful treatment of children in Palembang City in 2022. The average achievement in Palembang City is 96.4%. The majority of public health centers have fulfilled and achieved the target of successful treatment of children after treatment in Palembang City in 2022 by 90%, namely 30 health centers. Meanwhile, the other 5 health centers that did not reach the target were Dempo, Makrayu, Sosial, Sako, and OPI Health Center. There are 7 other health centers that do not have child tuberculosis cases.

Based on the mapping results, it shows that the highest number of child tuberculosis cases from hospitals, health centers, clinics and health facilities in sub-districts in Palembang City occurred in Kemuning District with 338 cases, while there are 3 sub-districts that have the lowest tuberculosis findings, namely Gandus, Kertapati, and Ilir Barat II sub-districts. Based on previous research, there are several factors in each individual, namely gender, contact history, immunization status, which are factors that influence the prevalence of tuberculosis. The increase in childhood tuberculosis cases occurred in the last 3 years, namely 140 cases in 2020, 383 cases in 2021, and 1,036 cases in 2022. Childhood tuberculosis cases are spread in various areas of Palembang city. This shows that the spread of tuberculosis is still ongoing and needs countermeasures.

Child tuberculosis cases in Palembang City do not follow the distribution of population density. The Kemuning District area has a high population density and a large number of cases. This may also be the reason for the large number of finds in this area. In contrast, the Ilir Barat I, Sukarami and Bukit Kecil sub-districts only have moderate density. There are possible factors other than density that affect the number of cases found in this area.

The first factor that can influence the incidence of childhood tuberculosis is age. One of the most influential factors or indicators in childhood in the development of disease is age. In addition, age is one of the risk factors for tuberculosis in children because this infection is not based on and recognizes ages 0 to 14 years. The majority of tuberculosis cases are suffered by children between the ages of 1 and 4 years old (Wismasa, 2021). The results of the analysis in Palembang City, it was also found that most tuberculosis cases were at the age of 0-4 years. This is due to the condition of children during early birth, young age, and the first 10 years of life when immunity is vulnerable and weak. The occurrence of transmission and infection of children is very high. Research suggests that there is a significant correlation between the age of the child (0 to 5 years) ($p = 0.035$) and the incidence of childhood tuberculosis (Brajadenta, Laksana, & Peramiarti, 2018).

Then, the second factor is gender. Boys are at highest risk with 1.6 times greater risk of contracting tuberculosis than girls (Agus Nurjana, Tjandrarini, & Gunawan, 2019). Research conducted at Abdoel Wahab Sjahranie Samarinda Hospital showed that out of 30 patients, the most children were male, namely 9 patients (30%) (Wiranti, Yuniati, & Mu'ti, 2023). Many cases of childhood tuberculosis are found in boys rather than girls. This is caused by exposure to tuberculosis risk factors that allow boys to have a high level of exposure due to doing a lot of outdoor activities and reduced compliance with taking medication.

The third factor is contact investigation. Contact investigation includes contact history, where children with low immunity will be at the highest risk of infection when they have household contact. Delayed diagnosis and treatment of tuberculosis patients can increase the risk of disease transmission to people with contact status (Wismasa, 2021). Contact history is a dangerous source of transmission which can come from the closest person such as an adult tuberculosis patient who can be transmitted through the air such as when talking, sneezing and coughing. According to research by Rita et al (2020), showed that the majority of children had a contact history status (62.6%) and the bivariate results showed that there was an association between contact history and childhood tuberculosis (OR = 1.33). Tuberculosis contact is when people have close contact for any period of time (Sitepu, Aditama, & Depari, 2020).

Most patients with pulmonary tuberculosis cases in Palembang City as infants have received the BCG vaccine, but it can not avoid contracting tuberculosis disease or transmission. Based on data analysis at the Palembang City Health Office, most BCG immunization status data were not included in the Tuberculosis Information System (SITB). Research on the effectiveness of BCG immunization explained that toddlers who are not immunized have an 8 times more likely to be infected with tuberculosis disease than toddlers who are immunized with BCG (Jafri & Sesrinayeti, 2018).

The results of data analysis from the Palembang City Health Office show that the level of awareness among the people of Palembang City regarding the importance of tuberculosis treatment in children is relatively good, as shown by 15 sub-districts that have reached the target achievement of 90%. However, there are still cases that tend not to complete treatment until the end, which affects the cure. This may also affect treatment adherence among tuberculosis patients because they are unable to access treatment (Nursasi, Huda, & Rahmasari, 2022). The role of parents as PMOs can supervise children's medication-taking behavior such as paying attention and controlling children every day and giving medicine to children directly at the specified time (Ratnasari, 2023).

The success of treatment takes priority over cure. If a case is found, treatment should be immediately carried so that the child can recover. Family awareness, such as through community education, may help parents recognize the onset of tuberculosis in children and

encourage access to health services in a timely manner (Laghari et al., 2019). Based on the results of the National Tuberculosis Control Strategy in Indonesia 2020-2024 guidelines, the proportion of cases with complete treatment has increased.

CONCLUSION

4 Spatial analysis describes the distribution of case findings by sub-district and public health center in Palembang City, from the mapping results, the areas that have the most case findings are hospitals, public health centers, clinics, and other health facilities in Kemuning District and Sekip Health Center. The distribution of childhood tuberculosis cases tends not to follow population density. Description of the characteristics of children according to age was obtained by the number of the 0-4 year group was the highest compared to the 5-14 year group with male gender. From the results of epidemiological indicators, the TB disease indicator was obtained, namely the discovery of childhood tuberculosis cases totaling 1,036 cases, which had a percentage achievement of 130%. Of the 42 health centers, 30 health centers have achieved the target of treatment success. It is necessary to increase public awareness by conducting treatment until the end provided by health facilities so that children achieve recovery and there is cross-sectoral collaboration related to efforts to prevent and control tuberculosis in children in order to decrease the incidence of tuberculosis, especially in areas with high case findings in Palembang City.

ACKNOWLEDGEMENT

The author would like to thank all those who have helped in writing this article. Thank you to the supervisor for providing advice, direction, motivation and support during the process of making the article. The author would also like to thank the Faculty of Public Health of Sriwijaya University and the Palembang City Health Office for providing research permits, advice, and input.

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