

ORIGINAL ARTICLE

MAPPING OF CHILDREN'S TUBERCULOSIS INCIDENCE BY COVERAGE OF BCG IMMUNIZATION, MALNUTRITION, AND HOME ENVIRONMENT

Peta Distribusi Kejadian Tuberkulosis Anak Berdasarkan Cakupan Imunisasi BCG, Kasus Gizi Buruk, dan Lingkungan Rumah

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ABSTRACT

Background: Based on the Global Tuberculosis (TB) Report, Indonesia is one of the countries with a triple burden of TB, and TB disease can attack all age groups, including children. East Java Province in 2019 was ranked third in the highest number of pediatric TB cases in Indonesia. **Purpose:** This study aims to describe the distribution trend of tuberculosis cases in children in East Java Province in 2017-2018 based on BCG immunization coverage, cases of malnutrition, amount of healthy houses, and households with PHBS. **Methods:** The research design was a descriptive study with a correlation study design. The populations were all districts/cities in East Java Province, with as many as 38 districts. The data analysis technique to describe the trend distribution of tuberculosis in children was the health mapper software on a computer developed by World Health Organization (WHO). **Results:** The distribution of the incidence of tuberculosis in children in East Java from 2017 to 2018 tends to increase. The city of Surabaya became the area with the highest incidence of tuberculosis in children from 2017 to 2018. Based on a spatial map, most districts or cities with BCG immunization coverage, cases of malnutrition, several healthy homes, and high PHBS households experience tuberculosis incidence in children is high. **Conclusion:** Based on the map, spatially, districts or cities with high cases of tuberculosis in children mainly occur in areas with cases of malnutrition, the number of healthy home environments, and high coverage of BCG immunization as well.

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ABSTRAK

Latar Belakang: Berdasarkan Global Tuberculosis (TB) Report Indonesia merupakan negara dengan triple burden TBC. Penyakit TB dapat

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menyerang seluruh kelompok umur termasuk anak. Pada tahun 2019, Provinsi Jawa Timur menempati urutan ke tiga kasus TB anak terbanyak di Indonesia. **Tujuan:** Penelitian ini bertujuan untuk menggambarkan distribusi kasus tuberculosis pada anak di Provinsi Jawa Timur tahun 2017-2018 berdasarkan cakupan imunisasi BCG, kasus gizi buruk, jumlah rumah sehat dan jumlah rumah tangga berperilaku hidup bersih dan sehat (ber-PHBS). **Metode:** Desain penelitian yang digunakan adalah penelitian deskriptif dengan desain studi korelasi. Populasi adalah seluruh kabupaten atau kota yang berada di Provinsi Jawa Timur sebanyak 38. Teknik analisis data yang digunakan untuk mendeskripsikan gambaran kecenderungan distribusi kejadian tuberculosis pada anak menggunakan software health mapper pada computer yang dikembangkan oleh World Health Organization (WHO). **Hasil:** Distribusi kejadian tuberculosis pada anak di Jawa Timur tahun 2017 hingga 2018 cenderung meningkat. Kota Surabaya menjadi wilayah tertinggi dengan kejadian tuberculosis pada anak dari tahun 2017 hingga 2018. Berdasarkan peta secara spasial, sebagian besar kabupaten atau kota dengan cakupan imunisasi BCG, kasus gizi buruk, jumlah rumah sehat, dan rumah tangga ber-PHBS yang tinggi mengalami kejadian tuberculosis pada anak yang tinggi. **Kesimpulan:** Secara spasial berdasarkan peta, kabupaten atau kota dengan kasus tuberculosis pada anak yang tinggi sebagian besar terjadi pada wilayah dengan kasus gizi buruk, jumlah lingkungan rumah sehat serta cakupan imunisasi BCG yang tinggi juga.

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INTRODUCTION

Tuberculosis (TB) is one of the infectious diseases caused by the bacterium *Mycobacterium tuberculosis* and has the etiological nature of Acid-Resistant Bacteria, so it is better known as BTA. Tuberculosis virus infection will occur if other people breathe air containing phlegm droplets from an infected person. Several factors that can affect tuberculosis transmission are the proximity and length of time in contact with the source of transmission, and the concentration of germs in the air (Pangaribuan, Kristina, Perwitasari, Tejayanti, & Lolong, 2020).

TB disease can affect all age groups, including children, especially at the age of 0-14 years. Most children infected with tuberculosis have the organism from adults in their environment. Besides, the risk of a child developing tuberculosis can depend on the immunological and genetic factors of the child (Lamb & Starke, 2017).

Globally, around 9-11 million people suffer from tuberculosis, and about 1.40 million people die; children aged <15 years account for 12% of TB cases. Indonesia is a country with a triple burden of TB, namely Drug Sensitive TB (SO), the incidence of Drug-Resistant TB (RO), and HIV TB (World Health Organization, 2019). In 2017 and 2018, Indonesia had the third-highest

tuberculosis incidence in the world after India and China. The number of new tuberculosis cases in Indonesia in 2019 was 543,874 cases and increased to 845,000 cases in 2021, while the number of child TB cases in 2019 was 63,111, and in 2021 the cases increased to 70,341 (Ministry of Health RI, 2021). Children have the highest risk of developing a more severe disease if infected with tuberculosis, whereas children under five years have a higher number of deaths than older children (Roy, Whittaker, Seddon, & Kampmann, 2019).

Tuberculosis is also closely related to with nutritional status of the child (Yuniar, Sarwono, & Lestari, 2017). According to research conducted by Rita, Saputri, Widakdo, Permatasari, & Kurniaty (2020), nutritional status in children is related to the incidence of tuberculosis. Based on their analysis results, malnourished children are 18 times more likely to get tuberculosis than children with normal nutritional status. Tuberculosis is one of the diseases that can be prevented by immunization. Meanwhile, the Bacillus Calmette Guerin (BCG) vaccine is the only vaccine licensed to avoid tuberculosis infection that effectively protects infants and children from tuberculosis infection (Zhu, Dockrell, Ottenhoff, Evans, & Zhang, 2018). According to research by Sjahrani & Sari (2018), there is a difference where children

will be at three times greater risk of developing tuberculosis if they do not get BCG immunization.

Creating a spatial map or called a *Geographic Information System* (GIS), is one way in epidemiology to identify the distribution of cases and areas at high risk of disease occurrence. It is also beneficial for helping authorities to take quick and appropriate policies, especially those related to the health sector (Saifudin, 2016). This study aims to describe the distribution of children's tuberculosis cases in East Java Province from 2017 to 2018 based on the coverage of BCG immunization, cases of malnutrition, the number of healthy homes, and the number of households with clean and healthy living behavior (PHBS).

METHODS

The type of research was descriptive research. It applied a correlation study design. The population in this study were all regencies or cities in East Java Province, with as many as 38 regencies/cities. The dependent variable of this study was the case of tuberculosis in children, and the independent variable was the coverage of BCG immunization, cases of malnutrition, the number of healthy houses according to the Ministry of Health, and the number of households with PHBS (Clean and Healthy Living Behavior). The case of child tuberculosis was an incidence in a place or region in children aged 0 to 14 years who were exposed to infectious diseases. It was caused by the bacterium *Mycobacterium tuberculosis*. The coverage of BCG immunization was in districts or cities, especially for children who have been immunized against the vaccine *Bacillus Calmette Guerin* (BCG).

According to the Regulation of the Minister of Health Number 29 of 2019 concerning Handling Nutritional Problems for Children Due to Disease, cases of malnutrition are incidences where the nutritional condition of children is very thin. Then, other conditions were accompanied or not with edema on both backs of the legs, body weight according to body length or body weight compared to a height less than -3 standard deviation, and/or upper arm circumference less than 11.50 cm in children aged 6-59 months. A healthy house is a residential building with health requirements consisting of the house components, sanitation facilities, and behavior, prioritizing healthy latrines, garbage disposal sites, clean water facilities, wastewater disposal facilities, good ventilation, appropriate housing density and house

floors not from land. The number of households with Clean and Healthy Behavior (PHBS) variable is the number of households that implement the ten indicators of Clean and Healthy Life Behavior based on the regulation that be appointed by the Indonesian Ministry of Health (Ministry of Health RI, 2019).

The data were the secondary data sourced from the Book of Health Profile in East Java Province in 2017 and 2018. Retrieval of the secondary data has obtained research ethics permit with ethical number 530/HRECC.FODM/IX/2021 at Universitas Airlangga Faculty of Dental Medicine Health Research Ethical Clearance Commission. From 2017 to 2018, East Java Province ranked second in Indonesia in the number of tuberculosis cases. However, data on the number of children's tuberculosis cases between regions in Indonesia East Java Province can be affected by the performance of the program tuberculosis case finding in each district/city (East Java Provincial Health Office, 2018, 2019).

The data analysis technique to describe the distribution trend of the incidence of tuberculosis in children in this study was using the software application *health mapper* using version 4.3.0.0, which was developed by the *World Health Organization* (WHO) (Dilita & Hendrati, 2019). The *health mapper* application can produce an overview of two cases of child tuberculosis at each point based on regional data, and the number of cases that have been inputted into the software. This study produced a distribution map of the incidence of tuberculosis in children based on the coverage of BCG immunization, cases of malnutrition, the number of healthy homes, and the number of households with PHBS (Clean and Healthy Living Behavior) in East Java Province from 2017 to 2018.

RESULTS

Distribution of Tuberculosis Incidence in Children with BCG Immunization Coverage

Based on the results of Figure 1, it was found that in 2017 there were three areas with the highest incidence of TB in children: Surabaya City, Regency Jember, and Pasuruan Regency. The three regions with the highest TB cases in children occurred in areas with high BCG immunization coverage Surabaya with BCG immunization coverage of 98.74%, Jember Regency with 90.32%, and Pasuruan Regency with 96.92%. Madiun and Nganjuk districts were districts that

did not have TB cases in children and have high BCG immunization coverage, which is the amount of 96.95% and 91.17%. In 2018 the city of Surabaya remained the area with the highest incidence of TB in children from 2017. The areas with the highest incidence of TB in children occurred in districts/cities with high BCG immunization coverage, namely 99.85%, 97.61%, and 105.93%. The districts/cities that did not have TB cases in children were Batu City, with high coverage of BCG immunization, which was 92.37%.

Distribution of TB Incidence in Children with Malnutrition

Based on the results of Figure 2, the highest tuberculosis cases in children in 2017 occurred in Surabaya City with 363 cases, Jember Regency with 290 cases, and Pasuruan Regency with 178 cases. Tuberculosis in children was highest in Surabaya City and Jember Regency, where there were 278 and 263 cases of malnutrition, respectively, while low cases of malnutrition in the Pasuruan Regency were 44 cases. There was Banyuwangi Regency with cases of malnutrition with the highest ranking of 526 with a low incidence of TB in children, that amount 76 cases. The highest TB incidence in children in 2018 was in Surabaya City, which was 438 cases, then Pasuruan Regency with 258, and Lamongan Regency with 170 cases. The city of Surabaya also has high cases of malnutrition, as many as 254 cases, while Pasuruan and Lamongan districts have cases of malnutrition in the low category, namely 33 and 94 cases.

Distribution of Children's TB Incidence with Amount of Healthy Houses

Figure 3 shows that, in 2017, tuberculosis cases in children with the highest number of cases occurred in Surabaya, with healthy homes included in the very high category of 572,897 houses with 86.99%. Nganjuk and Madiun districts have no TB cases in children, and the number of healthy houses in the two districts is in the high category, that is 155,758 houses or 59.17% and 158,954 houses or 77.43%. In 2018, Surabaya became the city with the highest cases of tuberculosis in children again, with 428 cases; the second position was Pasuruan Regency with 258 cases, then Lamongan Regency with 170 cases. In these three areas, some healthy houses are included in the high category. There are 586,623 healthy houses in

Surabaya, 304,759 in Pasuruan, and 299,143 in Lamongan.

Distribution of Children's TB Incidence with Number of PHBS Household

Figure 4 shows in 2017, the highest TB incidence in children was in Surabaya City with a total of 363 cases; wherein in Surabaya City, there were a high number of PHBS households, that in the amount of 159,293 RT or 72.62%. Batu City, Blitar City, Sumenep Regency, and Pacitan Regency are four regencies/cities with a deficient number of PHBS households, namely, 1,996, 3,754, 9,019, and 27,720 households. There were 2 cases of tuberculosis in Batu City, 11 cases in Blitar City, 43 cases in Sumenep Regency, and 2 cases in Pacitan Regency. In 2018, Surabaya remained the area with the highest incidence of TB in children, with 161,672 households with PHBS. The regencies/cities with deficient numbers of PHBS households are Pacitan Regency with 28,890, Magetan Regency with 46,960, Gresik Regency with 48,420, Banyuwangi Regency with 52,420, and Ngawi Regency 69,940. TB cases in children in five districts/cities with very low numbers of PHBS households, namely Pacitan Regency, Magetan Regency, Gresik Regency, Banyuwangi Regency, and Ngawi Regency, each were 6 cases, 10 cases, 163 cases, 142 cases, and 86 cases.

DISCUSSION

Based on the data on the map in Figures 1,2,3, and 4, the distribution of children's tuberculosis incidence in East Java Province from 2017 to 2018, was statistically analyzed, the correlation between child tuberculosis cases and BCG immunization coverage, the number of healthy homes, and PHBS households. From 2017 to 2018 in East Java Province, it showed that there was a negative correlation. Thus, the higher the number of tuberculosis cases, the lower the coverage of BCG immunization, the number of healthy homes, and PHBS households. It leads to districts or cities with low coverage of BCG immunization, districts or cities with low numbers of healthy homes, and households with PHBS followed by high tuberculosis cases. The correlation between tuberculosis cases in children and malnutrition shows a positive correlation or a unidirectional relationship, which means that the higher the number of cases of tuberculosis in children in East

Java Province, the higher the number of cases of malnutrition.

An increase in children's cases of tuberculosis in a district/city can occur, one of which is due to the decreased coverage of BCG immunization in that area. *Bacillus Calmette Guérin* (BCG) is a vaccine used to prevent tuberculosis. The BCG vaccine is made from *Mycobacterium Bovis* attenuated. The BCG vaccine until now remains the only vaccine that can protect against TB disease in childhood ((Fatima, Kumari, Das, & Dwivedi, 2020). Neonatal BCG vaccination, as recommended by WHO in countries with a high prevalence of tuberculosis, protects against tuberculosis in children but provides much less protection for adults (Roy et al., 2019). According to Kurniawan (2019), regarding the principle of the concept of immunology in his research, when the body receives the vaccination *Bacillus Calmette Guerin* (BCG), a process will begin to initiate an immune response from the non-specific immune system, phagocyte by macrophages and dendritic cells that can occur through the process of releasing components of immunomodulators, specifically cytokines and chemokines.

Almost all children with pulmonary tuberculosis had positive scar marks (83.85%). Scar marks were assessed to determine the history of BCG immunization which was used to prevent the incidence of tuberculosis (Rachim, 2017). Based on the results of the analysis of research by Wijayanti, Tamtomo, & Suryani (2020), BCG immunization does not have a significant relationship with the occurrence of tuberculosis. It may be due to the inappropriate timing of administration, in addition to the factors of how to give, dose, and store vaccines that are not appropriate, the effectiveness of the protection of the BCG vaccine is not also optimal.

According to research by (Jamil & Subiyatin, 2020), there is a significant relationship between incomplete immunization status and nutritional status in children, which means that immunization is one of the protective factors of poor nutritional status in children. Nutritional status plays an important role in the growth process of children. Meanwhile, poor nutritional status harms children's growth. When children have a weak immune system, it causes children to be susceptible to infectious diseases, including tuberculosis (Nadila, 2021).

Banyuwangi, Jember, and Magetan Regency are areas in East Java that are included in the category of very high cases of malnutrition. Two

of the three districts/cities, Banyuwangi and Jember districts, were also followed by high TB cases in children. Cases of high malnutrition can increase the occurrence of TB in children and vice versa. Malnutrition in developing countries significantly weakens the immune system and can reactivate latent tuberculosis infection in the body. On other hand, when a person is infected with tuberculosis, it can lead to a decrease in metabolism and appetite, leading to malnutrition (Martin & Sabina, 2019). Malnutrition in patients with tuberculosis can also be caused by reduced food intake and factors, such as cachexia due to metabolic dysfunction, poor food absorption, fever, and anorexia. Tuberculosis can cause dietary protein to be used more for energy than anabolism (Sinha et al., 2019).

According to research by Hoyt et al., (2019), poor nutrition is associated with increased cavitation and the extent of pulmonary tuberculosis. Low nutritional status can cause decreased immunity, causing an increase in the incidence of pulmonary tuberculosis in adults and children. Another study by Yuniar et al., (2017) showed a significant relationship between nutritional status and the incidence of tuberculosis in which people who were malnutrition 3,48 times a risk of suffering from pulmonary tuberculosis than people with adequate nutritional status.

Having a humidity of 40–70%, a temperature range of 18–30°C, ventilation of 10% of the floor surface, receiving enough natural light of 60–120 lux, and being able to maintain the density and cleanliness of the floor of the house are all characteristics of healthy homes (Noerhalimah, 2020). Poor environmental sanitation is associated with pulmonary tuberculosis. People living in homes with less sunlight, dense housing, and houses with poor circulation can be at risk of contracting pulmonary tuberculosis because the bacteria that cause tuberculosis can multiply and stay long (Butarbutar, 2018). Based on research by (Zulaikhah, Ratnawati, Sulastri, Nurkhikmah, & Lestari, 2019), there is a significant relationship between ventilation area and the incidence of pulmonary tuberculosis transmission. The respondents who live in homes with ventilation areas that are not eligible are at 5,57 times greater risk of developing pulmonary tuberculosis than those who live in houses with adequate ventilation areas.

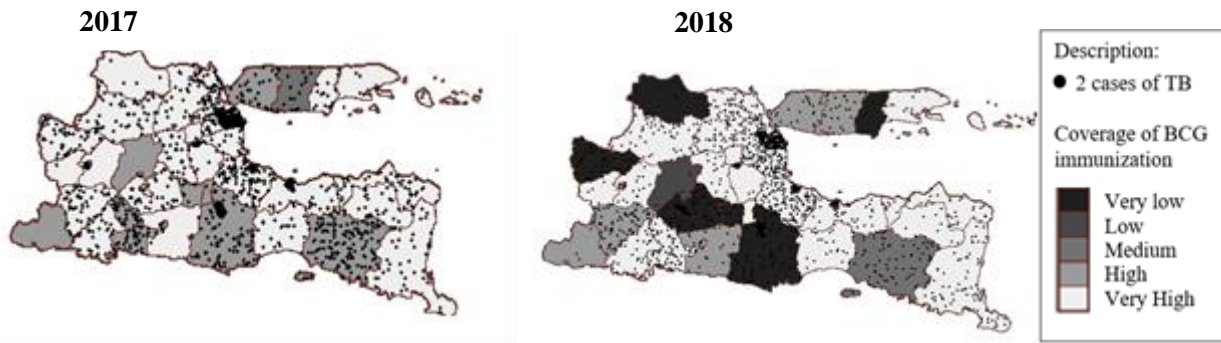


Figure 1. Distribution Map of Children's TB Incidence with BCG Immunization Coverage in East Java from 2017 to 2018

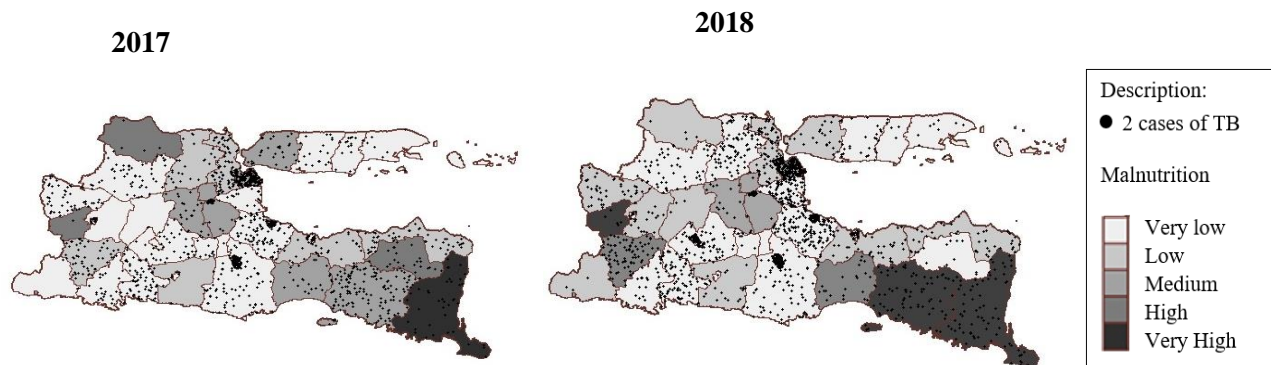


Figure 2. Distribution Map of Children's TB Incidence with Malnutrition Cases in East Java from 2017 to 2018

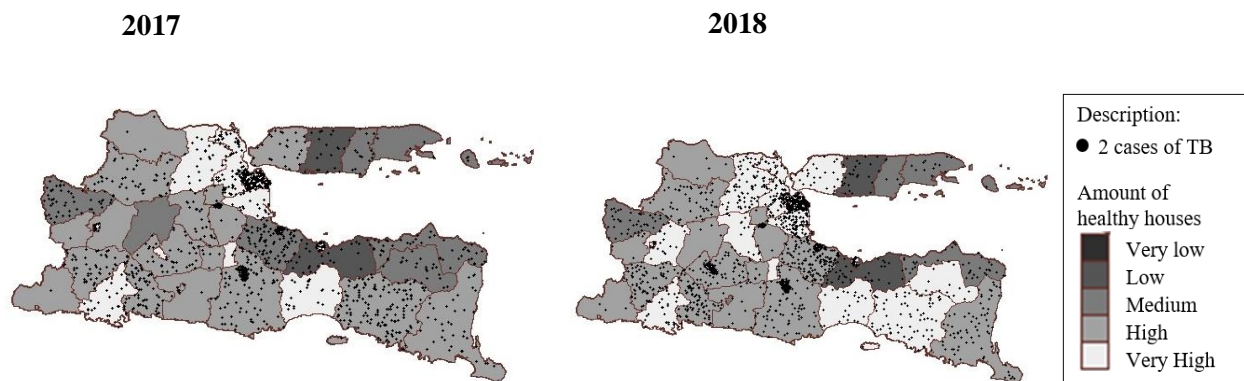


Figure 3. Distribution Map of Child's TB Incidence with Amount of Healthy Houses in East Java from 2017 to 2018

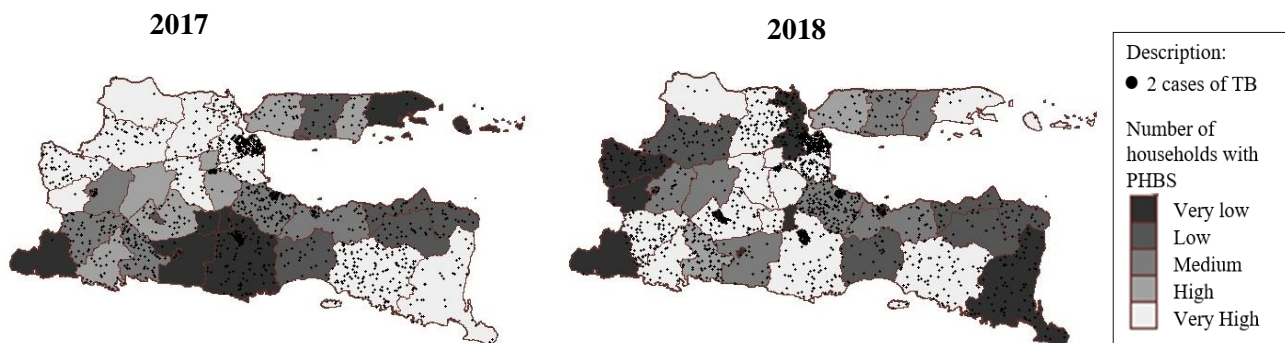


Figure 4. Distribution Map of Child's TB Incidence with Number of PHBS Household in East Java from 2017 to 2018

The bacteria that cause tuberculosis will survive in moist and moldy houses, so the transmission of tuberculosis in family members who live in one house will be greater. According to another study by (Muslimah, 2019), the analysis results in a significant relationship between the physical environment, precisely temperature, humidity, and lighting, and the presence of *Mycobacterium tuberculosis* in the air. East Java Province still has districts/cities with a low number of households with PHBS. Pacitan Regency is an area with a deficient number of PHBS households from 2017 to 2018. Besides, Batu City, Blitar City, and Sumenep Regency are areas with a deficient number of PHBS households in 2017 and 2018, and Magetan, Gresik, Banyuwangi, and Ngawi Regency are regions with a deficient number of PHBS households.

The results of research by Butarbutar (2018) say that the incidence of pulmonary tuberculosis in patients has a significant relationship with the state of environmental sanitation, so maintaining healthy living behavior and cleanliness is one of the efforts to prevent the transmission of disease, including tuberculosis in children. According to research by Noerhalimah (2020), there is a significant relationship between the incidence of tuberculosis and the number of households implementing PHBS (Clean and Healthy Living Behavior).

There are several differences between researchers. According to research by (Prasetya, 2020) there is no significant effect between Clean and Healthy Living Behavior (PHBS) and the incidence of pulmonary tuberculosis in the work area in Puskesmas Waru, Sidoarjo Regency. Another study by Muliyaniti, Karimuna, & Saktiansyah (2021) showed no relationship between house humidity and the incidence of pulmonary tuberculosis with a $p\text{-value} = 0.87$, and there was no relationship between house lighting and the incidence of pulmonary tuberculosis with $p\text{-value} = 0,86$. It is in line with research conducted by Rahmawati, Ekasari, & Yuliani (2021), which showed no significant relationship between house temperature and the incidence of tuberculosis.

Research Limitations

Based on the map of the children's tuberculosis incidence in East Java Province from 2017 to 2018, the sources were from the secondary data on the Health Profil Report of East Java Province in 2017 and 2018. Therefore, the

secondary data used in research for making maps depended on the performance of each holder's health program in every region in East Java Province from 2017 to 2018.

This study used secondary data and did not collect data directly. The research conducted was data correlation and analyzing the distribution map of tuberculosis in children generated by *health mapper software* without researching a significant relationship between variables. Consequently, the results of the distribution map of the incidence of tuberculosis in children in East Java Province from 2017 to 2018 contain several things that are not in line with the theory that previous researchers or other researchers have produced.

CONCLUSION

Tuberculosis cases in children in East Java Province have increased, and Surabaya became the highest region incidence of tuberculosis in children from 2017 to 2018. Spatially based on maps, districts or cities with high cases of tuberculosis in children mostly occurred in areas with a large number of healthy households, cases of malnutrition, households with PHBS, and high coverage of BCG immunization.

CONFLICT OF INTEREST

Sources of data used in this study are data that has been published by the East Java Provincial Health Office. The authors use the available data for epidemiological research related to the distribution map of the incidence of tuberculosis in children based on the number of occurrences of malnutrition, BCG immunization coverage, and the home environment in East Java Province.

AUTHOR'S CONTRIBUTION

All authors fully contributed to the research for the manufacture of articles, namely at the data collection stage, map making, data analysis, and the process of revising article writing. The details of the contributions of the two authors in making this article include GH: data collection, map-making, and revision of article writing. LH: conceptualization, data analysis, and editing.

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All data used in this research are available in reports published by the East Java Provincial

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