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Diarrhea Incidence in Tanah Bumbu, South Kalimantan, Under A Spatial Approach

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Abstract

Indonesia has seen an increase in diarrhea incidence from 4.5% in 2013 to 6.8% in 2018. South Kalimantan, diarrhea is still a common disease with a relatively high incidence rate. In Tanah Bumbu itself, the incidence of diarrhea from 2014 to 2019 was among the top 10 most common diseases. The percentage of patients served in 2019 was 33.26% of the detection targets. While in infants, only 3.4% of the number of detection targets. This study aims to see the spatial description and influence of the districts' condition in Tanah Bumbu Regency with the diarrhea incidence. This research took place in the ten districts of Tanah Bumbu Regency. The analysis used in this study was SAR to see the relationship between districts and the incidence of diarrhea and other factors. The results showed that in Tanah Bumbu, factors that affected the incidence of diarrhea include population density (p-value 0.0001), access to quality drinking water (p-value 0.0001), and health facilities (p-value 0.0001).

Introduction

As a developing country, Indonesia has diarrhea problems prevalent because of its high morbidity and mortality (Margarethy, 2020). The incidence of diarrhea needs to be watched out for because it could cause outbreaks (Bellido-Blasco & Arnedo-Pena, 2019). Diarrhea is a condition characterized by loose or watery stool, increased defecation frequency, usually more than three times a day, and can be accompanied by blood and/or mucus (Jung et al., 2017; Margarethy, 2020). Factors that can exacerbate diarrhea cases include germs, nutritional conditions, hygiene and sanitation, population density, sociocultural and socioeconomic conditions. Diarrhea is highly affected by environmental conditions. If the environment is unhealthy (because it is contaminated with diarrhea germs) and it accumulates with unhealthy human behavior (through food and drink), diarrhea will likely happen (Jarquin et al., 2016; Vincent, 2018).

Based on Basic Health Research, Indonesia has seen an increase in diarrhea incidence from 4.5% in 2013 to 6.8% in 2018 (Kemenkes, 2018). Meanwhile, in South Kalimantan, diarrhea is still one of the largest disease groups. It has a relatively high incidence rate. In 2018, the coverage of diarrhea services for children under five was only 41.12% (Directorate General of P2P, Ministry of Health RI, 2019) (Kemenkes RI, 2019; Kementrian Kesehatan RI, 2014). This condition is supported by environmental factors, mainly by common sanitation conditions that are still not good. For example, the use of water for daily needs that do not meet the requirements, family latrines that are still insufficient and does not meet

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the health requirements, as well as housing sanitation conditions that are still lacking and unhygienic (Berendes et al., 2017; Jarquin et al., 2016). In Tanah Bumbu Regency, the diarrhea incidence from 2014 to 2019 was in the top 10 most common diseases with the percentage of patients served in 2019 being 33.26% of the number of detection targets, while in under-five children only 3.4% of the number of detection targets (Profile of Tanah Bumbu Health Office).

The World Health Organization estimates that the most causes of diarrhea in developing countries are Rotavirus and Escherichia coli bacteria (Mumtaz Y, Zafar M, 2014; Steffen, 2017). The two agents of the disease are closely related to environmental factors such as sanitation and hygiene, adequacy of clean water and drinking water facilities, food hygiene, and safety. Water is also a medium for disease transmission that potentially decreases public health status (Esrey et al., 1991). Pollution in clean water facilities declines the quality both physically and biologically. Microbiologically, contaminated water contains coliform bacteria. The other pathogenic microorganisms in the water are protozoa, viruses, and parasites (Anwar et al., 2019; Jung et al., 2017).

We need to investigate the spatial aspects because the spread of this disease is greatly affected by geographic conditions and fluctuating environments (Nilima et al., 2018). An important aspect of spatial epidemiology is the potential factors that influence disease incidence in a region (Waller, 2005; (Nilima et al., 2018). From this description, it can be concluded that diarrhea is closely attached to environmental and regional conditions. Also, diarrheal disease is still a high public health problem that requires locality-based studies (Gedamu, 2017). Therefore, the authors want to know the influence of several factors related to the environment and territory on the incidence of diarrhea in the Tanah Bumbu Regency.

Methods

This research was conducted in Tanah Bumbu Regency in 2019 with a cross-sectional design and spatial regression analysis method in the form of autocorrelation regression to determine the existence of a relationship between one district and another. This spatial analysis is used to determine a more appropriate regression model by considering regional aspects. All variables will be analyzed, then which one describing the risk factors for the diarrhea cases distribution will be determined. The data collected in this research is secondary data obtained retrospectively, including the number of diarrhea cases during 2019 from the local Health Office and Central Statistics Agency (BPS or Statistics Indonesia) report. Furthermore, a multivariate spatial analysis of the Spatial Autoregression (SAR) test was carried out to determine the relationship between independent variables and the number of findings on the diarrhea incidence. The results will form a global regression equation for one district and its relation based on the p-value ($p < 0.05$).

Results and Discussion

Data on the number of incidents of diarrhea found and several independent variables are presented per sub-district throughout Tanah Bumbu Regency based on district health profiles and BPS data. The independent variables consist of area, population density, the number of healthcare facilities, proportion of the population having sustainable access to quality drinking water, percentage of drinking water facilities inspected for environmental health, and percentage of the population with access to healthy latrines.

Table 1. Diarrhea Incidence Data in Tanah Bumbu

Districts	Diarrhea incidence	Area (km^2)	Population density (/ km^2)	Number of Healthcare facilities	Access to quality drinking water (%)	Inspected drinking water facilities (%)	Access to healthy latrines (%)	Healthy food-management places (%)	Healthy public amenities (%)
Kusan Hilir	212	382.34	166.99	4	88.86	1.23	70.78	11.65	65.91
Sungai Loban	202	293.48	63.31	5	36.60	0.12	81.00	36.33	38.18
Satui	781	877.97	59.85	6	94.46	0.95	83.03	50.31	52.91
Angsana	299	895.74	108.41	3	123.06	62.86	86.43	14.41	28.57
Kusan Hulu	294	114.64	13.43	2	79.87	3.63	77.29	45	12.24
Kuranji	109	195.83	88.93	1	42.39	20.99	67.92	26.29	81.82
Batulicin	133	201.4	150.48	2	73.35	0.74	100	64.84	67.18
Karang Bintang	283	1504.74	101.03	2	69.38	11.52	86.11	31.25	18.64
Simpang Empat	348	289.01	268.80	10	77.72	0.15	72.53	18.93	71.82
Mantewe	217	135.16	26.96	1	31.20	0.23	81.72	3.92	15.87

Sources: Report of Tanah Bumbu Health Office and Statistics Agency (BPS) in 2019

The highest number of diarrhea incidents throughout 2019 happened to be in Satui District with 781 incidents, followed by Simpang Empat District with 348 incidents. Meanwhile, in 8 other districts, the number of incidents was still quite high, namely over 100 incidents. For this regency, the largest district is Karang Bintang District. Simpang Empat is the densest district which is in line with the number of healthcare facilities, as many as ten healthcare facilities. For access to quality drinking water, inspected drinking water facilities, and access to healthy latrines Angsana District has the highest percentage. As for healthy food processing places, the highest was in Batulicin District with 64.84%. For healthy public amenities, Kuranji District is the highest percentage with 81.82%.

The multicollinearity test results show that all independent variables have mutual dependencies with a VIF value <10. So it can be continued for the next stage, the spatial autocorrelation test, to find the variables that tend to have a particular pattern in an area. If I> I0, then the clustering pattern or autocorrelation is positive. If I <I0, then the diffuse pattern or autocorrelation is negative.

Table 2. Moran's Index Test Results

Variables	I	I_0	Remarks
Diarrhea incidence	-0.018		Negative autocorrelation
Area	-0.140		Positive autocorrelation
Population density	0.009		Positive autocorrelation
Number of healthcare facilities	-0.258		Positive autocorrelation
Access to quality drinking water	-0.092	-0.111	Negative autocorrelation
Inspecting drinking water facilities	-0.148		Positive autocorrelation
Access to healthy latrines (%)	-0.212		Positive autocorrelation
Healthy food-management places	-0.282		Positive autocorrelation
Healthy public amenities	0.002		Positive autocorrelation

Sources: Result of Geoda Application

The test results presented in Table 3 show that all variables have autocorrelation. The incidence of diarrhea and the percentage of people having access to safe drinking water has negative autocorrelation or spreading pattern. Whereas area size, population density, availability of health facilities, inspected drinking water facilities, access to healthy latrines, food management places that meet health requirements, and public amenities that meet health requirements have positive autocorrelation or have a clustering pattern.

Table 3. List of Neighboring Districts in Tanah Bumbu Regency

No	Districts	Number of neighboring districts	List of neighboring districts
1	Kusan Hilir	4	Batulicin, Karang Bintang, Kusan Hulu, Sungai Loban
2	Sungai Loban	5	Angsana, Satui, Kusan Hulu, Kuranji, Kusan Hilir
3	Satui	3	Kusan Hulu, Sungai Loban, Angsana
4	Angsana	2	Satui, Sungai Loban
5	Kusan Hulu	6	Mantewe, Karang Bintang, Kusan Hilir, Kuranji, Sungai Loban, Satui
6	Kuranji	2	Kusan Hulu, Sungai Loban
7	Batulicin	3	Simpang Empat, Karang Bintang, Kusan Hilir
8	Karang Bintang	5	Mantewe, Simpang Empat, Batulicin, Kusan Hilir, Kusan Hulu
9	Simpang Empat	3	Mantewe, Karang Bintang, Batulicin
10	Mantewe	3	Kusan Hulu, Simpang Empat, Karang Bintang

Sources: Report of Tanah Bumbu Health Office in 2019

The district with the most neighbors is Kusan Hulu. Meanwhile, the results of Moran's analysis show that districts in Tanah Bumbu Regency are in quadrant 1 (high-high), which means that all of these districts have a high incidence of diarrhea and tend to be close to areas where the incidence of diarrhea is also high. Before carrying out the SAR test, the assumption test for homoscedasticity with Breusch-Pagan, normality test with Jarqeu-Bera, and Lagrange Multiplier was carried out. The results showed that the homoscedasticity and the normality tests showed a p value> 0.05, which means both met the requirements. Meanwhile, the Lagrange Multiplier value is <0.05, which means that the data has met the assumption requirements to continue with the SAR test.

Table 4. SAR Test Results with a Complete Model

Variables	Coefficient	P-value	R squared
W_y (Diarrhea incidence)	-0.037	0.922	
Area	-0.131	0.284	
Population density	-2.669	0.003	
Number of healthcare facilities	62.118	0.000	
Access to quality drinking water	4.621	0.003	0.882
Inspecting drinking water facilities	-3.311	0.114	
Access to healthy latrines (%)	2.223	0.435	
Healthy food management places	-1.268	0.022	
Healthy public amenities	-0.131	0.305	

Sources: Result of Geoda Application

The SAR test results show the autocorrelation regression results, but there are still some insignificant variables including the weighting coefficient (w_y) so that the insignificant independent variables must be excluded.

Table 5. Final Results of the SAR Test After Several Variables are Excluded

Variables	Coefficient	P-value	R squared
W_y (Diarrhea incidence)	-0.528	0.066	
Population density	-2.225	0.000	0.779
Number of healthcare facilities	58.009	0.000	
Access to quality drinking water	3.681	0.000	

Sources: Result of Geoda Application

The table above shows the final model. The variable W_y shows no relationship between diarrhea incidents number in the adjacent sub-districts. With a p-value of 0.06 and a coefficient of -0.528. The negative coefficient value also means that the diarrhea incidence in the nearby area does not contribute to an increase in the other/neighboring areas. Furthermore, the variables of population density, health facilities, and access to quality drinking water showed significant results (0.000). The population density coefficient value has a negative value, which means that the smaller the population density, the lower the incidence of diarrhea in an area. The number of healthcare facilities and access to quality drinking water has positive coefficient values. It means the smaller the number of health facilities or the lower the community's access to quality drinking water, the greater the incidence of diarrhea. The R squared value of 0.779 means that 77.9% of the incidence of diarrhea can be explained by population density, number of healthcare facilities, and access to quality drinking water. The rest is explained by other factors.

A spatial approach is essential in mapping the spread of disease and aiding in policymaking. Targeting the control on risk factors for diarrhea transmission is a potential strategy to reduce diarrhea cases. In this study, the value of the proximity coefficient (W_y) has a negative coefficient. It means the diarrhea incidence in an adjacent area does not contribute to an increase in that area. It is also proved by Moran's analysis which states that all sub-districts in Tanah Bumbu Regency are in the high-high quadrant where all sub-districts have a high incidence of diarrhea and or are not much different.

Population density is still a factor in underlying various diseases, such as diarrhea. The population density and mobilization allow it to spread. The densely populated areas, like urban areas, with lots of waterlogging and the flow of urbanization continuing to increase annually, have made the problem of population density the main scourge for various diseases as well as diarrhea (Jarquin et al., 2016). Research in Anhui China illustrates that densely populated areas have a higher burden of infectious diseases, including diarrhea, than less densely populated areas (Hao et al., 2019).

Simpang Empat is the district with the highest population density in Tanah Bumbu Regency. In 2019 it was populated by 268.8 people/km2. In this case, it can be related to the high diarrhea incidence, because the district had high cases of diarrhea from 2009-2011. It can be related to the diarrhea incidence in Simpang Empat became second-highest after Satui. Diarrheal disease is a contagious disease, so if the population density is very high, the possibility of the transmission rate of diarrhea is also very high due to the very close distance between houses (Adane et al., 2017; Jarquin et al., 2016; Jung et al., 2017).

According to several studies, population density can affect the process of disease transmission or transfer from one person to another (Anwar et al., 2019; Berendes et al., 2017; Nilima et al., 2018), where the density of human settlements forces the location or construction of a septic tank adjacent to a well in a residential area (Margarethy, 2020). This condition can worsen the quality of groundwater consumed by the people living in the area since the population density is a fertile nursery for the virus (Steffen, 2017). A densely populated area will be more susceptible to transmission and reproduction so that it becomes more susceptible to the spread of infectious diseases such as diarrheal diseases (Adane et al., 2017; Jung et al., 2017). Susanti et al's research also showed that occupancy density relates to the diarrhea incidence in children under five. The more densely populated an area can quickly increase the potential for disease transmission between individuals. Dense human settlements can affect the location or construction of septic tanks close to each other/close to wells/drinking water sources in a residential area (Berendes et al., 2017; Thiam et al., 2017). In dense settlements, groundwater can easily be contaminated with Escherichia coli bacteria. Then residents will consume groundwater contaminated with E. coli because the distance between the well and the septic tank is less than 10 meters. The results showed that the potential for families to suffer from diarrhea was 1,103 times if they consumed drinking water that did not meet health requirements (Jarquin et al., 2016).

Another problem of densely populated areas is waste disposal. Garbages contained in people's homes that are not properly managed can be seen from the community's behavior who piles up rubbish for a long time around the house or throw them into waterways until water bodies become inundated and the trash decays (Margarethy, 2020). As a result, disease vectors such as flies are an indirect intermediary for diarrheal diseases. Mubarak and Chayatin (2009) say that the problem of waste is not simple at this time, the more the city is developing, the more the amount of waste produced, the more diverse the composition, the greater the management funds and other problems. Most of the waste is garbage originating from households (Berendes et al., 2017; Jung et al., 2017; Vincent, 2018). Poor waste management or the behavior of disposing of waste inappropriately can be a source of disease for the community (Gedamu, 2017; Jarquin et al., 2016). Another problem is regarding the sewerage channel. The presence of standing water around the house due to the sewerage that does not meet the requirements can trigger the emergence of disease vectors such as cockroaches as well as a cause of diarrhea (Thomas et al., 2020; Vincent, 2018).

The Indonesian Ministry of Health said that people who are reached by the provision of truly clean water have a lower risk of suffering from diarrhea compared to people who do not get clean water (Jung et al., 2017; Vincent, 2018). Some research results state that the high number of diarrhea cases is an area with low coverage of clean water facilities (Adane et al., 2017; Jarquin et al., 2016; Nilima et al., 2018). In addition, it may be affected influenced by people's attitudes and knowledge (Mumtaz Y, Zafar M, 2014). The cause of diarrhea is not only affected by physical environmental factors, in this case, clean water facilities, but can also be influenced by the social environment, behavior, health services, and so on (Berendes et al., 2017; Hedengran et al., 2018; Jung et al., 2017). For example, most people have the habit of not boiling water until it boils before drinking them. It will cause germs or bacteria that may not die in the water, causing germs or bacteria that may be in the water to enter the body and cause illness (Jarquin et al., 2016; Jung et al., 2017).

According to Setyawati (2005), the diarrheal disease can be transmitted by waterborne and water washed. High clean water coverage can only prevent diarrhea transmission through a water-washed method (Vincent, 2018)(Thomas et al., 2020). It is because water-washed transmission is only related to general and personal hygiene. Meanwhile, waterborne prevention of diarrhea can only be done if the bacteriological quality of clean water meets health requirements (Steffen, 2017). It is due to waterborne transmission is related to the presence of pathogens in water that can cause disease in humans(Thiam et al., 2017; Thomas et al., 2020)(Jung et al., 2017). In another study, it was stated that families who consumed drinking water that did not meet the health requirements had a chance of suffering from diarrhea more than 1,1 times when compared to the ones who drink water that met health requirements (Thiam et al., 2017; Vincent, 2018) The active involvement of health professionals in hygiene and sanitation is essential to accelerate and consolidate progress in disease prevention (Adane, Mengistie, Kloos, et al., 2017).

People tend to seek treatment at healthcare facilities only when they are truly unable to help themselves. The public's misperception in response to illnesses has resulted in underutilizing existing healthcare facilities even though it is available in the area where they live. The wrong perception of the condition will result in low healthcare and insurance utilization (Arvelo et al., 2019). It also stems from inappropriate health behaviors (Nilima et al., 2018). Health behavior in preventing diarrhea is also affected by environmental factors, same as the availability of supporting facilities. Facilities can be interpreted as anything that can facilitate the implementation of any business (Arikunto dkk, 2008). Healthcare facilities whose primary goal is basic sanitation include clean water sanitation, sanitizing sewage, sanitation of waste and garbage (Adane et al., 2017; Nilima et al., 2018). Healthcare facilities must be available to all citizens. Increasing access to health facilities can provide a significant health benefit. Every effort should be made to achieve the highest possible public health degree. However, there are still people

who still do not have easy access to healthcare facilities. It is affected by economic conditions related to geographical location (Adane et al., 2017; Hao et al., 2019). The people having access to healthcare facilities are constrained by long distances and significant costs so that they cannot take advantage of these health facilities (Arvelo et al., 2019; Woldeamanuel, 2020). From the results of this study, the number of healthcare facilities in each district is not evenly distributed. Only one is available in Kuranji and Mantewe when another has up to ten healthcare facilities. A study in Addis Ababa, Ethiopia, in 2017 concluded that increased proximity to healthcare and health education facilities could encourage and improve health-seeking behavior and accessibility of healthcare facilities for the treatment of acute diarrhea in children under five in slum areas (Ahmed et al., 2009)(Luckow et al., 2017). It means that apart from the existence, the distance to healthcare facilities is also vital to determine the utilization of healthcare facilities so the level of public health can improve (Adane et al., 2017; Ahmed et al., 2009; Thomas et al., 2020). In one survey, the use of healthcare facilities was significantly associated with diarrhea accompanied by fever and vomiting. It means that the severity of the disease forces people to seek health facilities (Nhampossa et al., 2013; Woldeamanuel, 20-20). Thus the existence of healthcare facilities that are close to and easily accessible is very important as an input for the government to tackle disease incidents and improve the degree of public health.

Conclusion

This research shows spatially population density, the presence of healthcare facilities, and access to safe drinking water affect the incidence of diarrhea. These conditions are closely related to each other, so there is a need for cross-sector cooperation (health, population, urban planning, regional drinking water companies) to control diarrhea in Tanah Bumbu Regency.

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