

Spatial patterns of maternal mortality causes in West Kalimantan, Indonesia

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Abstract

Background: Maternal Mortality Rate (MMR) is one of the health indicators to see maternal survival in general and is a component in the health development index. Maternal Mortality Rate is also an important indicator of the quality of health services and the performance of the Health system.

Objective: This study aimed to analyze the spatial patterns of maternal mortality based on the mortality causes in Sambas District, West Kalimantan, Indonesia.

Methods: This study used a descriptive and exploratory approach to be able to see the distribution of maternal mortality and the coverage of the distribution of health care facilities. A spatial pattern was carried out to analyze the distribution pattern of maternal mortality cases using the Average Nearest Neighbor.

Results: The results showed that most maternal mortality causes include bleeding, pregnancy hypertension, circulation system disorders (heart, stroke), metabolic disorders (diabetes mellitus), and other causes, such as pulmonary embolism. The analysis using a buffer of 3 kilometers and 5 kilometers show that not all the areas are covered by health service facilities in the Sambas district. Analysis of the mean of the nearest neighbors showed that the Nearest Neighbor ratio was 1.039398 with a z-score of 1.022396, which means that the pattern of distribution of maternal death according to the cause of death has a random pattern.

Conclusion: The spatial pattern of cases of maternal death according to the cause of death in the Sambas district, West Kalimantan, Indonesia, has a random pattern. This finding can be used as a basis for decreasing the maternal mortality rate.

Keywords: spatial patterns; maternal mortality causes; Indonesia

Background

Maternal Mortality Rate (MMR) is one of the health indicators to see maternal survival in general and is a component in the health development index

(Susiana, 2019). Maternal Mortality Rate is also an essential indicator of the quality of health services and the performance of the health system (Webel, 2004). Based on World Bank data in 2017, the MMR in Indonesia is 177 deaths per 100,000 births (World Bank, 2019). Every year, the MMR is also predicted

to be 358,000 maternal deaths worldwide, and around 99% of deaths occur in developing countries, where 67% occur in eleven countries, including Indonesia (Aeni, 2013).

The results of the Indonesian Basic Health Survey showed that the maternal mortality rate in Indonesia in 2015-2019 decreased compared to the previous few years, which was 305 maternal deaths per 100,000 live births (World Bank, 2019). Based on data from the Sambas District Health Office from 2014 to 2019, the maternal mortality rate continues to increase. Based on data collected from health centers and hospitals in 2011, the maternal deaths were 15 people from 11,541 live births. The number of maternal deaths in 2011 increased compared to 2010, 14 cases out of 10,516 live births. The main cause of maternal deaths in 2011 was bleeding (Dinas Kesehatan Kabupaten Sambas, 2019).

There are many factors that cause maternal death (Fortney et al., 1988; Afifah et al., 2016), including problems related to pregnancy and childbirth as well as maternal health status and readiness to become pregnant, antenatal care (pregnancy period), delivery assistance and immediate care after delivery, and socio-cultural factors. However, the highest cause of MMR is bleeding during pregnancy (Susiana, 2019). According to Novita (2010), the factors that cause the number of maternal deaths vary by region between districts/cities, so it is indicated that there is a spatial factor, namely that the locations of maternal deaths that are close together have significant similarities. This means that adjacent locations have the same cultural characteristics that cause similar behavior, especially towards maternal mortality.

Spatial is often interpreted as something related to space or place. In geography, the term spatial is also known as data about the earth, including the surface and under the earth and the ocean and below the atmosphere. Geographic Information System (GIS) is a system designed to store, manipulate, analyze, and display all types of geographic data, and GIS cannot be separated from spatial data (Irwansyah, 2013). The spatial perspective on maternal mortality will analyze the causes of maternal mortality in each region and their distribution patterns. Each region has a different influence on the life on it (Prihandini, 2016).

Several previous studies on the incidence of maternal mortality have been carried out, especially regarding risk factors for maternal mortality and mapping of maternal mortality rates (Liu et al., 2007; Alvarez et al., 2009). However, the use of geographic information systems to map the causes of maternal death based on the region is still not much research done. Geographic information systems can be used to create health maps, and this information, when mapped, will be a useful tool for mapping the causes of maternal death. Thus, this study aims to determine the distribution of maternal deaths based on the cause of death in Sambas district., West Kalimantan.

Methods

Study Design

This study used a descriptive and exploratory approach to see the distribution of maternal mortality and the coverage of the distribution of health care facilities and analyze the spatial pattern of the distribution of maternal mortality in the Sambas district, Indonesia. The research was conducted from April 2019 until April 2020.

Sample

This study used secondary data from the Sambas District Health Office in 2017-2019, namely data on the number of maternal deaths referred to and experienced emergencies for the last three years. Total sampling of 19 maternal deaths was used.

Data Collection

The secondary data were collected in the form of the number of maternal mortality cases, causes of maternal death, data on health service facilities (PONED Primary Health Care, NON-PONED Primary Health Care, and hospitals). In addition, another secondary data collection was carried out to support the results and discussion in this study, including the collection of document and file data relating to the Sambas Administration Map. Research results are collected in the form of images or map visualizations.

Data Analysis

Data were analyzed in two stages: 1) descriptive analysis to get a picture of the distribution of maternal mortality and describe the coverage of health facilities using buffering analysis; 2) spatial pattern analysis was carried out for the distribution pattern of maternal mortality cases.

Ethical Consideration

This study has been approved by The Research and Community Service Institute (LPPM) of Universitas Esa Unggul.

Results

Mapping the Distribution of Maternal Mortality Causes in Sambas District

Cases of maternal death in the Sambas district

almost occur every year and are spread in several families and sub-districts, Sambas district. The results obtained at the time of data collection related to causes of maternal death in the Sambas district, most of the causes of maternal death include bleeding, pregnancy hypertension, circulation system disorders (heart, stroke), metabolic disorders (diabetes mellitus), and other causes such as pulmonary embolism. The mapping of the distribution of maternal mortality causes by villages in Sambas district can be seen in the Figures below.

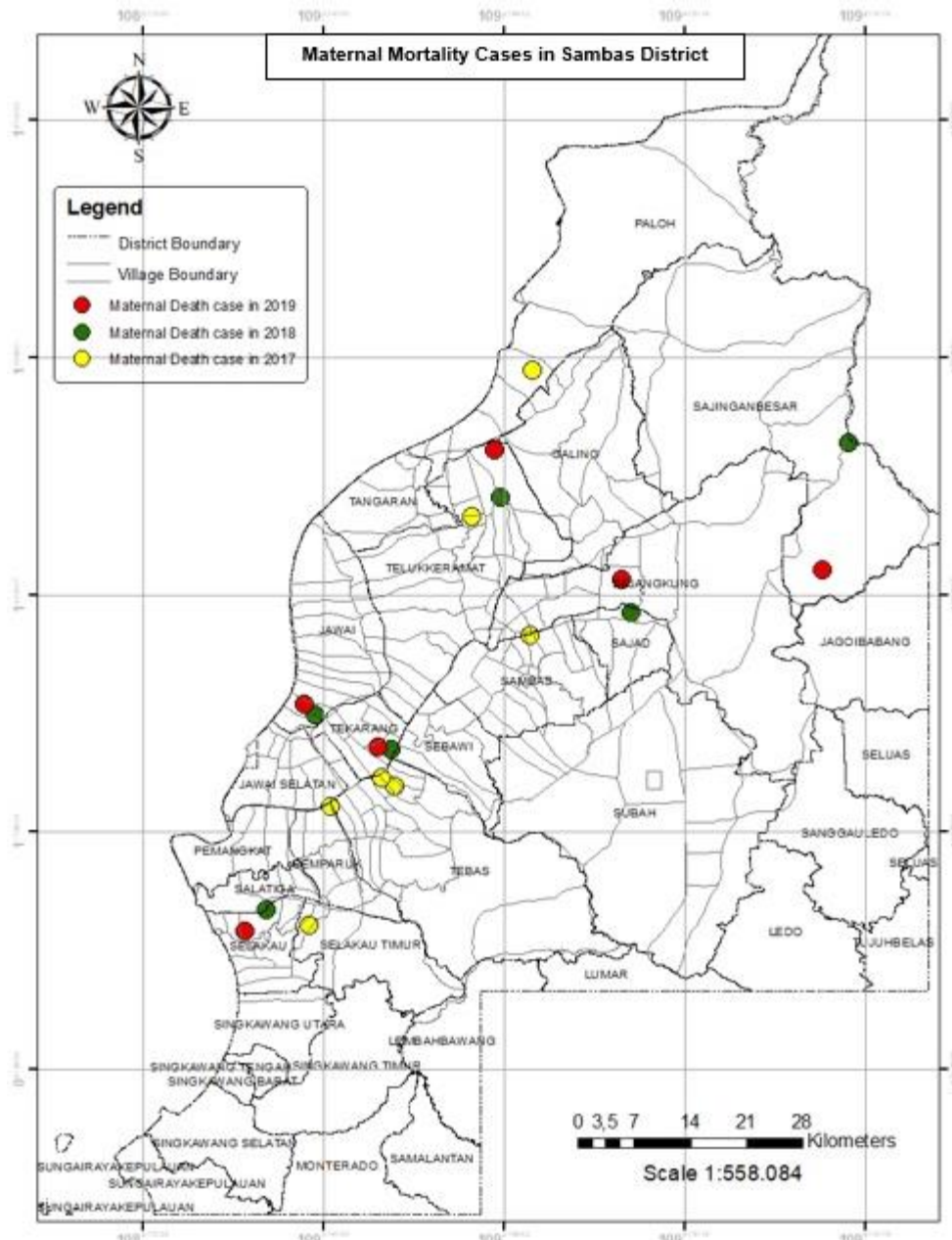


Figure 1 Maternal Mortality Cases in Sambas District

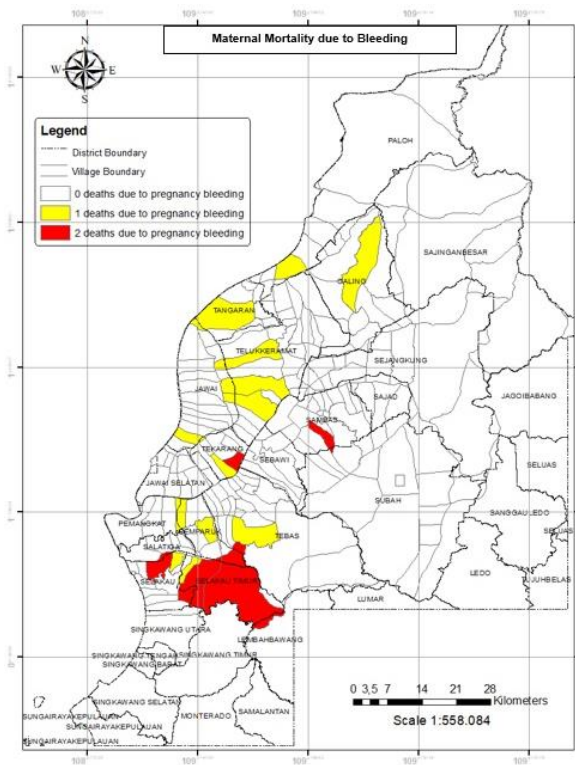


Figure 2 Maternal Mortality due to Bleeding

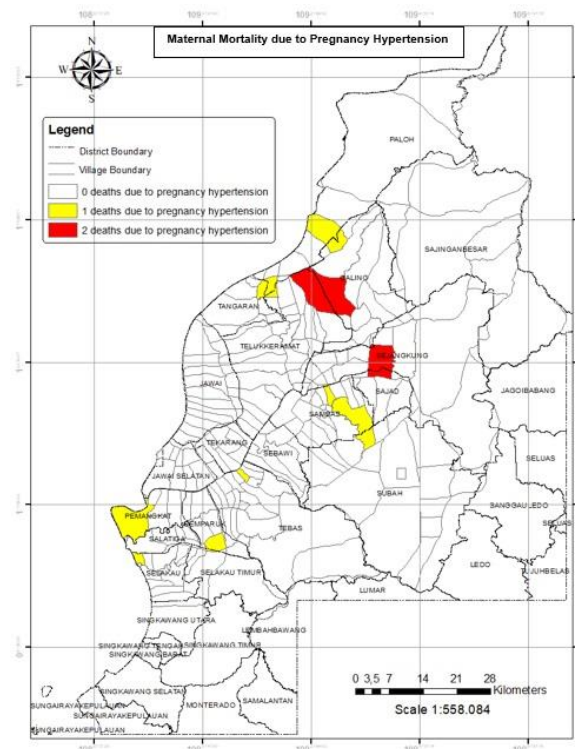


Figure 3 Maternal Mortality due to Pregnancy Hypertension

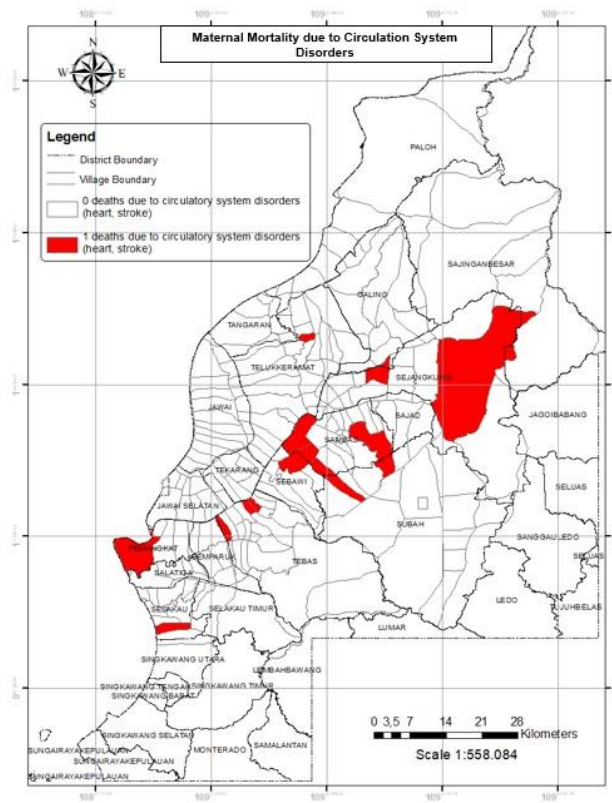


Figure 4 Maternal Mortality due to Circulation System Disorders

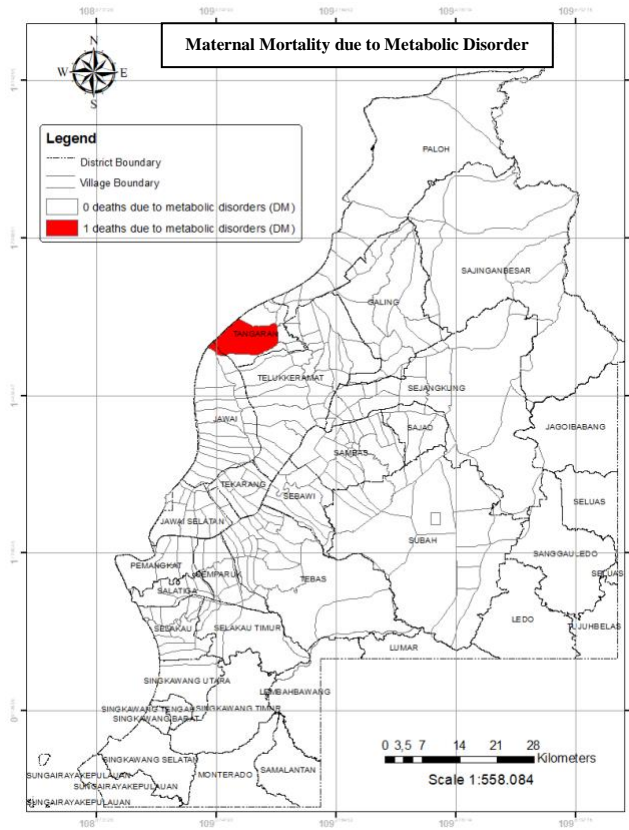


Figure 5 Maternal Mortality due to Metabolic Disorder

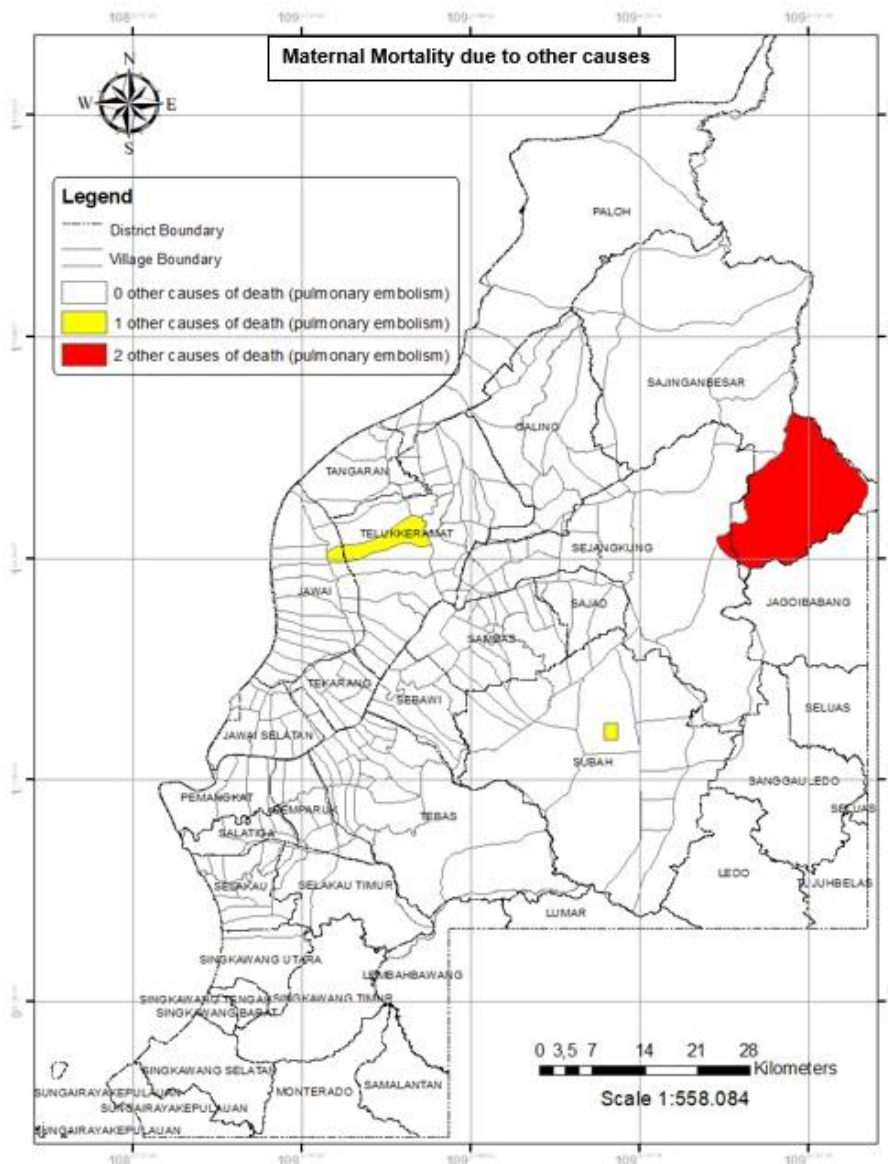


Figure 6 Maternal Mortality due to other causes

Buffer Analysis of Health Care Coverage in Sambas District

The use of layered buffers for mapping the coverage of health care facilities in Sambas district, as shown in Figure 7 provides information on areas that are not covered by various buffer sizes. The mapping of the coverage of health service facilities in Sambas district can be seen in the Figure 7.

Based on the data obtained regarding the maternal mortality causes, it demands a large role for health care facilities in dealing with the causes of death. Health Service Facilities in the Sambas Regency area have Poned Primary Health Care, Non Poned Primary Health Care, and Hospitals. Most of the Health care facilities have spread across the Sambas district.

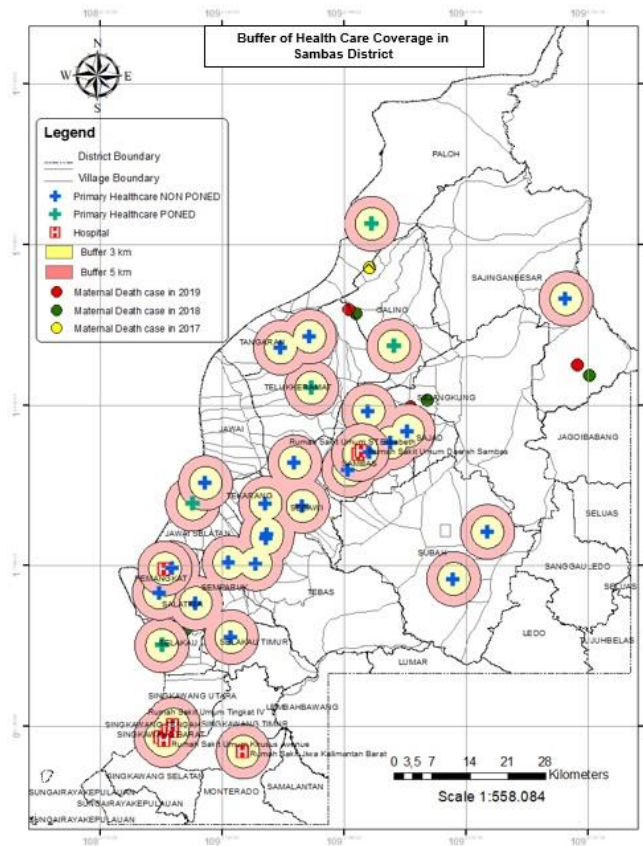


Figure 7 Buffer of Health Care Coverage in Sambas District

Spatial Pattern Analysis of Maternal Death Causes in Sambas District

The spatial analysis was carried out to determine the pattern of distribution of cases in the Sambas

district. The distribution pattern used the Average Nearest Neighbor Analysis, which can be seen in the following Figure 8.

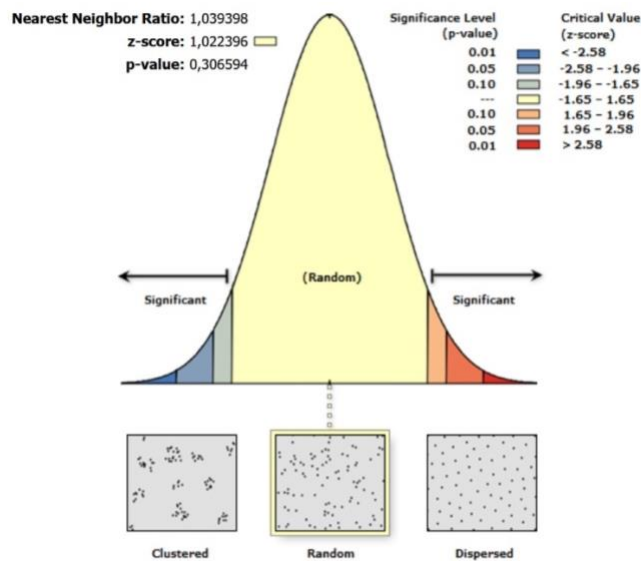


Figure 8 Average Nearest Neighbor

Table 1 Average Nearest Neighbor shows information about the analysis results, including the analyzed mean distance, estimated mean distance, Nearest Neighbor ratio, z-score (standard deviation), and p-value (random probability). The following table 2 shows information about Dataset Information. Then another table shows information about the data used, including the class being analyzed, the method of calculating the distance between features in the class, and also the research area of the analysis. The analysis of the mean of the nearest neighbors showed that the Nearest Neighbor ratio was 1.039398 with a z-score of 1.022396, which means that the pattern of distribution of maternal death according to the cause of death in the Sambas district has a random pattern.

Table 1 Average Nearest Neighbor Summary

Average Nearest Neighbor Summary	
Observed Mean Distance	0.0297
Expected Mean Distance	0.0296
Nearest Neighbor Ratio	1.039396
z-score	1.022396
p-value	0.306594

Table 2 Dataset Information

Average Nearest Neighbor Summary	
Input Feature Class	61010000
Distance Method	EUCLIDEAN
Study Area	0,600435
Selection Set	False

Discussion

Based on the data obtained, most of the areas with the highest number of cases of maternal death are caused by bleeding, then hypertension and circulatory system disorders. On the other hand, the lowest causes of death are due to other causes and metabolic disorders. This is in line with (Setiawan et al., 2016) regarding the analysis of the spatial distribution of maternal mortality in Banjarnegara Regency in 2011-2013 that found the highest cause of maternal death, namely heart disease and pulmonary TB. In addition, another study by (Manyeh et al., 2018) on the spatial pattern of distribution and trends in maternal mortality in Nigeria is caused by risk factors for non-communicable diseases.

Based on the Indonesian Ministry of Health data center, the cause of maternal death in Indonesia itself is mainly caused by bleeding. Besides, other causes play a significant role in maternal mortality (Pusat Data dan Informasi Kemenkes Republik Indonesia, 2014). The results of this study also show that cases of maternal mortality are not evenly distributed across the study area within a period of three years. Since understanding the spatial pattern of health-related problems is one of the basic principles of public health, these results provide evidence of the need for local governments to target intervention programs in high-risk areas where cases are most likely to occur. Population-wide interventions may be very expensive to implement, but research has shown that interventions at the district level, i.e., more specific areas, may lead to reduced maternal mortality.

The analysis results using a buffer of 3 kilometers and 5 kilometers show that not all have been covered by health service facilities in the Sambas district. The results of the buffering analysis show that areas that are not covered by the buffer area are included in the category that requires the most health service facilities compared to other areas. This area is a high-priority area in Sambas district where it can also be seen that there are several cases of maternal mortality that have not reached the coverage of health care facilities in various buffer areas.

According to the data center of the Ministry of Health of the Republic of Indonesia related to the scope of delivery services for pregnant women, most of them are carried out at home, and if it is related to the place of delivery of the mother and the cause of maternal death, it can be the cause of maternal death (Pusat Data dan Informasi Kemenkes Republik Indonesia, 2014). However, based on the data obtained, most of the mothers who died gave birth in health facilities, and most of them were in hospitals.

Based on the mapping of the distance between health facilities, especially hospitals, the average number of cases of death may be due to the accessibility of mothers during delivery at health facilities, where most of them do not cover all areas in Sambas district. Mapping the coverage of available health service facilities is used to see the presence of health facilities in each region. The

thing that needs to be considered in distributing health facilities is the coverage of these health facilities. The health facility coverage map will help local governments in better and more targeted distribution.

Research conducted by (Ismaila & Usul, 2013) regarding the analysis of the availability of health facilities by describing the coverage of health services as far as a radius of 1 km, it was found that some areas in the research area were not within the coverage of health facilities, which meant that there was an uneven distribution of health facilities, in addition, some health facilities had overlapping coverage, while in certain areas there are areas that are not within the coverage of health facilities.

Average Nearest Neighbor is an analysis tool used to measure the distance between the points that are the center point of the feature with the center point of the closest feature. If the results of the analysis are less than the number of random distributions (Random), it will get the results collected (Clustered), but if it is more, the results will be scattered (Dispersed) (Esri ArcGIS Pro, 2020).

The results of the analysis of the mean of the nearest neighbors showed that the Nearest Neighbor ratio was 1.039398 with a z-score of 1.022396, which means that the pattern of distribution of cases of maternal death or maternal death according to the cause of death in the Sambas district has a random pattern. It can also be interpreted that cases of maternal death can occur anywhere, and there is no case grouping or clustered. The results of this calculation refer to (Haylan, 2019) which states that if the T interval (nearest neighbor index) is between 0.7 to 1.4, then the spatial pattern is categorized as a random pattern. It also explained that if the index is less than 1, the pattern exhibits clustering; if the index is greater than 1, the trend is toward dispersion or competition.

Conclusion

The most areas with the highest number of cases of maternal mortality in Sambas District were caused by bleeding, then hypertension and circulation system disorders. The lowest causes of death are due to other causes and metabolic disorders. In addition, the results of the analysis using a buffer of

3 kilometers and 5 kilometers show that not all of them are covered by health service facilities in the Sambas district. The results of the buffering analysis show that areas that are not covered by the buffer area are included in the category that requires the most health service facilities compared to other areas. The results of the analysis of the mean of the nearest neighbors showed that the Nearest Neighbor ratio was 1.039398 with a z-score of 1.022396, which means that the pattern of distribution of cases of maternal death or maternal death according to the cause of death in the Sambas district has a random pattern.

Declaration of Conflicting Interest

The authors declare that they have no conflict of interest in this study.

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Author Contributions

Conceptualization (TSP, MN), acquiring data (TSP, NAT), methodology and data analysis (TSP, NAT, MN), interpreting the result (TSP, NAT, MN), writing and editing the manuscript (TSP, NAT, MN). All authors approved the final version of the manuscript.

Author Biographies

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