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ORIGINAL ARTICLE

TODDLER FECES MANAGEMENT AND BASIC IMMUNIZATION ON THE INCIDENCE OF DIARRHEA: A SPATIAL ANALYSIS

Pengelolaan Feses Balita Dan Imunisasi Dasar Terhadap Kejadian Diare Balita: Analisis Spasial

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ABSTRACT

Background: Diarrhea is one of the leading causes of child morbidity and mortality in low and middle-income countries. 23.8% prevalence of diarrhea was found among children under five years of age. Area-based management is required to address and provide specific interventions. **Purpose:** The study aims to analyze the effect of unsafe toddler feces management and incomplete primary immunization on the incidence of diarrhea using a spatial analysis in East Java, Indonesia. **Methods:** The data used is the 2018 Basic Health Research data. The measurement of the relationship between region and diarrhea was carried out by studying Moran's I index. Lisa Cluster Map and the Lisa Significance Map were also studied to understand distribution and significance. The regression used is OLS regression, spatial lag, and spatial error. The best model is assessed by comparing various parameters. Data were analyzed using GeoDA. **Results:** Moran's I result shows an index value of 0.489 with a pseudo-value of 0.001 ($p < 0.05$) and a z-value of 3.7515. Lisa Cluster Map shows seven high-high category areas, five low-low category areas, and one high-low category area. Lisa's Significance Map shows six areas p=0.05, three areas p=0.01, and four areas p=0.001. The unsafe management of toddler feces and incomplete primary immunization related to diarrhea shows a significance of $p<0.05$. By comparing the R square, log-likelihood, p(sign), and sigma square values, the better model is the spatial lag model. **Conclusion:** The unsafe toddler

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feces management and incomplete primary immunization related to diarrhea.

ABSTRAK

Latar belakang*: Diare merupakan salah satu penyebab utama morbiditas dan mortalitas anak di negara berpenghasilan rendah dan menengah. . 23,8% prevalensi diare ditemukan pada anak dibawah usia 5 tahun.Untuk mengatasi dan memberikan intervensi khusus, diperlukan pengelolaan berbasis wilayah.* ***Tujuan:*** *Penelitian bertujuan menganalisis pengaruh pengelolaan feses balita yang tidak aman dan imunisasi dasar yang tidak lengkap terhadap kejadian diare balita menggunakan evaluasi spasial di Jawa Timur, Indonesia.* ***Metode:*** *Data yang digunakan adalah data Riset Kesehatan Dasar tahun 2018. Pengukuran hubungan daerah dengan diare dilakukan dengan mempelajari indeks Moran I. Peta Cluster Lisa dan Peta Signifikansi Lisa juga dipelajari untuk memahami distribusi dan signifikansi. Regresi yang digunakan adalah regresi OLS, spasial lag, dan spasial error. Model terbaik dinilai dengan membandingkan berbagai parameter. Data dianalisis menggunakan GeoDA.* ***Hasil:*** *Hasil Moran's I menunjukkan nilai indeks sebesar 0,489 dengan nilai semu sebesar 0,001 (p<0,05) dan nilai z sebesar 3,7515. Peta Klaster Lisa menunjukkan bahwa terdapat 7 wilayah dengan kategori tinggi-tinggi, 5 wilayah dengan kategori rendah-rendah, dan 1 wilayah dengan kategori tinggi-rendah. Peta Signifikansi Lisa menunjukkan 6 area p=0,05, 3 area p=0,01, dan 4 area p=0,001. Pengelolaan feses balita yang tidak aman dan imunisasi dasar yang tidak lengkap terkait diare menunjukkan signifikansi p<0,05. Dengan membandingkan nilai R square, log-likelihood, p(sign), dan sigma square, model yang lebih baik adalah model spatial lag.* ***Simpulan:*** *Penanganan feses balita yang tidak aman dan imunisasi dasar yang tidak lengkap terkait diare.*

INTRODUCTION

Diarrhea is a common disease in children (1). The World Health Organization (WHO) defines diarrhea as defecating more fluids per day or more frequently than average for a person. Based on its duration, diarrhea can be divided into acute or chronic diarrhea. When symptoms last 2-4 weeks, diarrhea is called persistent or chronic diarrhea (2).

Diarrhea can occur in children under the age of 5 globally (3). Although deaths from childhood diarrhea have decreased substantially since the 1980s (4), diarrhea is a major cause of child morbidity and mortality in low and middle-income countries (5). Diarrhea also causes a significant economic burden on children in Indonesia (6). Bauleth et al (2020) found a 23.8% prevalence of diarrhea in the two weeks before the survey among children under five (7).

In order to help identify the best interventions to treat children with diarrhea, knowledge of the risk factors for death due to diarrhea is needed (3). Diarrhea is a disease associated with the environment. A targeted whole-of-society intervention approach that reaches all children with diarrhea may be helpful but needs to focus on regional aspects (8). Based on priority, interventions should be channeled to the most affected districts—availability of effective interventions in locations where diarrhea can be prevented. Previous studies have found that diarrhea is related to the area of residence (7).

Based on data on the use of health insurance in Indonesia, it is known that there were 344,528 cases of diarrhea in 2017 and 243,983 cases of diarrhea in 2018. The five provinces with the most cases of diarrhea in 2017 and 2018 are West Java, East Java, Central Java, Jakarta City, and Sumatra North. The costs incurred for diarrhea patients in 2017 amounted to 475.95 billion, and in 2018, amounted to 304.25 billion. The budget is quite large for handling diarrhea, which should be prevented by living a clean and healthy lifestyle and improving environmental sanitation (9).

Poor hygiene patterns. Improper hand-washing habits, unsafe disposal of children's feces, not treating drinking water at home, consuming leftover food stored at room temperature, and lack of knowledge about the main risk factors for diarrhea are potential factors for diarrhea (10). The results of this research also support that good sanitation, regular waste collection, access to health services, and health education can improve the living conditions and better the health of the population and prevent diseases such as diarrhea (11).

Immunization is administering vaccines to increase toddlers' immunity and is carried out according to a predetermined schedule. Immunization is an effort to inject a vaccine to increase a person's immunity so that the risk of exposure and severity of certain infectious diseases can be minimized (12). One of these efforts can prevent children from experiencing problems such as diarrhea. This research focused on the factors related to geographical conditions in East Java. Only a few previous research has discussed these connections and factors that influence the occurrence of diarrhea. The study aims to analyze the effect of unsafe toddler feces management and incomplete primary immunization on the incidence of diarrhea under five using a spatial evaluation in East Java, Indonesia.

METHODS

Dataset

The data used is Basic Health Research data for 2018. The areas accessed are 38 districts or cities in East Java Province, Indonesia. Basic Health Research (RISKESDAS in Indonesia) is a community-based national-scale research carried out regularly by the Ministry of Health of the Republic of Indonesia (13). The results of this have been widely used for planning, monitoring, and evaluating health development programs at the national, provincial, and district/city levels. The 2018 Basic Health Research design was cross-sectional with the census block sample frame. The population is households in Indonesia in all provinces and districts/cities (34 provinces, 416 districts, and 98 cities) (14).

The required number of samples is 300,000 households obtained from 30,000 survey blocks (each consisting of 10 households). The independent variables studied in this study were unsafe toddler feces management and incomplete primary immunization—prevalence of diarrhea at the district level as the outcome variable considered in this study. The significance map is shown with LISA statistical value. High-high and low-low districts show geographic grouping with the same diarrhea prevalence values, while high-low and low-high districts show spatial outliers. $p < 0.05$ was considered significant overall.

Confirmatory Spatial Analysis

The explanatory variable regression technique was used to determine the relationship between the percentage of diarrhea incidents. The classical assumption test was first carried out before the regression test. Normality test using Shapiro Wilk. The multicollinearity test uses the scatter plot approach. The residual test between independent observations was tested with Durbin-Watson. Contiguity weight using Queen continuity.

Spatial Regression

A technique for predicting the value of an outcome variable based on the value of a set of explanatory variables, taking into account spatial dependence, namely spatial regression. Data were analyzed using OLS. Spatial error and spatial lag were two forms of spatial dependence. The dependency is said to be on the spatial error if the error terms across different spatial units are correlated. Bivariate LISA were used to examine the spatial relationship between the exposure and the response variable across the geographic locations. Comparison of the models was based on model diagnostic measures, including R Square, Log-likelihood, p, and sigma square. The tests were performed using GeoDA software.

This study received approval from the Research Ethics Committee of the Faculty of Dental Medicine Health Research of Universitas Airlangga on December 29, 2023 with a reference number 1431/HRECC.FODM/XII/2023.

RESULTS

Based on the Basic Health Research (RISKESDAS in Indonesia), the population is households in Indonesia in all provinces and districts/cities (34 provinces, 416 districts, and 98 cities). This study focused on East Java, which had 38 regencies/cities.

Table 1
District Characteristics

District	Area width	Total population	Diarrhea prevalence (%)	Unsafe management of toddler feces prevalence (%)	Incomplete basic immunization prevalence (%)
Bangkalan	1,001.4	978,892	7.05	36.96	40.11
Banyuwangi	5,782.4	1,609,677	14.03	43.71	18.13
Blitar	1,336.5	1,157,500	7.23	20.26	13.33
Bojonegoro	2,198.8	1,246,927	6.24	21.82	33.71
Bondowoso	1,526.0	772,297	17.88	56.83	26.16
Gresik	1,191.3	1,299,024	13.24	48.71	23.55
Jember	3,092.3	2,440,714	17.15	55.08	44.87
Jombang	1,115.1	1,258,618	6.13	23.73	2.12
Kediri	1,386.1	1,568,113	8.09	16.35	17.22
Batu City	136.7	205,788	5.41	29.54	40.94
Blitar City	32.6	140,971	12.99	23.11	8.15
Kediri City	63.4	285,582	1.20	23.12	17.99
Madiun City	33.9	176,697	7.08	23.85	33.90
Malang City	145.3	866,118	10.93	39.31	6.01
Mojokerto City	16.5	128,892	7.19	38.81	23.34
Pasuruan City	35.3	199,078	11.05	55.57	18.40
Probolinggo City	56.7	235,211	14.06	46.38	40.02
Surabaya City	350.5	2,885,555	10.14	33.44	33.39
Lamongan	1,782.1	1,188,913	13.83	33.16	16.99
Lumajang	1,790.9	1,039,794	13.16	39.34	29.92
Madiun	1,037.6	681,394	6.51	19.27	25.85
Magetan	688.8	628,924	5.37	14.89	10.25
Malang	3,530,7	2,591,795	13.48	28.98	9.48
Mojokerto	717,8	1,108,718	9.19	19.43	12.53
Nganjuk	1,224.3	1,051,900	8.15	22.71	23.79
Ngawi	1,296.0	830,090	12.75	19.57	15.19
Pacitan	1,389.9	554,394	6.93	16.17	14.42
Pamekasan	792.2	871,497	12.49	56.90	41.93
Pasuruan	1,474.0	1,616,578	11.21	41.50	35.42
Ponorogo	1,305.7	870,705	6.90	12.71	21.91
Probolinggo	1,696.2	1,162,092	17.38	67.26	33.84
Sampang	1,233.1	968,520	8.51	50.01	30.61
Sidoarjo	634.4	2,216,804	12.58	46.49	29.14
Situbondo	1,669.9	679,993	15.83	68.06	35.70
Sumenep	1,998.5	1,085,227	5.52	64.24	42.66
Trenggalek	1,147.2	694,902	9.76	20.69	8.03
Tuban	1,834.2	1,168,277	7.59	41.26	36.29
Tulungagung	1,055.7	1,035,290	3.03	17.83	29.99

Source: Indonesia Ministry of Health (2018), East Java Health Service (2019) (13,14)

The most expansive district area is Banyuwangi. The largest population is Surabaya. The district that has the highest prevalence of diarrhea is Bondowoso. The highest prevalence of the unsafe management of toddler feces is Situbondo. The highest prevalence of incomplete primary immunization is Jember. District characteristics are presented in Table 1.

Figure 1 shows a map of East Java Province. Moran's I result shows an index value of 0.48 with a pseudo-value of 0.001 and a z-value of 3.75, which indicates that the region related to diarrhea is under five ($p < 0.05$)—z-scores and p-values to evaluate the significance of the Moran I Index. P-values are numerical estimates of the area under the curve for a known distribution constrained by

the test statistic. Moran's I results are shown in Figure 2.

The Lisa cluster map shows areas in the high-high category: Probolinggo City, Probolinggo Regency, Situbondo, Bondowoso, Jember, Lumajang, and Banyuwangi. The low-low category is Ponorogo, Trenggalek, Nganjuk, Kediri district, and Madiun City, and the high-low category is Ngawi. The high-high category was presented in red mark. Based on Figure 3 and Figure 4, the Lisa significance map shows that there are six regions, namely Ngawi, Ponorogo, Trenggalek, Kediri district, Madiun city, Probolinggo city (p=0.05), three regions, namely Nganjuk, Lumajang, and Banyuwangi districts (p=0.01) and Probolinggo, Jember, Bondowoso and Situbondo (p=0.00). The results of the Lisa Cluster Map and Lisa Significance Map are shown in Figure 3 and Figure 4.

The unsafe management of toddler feces and incomplete basic immunization affect the occurrence of diarrhea in children under five with a p-value < 0.05. This result was presented in the OLS, Spatial lag, and Spatial error models. The results of the regression test are presented in Table 2. Spatial lag and error models are two basic models in spatial econometrics. By comparing the R square, log-likelihood, p(sign), and sigma square values, the better model is the spatial lag model. Table 3 compares linear regression models, spatial lag, and spatial error. The spatial lag model was the best compared to the regression model and spatial error based on the R square.

Table 2
Estimated Regression Coefficients Obtained From OLS, Spatial Lag, and Spatial Error Model

Variable	OLS model			Spatial lag model			Spatial error model		
Constant	5.69	1.35	0.00	4.35	1.50	0.00	5.74	1.35	0.00
Management of toddler feces	0.19	0.03	0.00*	0.15	0.03	0.00*	0.19	0.03	0.00*
Universal Child Immunization	-0.10	0.05	0.04*	-0.10	0.04	0.03*	-0.10	0.05	0.03*
Lambda	-	-	-	-	-	-	0.05	019	0.27
Rho	-	-	-	0.24	0.15	0.11	-	-	-

*Significant

Table 3
Comparison of Linear Regression Models, Spatial Lag, and Spatial Error

Comparison	Model		
	Regression Linear (OLS)	Spatial Lag	Spatial Error
R square	0.43	0.48	0.44
Log Likelihood	-95.72	-94.62	-95.69
p		0.13	0.82
Sigma square		8.36	9.00

Figure 1. Map of East Java

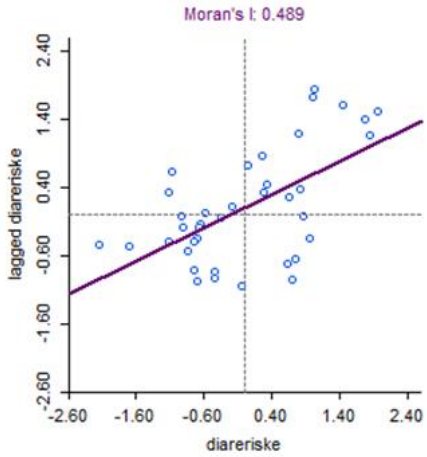

Figure 2. Moran's I Index Analysis

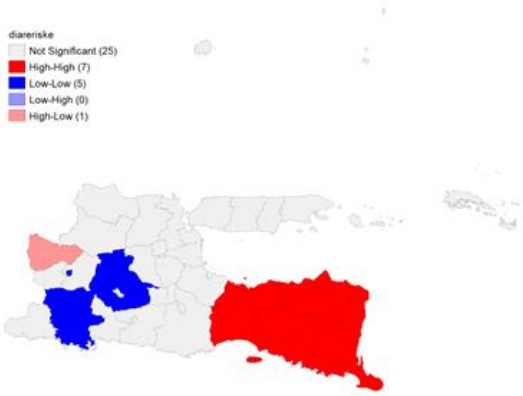

Figure 3. Lisa Cluster Map

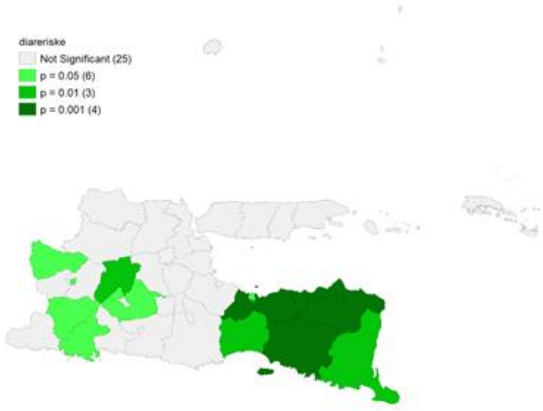

Figure 4. Lisa Significance Map

DISCUSSION

The results show a correlation between the incidence of diarrhea in children and regions. The results of Moran's I are also confirmed by the results of Lisa's cluster map and Lisa's significance map. Several areas are indicated to be significant, and clusters are formed. Understanding the local epidemiology of diarrhea across the country is critical for defining what can contribute to accelerating the reduction of morbidity-mortality of diarrhea (15). A study determined the spatial pattern of diarrheal causes of death worldwide during the study period from 2000 to 2017. The results found that the focal point of diarrheal deaths was mainly in Asian countries until 2010, and this focus shifted to Africa in 2011 (16). A study in India using DLHS-3 and NFHS-4 data showed a spatial autocorrelation (Moran's I = 0.57 and 0.36, respectively) when modeling diarrhea data (18). Some spatial groupings and outliers were present in the prevalence of childhood diarrhea, thus indicating the need for interventions in the target area (17). Interventions can be carried out by improving the nutritional status of children, especially targeting a high prevalence (19). Diarrheal among children under five is highly seasonal and spatially clustered (20).

The unsafe management of toddler feces and complete primary immunization affect the occurrence of diarrhea in children. These results are similar to other studies that show poor hygiene patterns. Improper hand-washing habits, unsafe disposal of children's feces, not treating drinking water at home, consuming leftover food stored at room temperature, and lack of knowledge about the main risk factors for diarrhea are potential factors for diarrhea (10). The results of this research also support that good sanitation, regular waste collection, access to health services, and health education can improve the living conditions and better health of the population and prevent diseases such as diarrhea (11). The type of roofing material, hand washing facilities, latrines, feces around holes, feces around housing complexes, and the risk of contamination of household storage areas have a significant relationship with diarrhea morbidity (21). Therefore, public awareness about hygiene and sanitation that focuses on handling human waste properly, handling safe water, practicing proper hand washing, and managing food waste must be increased to prevent children from acute diarrheal disease.

Childhood diarrhea did not occur at random. It has spatiotemporal variation and seasonal patterns with a decreasing temporal trend (22). Spatial lag and error models are two basic models in spatial econometrics. By comparing the R square, log-likelihood, p(sign), and sigma square values, the better model is the spatial lag model. The Lagrange multiplier test was conducted to determine whether the spatial lag model was better. If LM-Lag is more significant than LM-

Error in the spatial dependency test, then R-LM-Lag is significant, and R-LM-Error is not significant; it can be assessed as spatial lag. Model. Alternatively, if the LM-Error is statistically more significant than the LM-Lag, and the R-LM-Error is significant while the R-LM-Lag is not significant, then it can be determined that the spatial error model is the appropriate model (23).

Research Limitations

The weakness of this research is that research uses secondary data, so errors can occur in data collection. In addition, the location is limited in East Java Province. The recommendation for further research is comparing several years of health research to understand the risk factors to prevent childhood diarrhea in affected areas.

CONCLUSION

The unsafe management of toddler feces and incomplete primary immunization affect the occurrence of diarrhea in children. There was a correlation between diarrhea and region.

CONFLICT OF INTEREST

There is no conflict of interest.

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