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SPATIAL ANALYSIS TO IDENTIFY HOTSPOT OF DIARRHEA AMONG CHILDREN UNDER FIVE YEARS IN 154 DISTRICTS/CITIES IN SUMATERA ISLAND

Muhammad Syukri*, Rd. Halim
Public Health Department, Faculty of Medicine and Health Sciences, Universitas Jambi, Jl. Letjend Soeprapto No.33, Telanaipura, Jambi, 36122, Indonesia
*syukri.muhammad@unja.ac.id

ABSTRACT
Diarrhea in under-five children is still a big challenge at the global and local level. Diarrheal disease is the second leading cause of death in children under the age of five worldwide. A spatial analysis of the incidence of diarrhea in under-five children has been conducted in Indonesia. However, there has been no research on the pattern of spatial distribution and hotspots of diarrhea in under-five children conducted on the island of Sumatra. This study aimed to identify hotspots for cases of diarrhea in under-five children on the island of Sumatra in 2018. This study used Basic Health Research data from 2018. Data analysis was carried out using Global Moran's Index and Local Indicator for Spatial Autocorrelation (LISA)) methods. Distribution map was carried out using QGIS 3.30 software and spatial autocorrelation analysis using software open-source GeoDa 1.20 software. The results of this study found hotspots in the eastern part of the island of Sumatra, namely the Provinces of Nangroe Aceh Darussalam, North Sumatra, and Riau and low spots in the western part of the island of Sumatra, such as the Provinces of Lampung, Bangka Belitung, Riau Islands. This study suggests the health authorities to intensify programs in hotspot categories with high prevalence.

Keywords: hotspot; sumatera island; under-five diarrhea

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INTRODUCTION

Diarrhea in under-five children is still a big challenge at the global and local level. Diarrheal disease is the second leading cause of death in children under the age of five worldwide. In 2017, it was found that almost 1.7 billion children under-five suffered from diarrhea and killed more than half a million children under-five each year (World Health Organization, 2017). In 2019, it is estimated that there will be as many as 370,000 cases of death due to diarrhea in children (World Health Organization, 2019). Diarrhea is an infectious disease of the digestive tract that can be caused by bacteria, viruses or parasites (Drancourt, 2017). This infection can be spread through contaminated food or drinking water or poor sanitation conditions (Hutasoit, 2020). Diarrhea is generally defined as the discharge of feces or faeces in liquid form followed by an increase in the frequency of defecation (BAB) 3 or more times a day (Kementerian Kesehatan Republik Indonesia, 2022).

The prevalence rate of diarrhea in children under-five in Indonesia in 2018 reached 11 percent, an increase of more than half compared to the prevalence of diarrhea in children under five in 2013 with Sumatra Island contributing more than 10 percent of the total national

prevalence of diarrhea under-five (Badan Penelitian dan Pengembangan Kesehatan Kemenkes RI, 2013, 2018). Although most of the prevalence of diarrhea under-five in each province on the island of Sumatra is below the national prevalence of diarrhea, the distribution of diarrhea prevalence data in each province still shows heterogeneous distribution of data so it is necessary to do an analysis based on a Geographic Information System. Geographic Information Systems have been widely used in conducting studies on various diseases, both communicable and non-communicable diseases. GIS is able to visualize the dynamics of disease transmission and identify disease clusters and their risk factors (Cromley, 2003; Rushton, 2003; Turnbull et al., 2020).

Clusters of under-five children diarrhea can occur both according to spatial and temporal aspects. Moran's Global Index is widely used to measure global spatial autocorrelation, and Local Indicator for Spatial Autocorrelation (LISA) is generally used to identify specifically how the relationship between one observation location and another observation location (Yuriantari et al., 2017). Global and Local Analysis Moran Index also helps detect significant hotspot from a spatial and temporal perspective which can be used as a reference in making policies and programs to prevent and reduce the incidence of diarrhea in under-five children (Schmal et al., 2017).

Several spatial-temporal studies regarding the incidence of diarrhea in under-five children have been carried out in several countries (Alemayehu et al., 2020; Azage et al., 2015; Beyene et al., 2018; Dmello et al., 2022; Nilima et al., 2018), including Indonesia (Fauziyyah et al., 2022; Iryanto et al., 2022). Research on the incidence of diarrhea in under-five children conducted in Ethiopia found that there were several areas that became clusters with high significance rates which were in the Bero, Maji, Surma, Minit Sasha, Guraferda, Kota Mizan Aman, and Sheko regions. Then the area that becomes a hotspot for diarrhea in under-five children is in the North Bench region (Alemayehu et al., 2020). In addition, research conducted by Hunachew Beyene, Wakgari Deressa, et al found that there were areas that became clusters of diarrhea among under-five children in the Boricha region. Then the statistically significant hotspot areas were in the Malga region from December 2012 to January 2015(Beyene et al., 2018).

Spatial and temporal studies of the incidence of diarrhea among under-five children have been carried out in Indonesia. A study conducted by Iryanto, et al in Padang City (2022) found areas with a high incidence of diarrhea under five children were in the South Limau Manis, Cupak Tangah, and Koto Lua areas with the results of a spatial autocorrelation analysis having a negative correlation where the incidence of diarrhea among children under five in the Pauh region had a distribution pattern spread or no autocorrelation was found between villages (Iryanto et al., 2022). A study conducted in East Kalimantan found an autocorrelation of cases of diarrhea among under-five children with hotspot occurring in Samarinda City and Mahakam Ulu District (Hayati et al., 2019). Many studies on risk factors regarding the incidence of diarrhea among under-five children have been carried out in Indonesia (Arina Cahyaningrum et al., 2018; Otsuka et al., 2019; Ravida, 2022; Santika et al., 2020; Sumampouw et al., 2019; Trisiyani et al., 2021). However, there has been no study on the pattern of spatial-temporal distribution of the incidence of under-five children diarrhea that has been conducted on the island of Sumatra. Identifying the spatial and temporal patterns of diarrhea in young children can help find specific hotspot with seasonal patterns for early warning of outbreaks and for more rapid mitigation. Spatio-temporal information will be very useful in efforts to design national and regional strategies more efficiently in reducing the

incidence of diarrhea in children under-five. Therefore, this study aimed to identify the pattern of spatial distribution of uder-five children diarrhea on the island of Sumatra.

METHOD

Geographically, Sumatra Island is located between 95° East-105° East and 6° North Latitude – 6° South Latitude with an area of about 473,481 km^2 which makes this island the third largest island in Indonesia and the sixth largest in the world. The island of Sumatra is divided into 10 provinces, namely the provinces of Aceh, North Sumatra, Riau West Sumatra, Riau Islands, Jambi, Bengkulu, South Sumatra, Lampung and Bangka Belitung with a total of 154 districts/cities (Indonesia, 2023). The first step before doing the analysis is to do the weighting to define neighbors. In this study using the distance weight, namely knn (k-nearest neighbor) which defines neighbors based on the closest distance. The Moran's Index test is used to identify global autocorrelation, and the Local Indicator for Spatial Autocorrelation (LISA) is used to identify hotspot for cases of diarrhea among under-five children. Moran's Index values range from +1 and -1, a value of 0 indicates no spatial autocorrelation. A positive Moran's value indicates the presence of spatial or cluster autocorrelation, while a negative value indicates the data is spread out. Cluster areas were determined by Moran's Scatter plot by dividing the map analyzed using LISA into four categories, namely areas with a high prevalence of diarrhea among children under-five surrounded by areas with high prevalence of diarrhea among children under-five (high-high or hotspot), areas with a low prevalence of diarrhea among children under-five surrounded by areas with a low prevalence of diarrhea among children under-five (Low-Low or Low spot), outliers with high prevalence of diarrhea among children under-five are surrounded by areas with low prevalence of diarrhea among children under-five (High-Low), outliers where areas with low prevalence of diarrhea among children under-five are surrounded by areas with high prevalence of diarrhea among children under-five (High-Low)(ESRI, 2021).

The data in this study were obtained from the 2018 Basic Health Research report by province which can be accessed free of charge on the website https://labmandat.litbang.kemkes.go.id/riset-badan-litbangkes/menu-riskesnas/menu-riskesdas/426-rkd-2018. This research was conducted on the island of Sumatra in 10 provinces with 154 districts/cities. Diarrhea in under-fives in this study is the proportion of cases of diarrhea in under-fives in each district/city on the island of Sumatra. Basic Health Research is a national survey with representation of the Indonesian population. The aim of Basic Health Research is to provide estimates of diseases, health problems and their risk factors to monitor the health status of the Indonesian population. The Basic Health Research is a cross-sectional survey with a two-stage sample design.

RESULTS

The distribution of under-five diarrhea cases in Sumatera Island varies by region. The darker color on the map below shows a higher prevalence. The following is a map of the distribution of under-five diarrhea according to Basic Health Survey report:

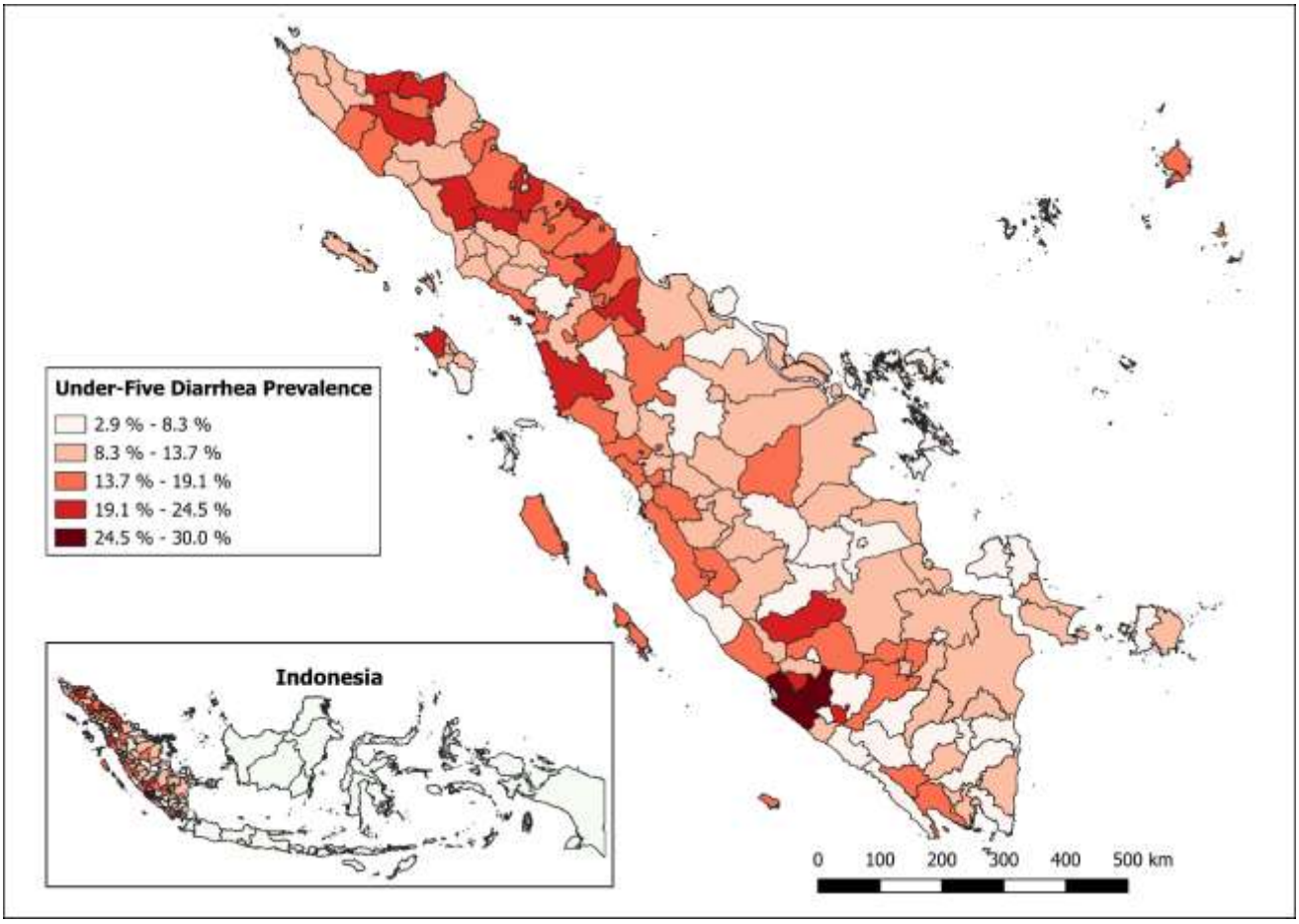

Figure 1. Prevalence of Under-five Children Diarrhea in Sumatera Island 2018

Figure 1. shows that the high prevalence of diarrhea among under-five children is mostly spread in the western region of the island of Sumatra and a small proportion is spread in the eastern region.

Spatial Distribution Pattern Maps

Global Moran's Index

Global Moran's Index aims to evaluate whether there is autocorrelation of disease with patterns of dispersion, clustering, or random distribution. The results of the analysis using the Global Moran Index in table 1 below show that there is a spatial autocorrelation of cases of diarrhea among under-five children at the district/city level on the island of Sumatra.

Table 1.
Distribution Pattern of Under-Five Children Diarrhea in Sumatera Island 2018

Year	Moran's Index	E[I]	P value	Distribution pattern
2018	0.113	-0.0065	0.001	Clustered

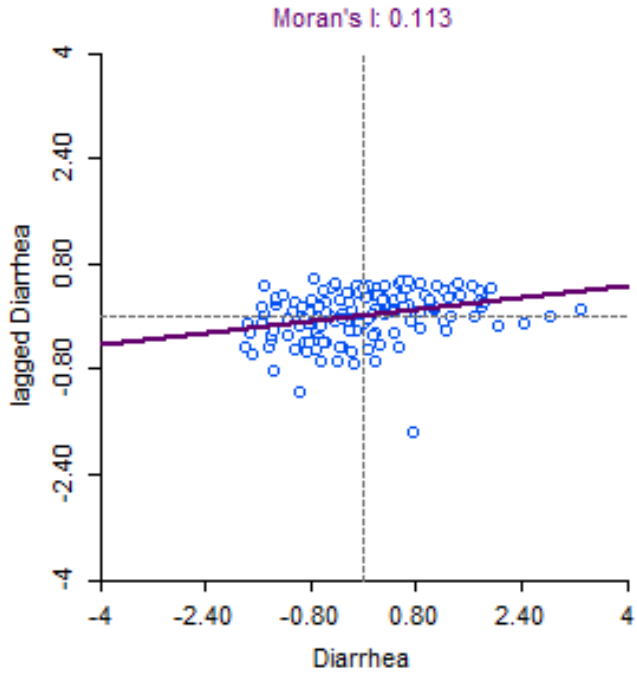

Figure 2. Moran Scatter Plot for Under-five Children Diarrhea in 154 Districts/Cities, Sumatera Island 2018

Local Indicator for Spatial Autocorrelation

Local Autocorrelation analysis uses the Local Indicator of Spatial Autocorrelation (LISA) test which aims to produce clustering based on area identification and finding patterns of spatial relationships based on local areas. The LISA index value is a local indicator value from spatial association which is useful for detecting hotspot or low spot (Fatati et al., 2017). The results of the local spatial autocorrelation analysis are as follows:

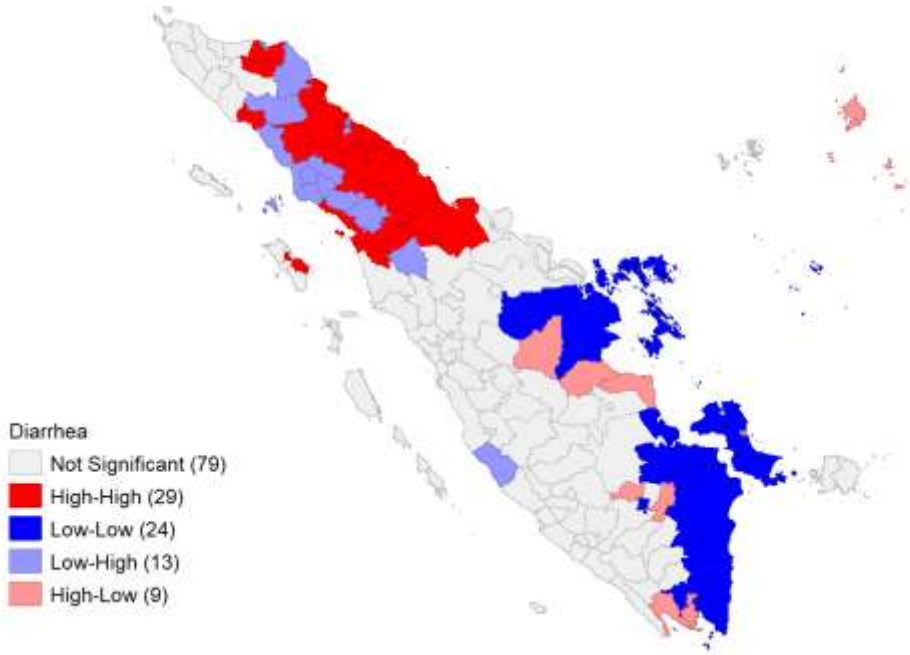

Figure 3. LISA Map of Under-five Children Diarrhea in 154 Districts/Cities, Sumatera Island 2018

The results of the analysis using LISA show that there are 29 districts/cities in the hotspots category and 24 districts/cities in the low spots category. There are three provinces where there is no autocorrelation, both positive and negative autocorrelation cases of diarrhea among under-five children, namely West Sumatra, Jambi and Bengkulu:

Table 2.
Hotspot and Low Spots of Diarrhea Cases Among Under-five Children in 154 Districts/Cities in Sumatra Island 2018

Province	Hotspot	Lowspot
Nangroe Aceh Darussalam	Aceh Tenggara, Aceh Barat Daya, Langkat, Aceh Tamiang, Kota Langsa, Bener Meriah, Aceh Utara	-
North Sumatera	Nias, Padangsidimpuan, Kota Sibolga, Padang Lawas Utara, Tapanuli Selatan, Toba Samosir, Labuhan Batu, Samosir, Labuhan Bau Utara, Kota Pematangsiantar, Kota Tanjung Balai, Asahan, Simalungun, Karo, Kota Tebing Tinggi, Batubara, Kota Binjai, Serdang Bedagai, Deliserdang,	
Riau	Rokan Hilir,	Pelalawan,
South Sumatera	-	Kota Prabumulih, Kota Palembang, Ogan Komering Ilir, Banyuasin,
Lampung	-	Kota Bandar Lampung, Pringsewu, Kota Metro, Lampung Tengah, Tulang Bawang Barat, Tulang Bawang, Mesuji, Lampung Selatan, Lampung
Bangka Belitung	-	Bangka Selatan, Bangka Tengah, Bangka Barat, Bangka
Riau Islands	-	Bintan, Kota Tanjungpinang, Karimun, Kota Batam, Bintan,

DISCUSSION

Diarrhea is one of the main health problems in low- and middle-income countries such as Indonesia, and is the one of the main killer of children in Indonesia (UNICEF, 2019). Various efforts have been made by the Indonesian government to reduce and overcome the problem of diarrhea among under-five children by making and implementing efforts to prevent and control diarrheal diseases through the LINTAS DIARE (Five Steps to Complete Diarrhea) program including, 1) Giving ORS, 2) Giving Zinc tablets for up to 10 days successively, 3) Continue breastfeeding and eating, 4) Give antibiotics selectively, and 5) Give advice to mothers and families (Kementerian Kesehatan RI, 2011). This program is expected to help reduce the incidence of diarrhea among children. Regardless of the efforts that have been

made, diarrhea remains a major health problem which is the main cause of death in under-five at the national level (Kementerian Kesehatan Republik Indonesia, 2022).

This study aimed to identify hotspots for diarrhea on Sumatra Island in 2018. This research is the first study to carry out a spatial analysis of diarrhea cases using the Moran's Index method for under-five children on Sumatra Island using Basic Health Research report data. The purpose of the Moran's Index analysis in this study was to identify whether the prevalence of diarrhea among children under-five at the district/city level on the island of Sumatra has a clustered spatial distribution, dispersed or spread randomly. This study found a spatial autocorrelation of cases of diarrhea among children under-five on the island of Sumatra which indicated that cases of diarrhea in under-five children did not occur randomly, but were related to cases of diarrhea that occurred in the surrounding area. In this study the data analyzed were data derived from Basic Health Research reports by province in 2018. This study found hotspots in the lower part of the island of Sumatra, namely in NAD, North Sumatra and Riau Provinces. On the other hand, this study found low spots to occur in the eastern part of the island of Sumatra, which are in the Riau Archipelago, Bangka Belitung, South Sumatra and Lampung Provinces. The results of this study are in line with the results of a study conducted in Ethiopia which analyzed Demographic and Health Survey data in that country and found that cases of diarrhea were clustered. Clusters are found in the Southern Nations Nationalities and people, West Oromia, Gambella, Benshangul Gumuz, and Somalia regions. Clustering also occurs in the border areas of Southern Nations Nationalities and People and Tigray, Central Somali and Western Oromia, Gambella and Amhara (West Gojam, Awi, Oromia, and Wag Himra) (Bogale et al., 2017). Another study conducted in India also found spatial autocorrelation and hotspots for cases of diarrhea among children in the Maharashtra, Bihar, Odisha, and Gujarat regions (Ghosh et al., 2023). The same study was also conducted in the Karnataka region of India which also found a spatial autocorrelation of cases of diarrhea among under-five children (Dmello et al., 2022).

Provinces where hotspots were found were 7 hotspot areas in NAD Province, 19 hotspot areas in North Sumatra Province, and 1 hotspot area in Riau Province. The pattern of distribution of cases of diarrhea in under-fives found in this study shows that the spatial distribution of cases of diarrhea on the island of Sumatra varies, this leads to the need for policies that focus on areas that are included in hotspot areas. The results of this study can be an important input in understanding the complex geographical aspects of diarrhea among under-five children on the island of Sumatra. The results of this study should also be continued by conducting in-depth research regarding the factors associated with the incidence of diarrhea among under-five children using spatial regression in that area to better understand the causes of clustering. Things that need to be underlined are the characteristics of the social and demographic environment such as poverty, housing environment, exclusive breastfeeding, distance to health services.

CONCLUSION

This study found that hotspots were in the eastern part of the island of Sumatra, namely the Provinces of Nangroe Aceh Darussalam, North Sumatra, and Riau and low spots in the western part of the island of Sumatra, such as the Provinces of Lampung, Bangka Belitung, Riau Islands. This study suggests the health authorities to intensify programs in hotspot categories with high prevalence.

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