

# Spatial Analysis of Pneumonia in Toddlers Based on Environmental, Individual, and Behavior Factors in Pelalawan Regency, Riau Province

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## Abstract

Pelalawan Regency is one of twelve districts in Riau Province with pneumonia cases in toddlers is quite high, namely in 2016 there were 155.7% of pneumonia cases in toddlers. Based on these cases, there is no clear information on how the cases were spread related to environmental risk factors. The research aims to conduct spatial pneumonia analysis in toddlers based on environmental, individual and behavioral factors. By knowing the pattern of disease distribution and its possible causes, it will be easier for officers to plan pneumonia prevention efforts and prevention more effectively, community-based or make it easier to design the development of further prevention programs. This research is a survey research with quantitative analytic methods conducted in 12 Districts of Pelalawan Regency, Riau Province. The results showed the highest distribution of pneumonia frequency in toddlers by region in 12 Districts of Pelalawan District was the highest in Districts of Pelalawan.

**Keywords:** *Pneumonia, Toddler, Spatial Analysis, Environmental Risk Factors, Individuals, Behavior*

## Introduction

Pneumonia is a disease that attacks the lungs and is characterized by coughing and breathing difficulties<sup>(1)</sup>. Pneumonia is one of the types of lower respiratory tract infections and has become a serious concern, because it is a major cause of infant mortality, especially in developing countries with 3 million deaths each year. Pneumonia in toddlers is most often caused by respiratory viruses and most often caused by the bacterium *Mycoplasma Pneumoniae*<sup>(2),(3)</sup>. Globally, pneumonia is the 7th largest cause of death related to the environment. <sup>(4)</sup>.

Toddlers are the most vulnerable group to pneumonia. In 2015, the World Health Organization (WHO) reported nearly 6 million toddlers died, 16% of this number was caused by pneumonia as the number 1 killer of toddlers in the world. Based on data from the United Nations Agency for Children (UNICEF), in 2015

there were approximately 14 percent of 147,000 children under the age of 5 in Indonesia died of pneumonia. From these statistics, it can be interpreted as many as 2-3 children under the age of 5 years die from pneumonia every hour. This causes pneumonia as the main cause of death for children under 5 years of age in Indonesia <sup>(5)</sup>.

The prevalence of pneumonia in toddlers in Indonesia in 2016 has reached 25% and increased in 2017 by 46.34% (447,431 cases). The number of underfive deaths due to pneumonia in 2017 amounted to 1,351 people with a Case Fatality Rate (CFR) of 0.3%<sup>(6)</sup>.

The number of cases of finding and handling pneumonia in toddlers in Riau Province in 2014 was 10,367 cases, in 2015 9,552 cases and an increase in 2016 amounted to 11,250 cases. From reports of health problems due to smoke and land fires mentioned from 6 Provinces (Riau, Jambi, South Sumatra, Central Kalimantan, West Kalimantan and South Kalimantan) monitored by the Ministry of Health, pneumonia cases in Riau Province are quite high and tend to increase. One indicator to be achieved in the Millennium Development Goals (MDGs) is to reduce infant and toddler mortality<sup>(7)</sup>.

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Some research results reveal that environmental conditions influence the occurrence of pneumonia in toddlers. Poor air quality caused by the presence of air pollution sources such as land / forest fires, motor vehicle and industrial exhaust gases containing SO<sub>2</sub>, NO and NO<sub>x</sub> pollutants<sup>(8)</sup>. Waste disposal, the presence of livestock around the residence is a factor associated with pneumonia<sup>(9)</sup>. Environmental factors in the home such as inadequate ventilation area<sup>(10)</sup>, inadequate floor and wall conditions of the house<sup>(11)(12)</sup>, temperature and humidity air in the house that is too low or high has a big role in the pathogenesis of pneumonia<sup>(9)</sup>. The density of residential in the house, lighting that does not meet the requirements to increase the growth of gram-positive bacteria<sup>(13)</sup> and the use of mosquito coils and the presence of smokers in the home can be a cause of transmission of pneumonia in toddlers<sup>(14)(29)</sup>.

Socio-economic factors also play a role in the occurrence of pneumonia such as working mothers and low family incomes in meeting the living needs of family members. Children who have poor nutritional status, do not get exclusive breastfeeding and are not immunized include factors that influence the onset of pneumonia in toddlers<sup>(15)(4)</sup>. Pneumonia is also influenced by climatic conditions and seasons. Parasites and disease vectors are very sensitive to climatic factors, especially temperature, humidity, and rainfall<sup>(16)</sup>. Climate change has direct and indirect effects on human health, the direct effects of extreme cold and heat. Extreme rainfall can increase pneumonia cases<sup>(17)</sup>. Further, to see a picture of the situation of pneumonia along with the factors that influence it, then spatial analysis can help map the distribution of a disease.

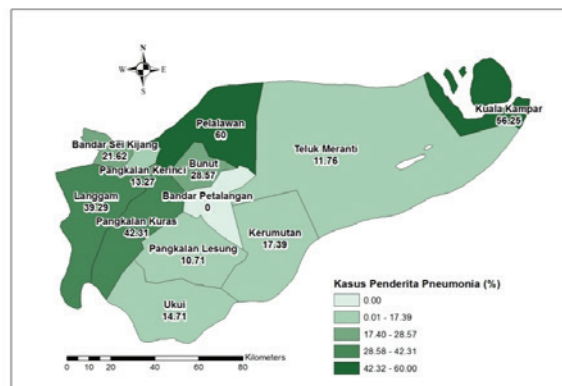
Pelalawan Regency is one of twelve districts in Riau Province with pneumonia cases in toddlers is quite high, namely in 2016 there were 155.7% of pneumonia cases in toddlers. Topographically Pelalawan Regency has a low and hilly land structure. Physically part of this area is a conservation area with soil characteristics in certain parts are acidic and is organic soil, brackish ground water, humidity and air temperatures are rather high. The difference in height of an area will affect the differences in climate conditions<sup>(16)</sup>. Based on the background above, it is necessary to conduct research

on the spatial analysis of pneumonia in toddlers based on environmental, individual and behavioral factors in Pelalawan Regency, Riau Province.

## Method

This research is a survey research with quantitative analytic methods. This research was conducted in 12 Districts of Pelalawan Regency, Riau Province began in 2019. The population in this study was households with children under the age of 1 to 5 years who lived in Pelalawan Regency, Riau Province. The minimum sample size in this study was 394 respondents, this was calculated using the lemes how formula. The sampling technique in quantitative research is Probability sampling with cluster random sampling technique. The distribution of pneumonia will be analyzed using spatial analysis and the data used consists of spatial and non-spatial data. The statistical method used to analyze data by calculating spatial factors is Geographically Weighted Logistic Regression (GWLR).

## Findings and Discussion



**Figure 1. Percentage of pneumonia distribution in toddlers in Pelalawan District**

Figure 1 above shows the spread of cases of pneumonia in toddlers in each district. The full model and the reduction model produce the significance of different variables. To compare the best model, the AIC (Akaike Information Criterion) value is used for each model. The model that has the smallest AIC value is the best model. The full model has a value of AIC = 170.21 while the reduction model has a value of AIC = 157,644. The reduction model has a smaller AIC value than the full model so the reduction model is the best model.

**Table 1. Estimating the parameters of the final logistic regression model**

| Variable                 | Parameter Coefficient Value | Standard Error | p-value  |
|--------------------------|-----------------------------|----------------|----------|
| (Intercept)              | -11.61                      | 1.979          | 0.000**  |
| Wall                     | 2.977                       | 0.5279         | 0.000**  |
| Lighting                 | 1.304                       | 0.4792         | 0.0065** |
| Humidity                 | 1.845                       | 0.5007         | 0.000**  |
| The existence of smokers | 2.112                       | 0.6591         | 0.0013** |
| Birth weight             | 0.00259                     | 0.000616       | 0.000**  |
| Immunization             | 1.716                       | 0.5025         | 0.000**  |
| Pseudo R-Square          |                             | 0.70           |          |
| AIC                      |                             | 145            |          |

Note: \* = significant at the level 10%, \*\* = significant at the level 5%

Model Comparison

**Table 2. Comparison between models**

| Model                       | AIC    |
|-----------------------------|--------|
| Binary Logistics Regression | 145.00 |
| GWLR                        | 142.92 |

The model comparison test in this study was conducted by comparing the binary logistic regression model with the GWLR model based on the AIC value. So, it can be concluded that the GWLR model is the best model.

**Table 3. Summary of GWLR Model Parameter Coefficients**

| Independent Variable     | Parameter coefficient value |          |         |
|--------------------------|-----------------------------|----------|---------|
|                          | Minimum                     | Average  | Maximum |
| Intercept                | -12.389                     | -11.6893 | -9.4711 |
| Wall                     | 2.55457                     | 2.906877 | 2.9965  |
| Lighting                 | 1.15773                     | 1.225492 | 1.5164  |
| Humidity                 | 1.63911                     | 1.887415 | 1.9591  |
| The existence of smokers | 1.94845                     | 2.174809 | 2.305   |
| Birth weight             | 0.00199                     | 0.002642 | 0.0029  |
| Immunization             | 1.65114                     | 1.715248 | 1.7968  |
| Pseudo R-Square          | 0.717                       |          |         |

Table 3 shows the interval coefficient values for each independent variable based on the minimum, average, and maximum values. In addition, the Pseudo R-Square value of 0.717 indicates that the independent variables are able to explain the diversity of pneumonia status by 71.7% while the rest are explained by other variables outside the model.

Map of Pneumonia Distribution in Toddlers Based on Factors Affecting it

The following is a map of the distribution of pneumonia in toddlers based on the type of wall of the house, lighting, humidity, the presence of smokers in the house, birth weight and immunization status in Pelalawan District.

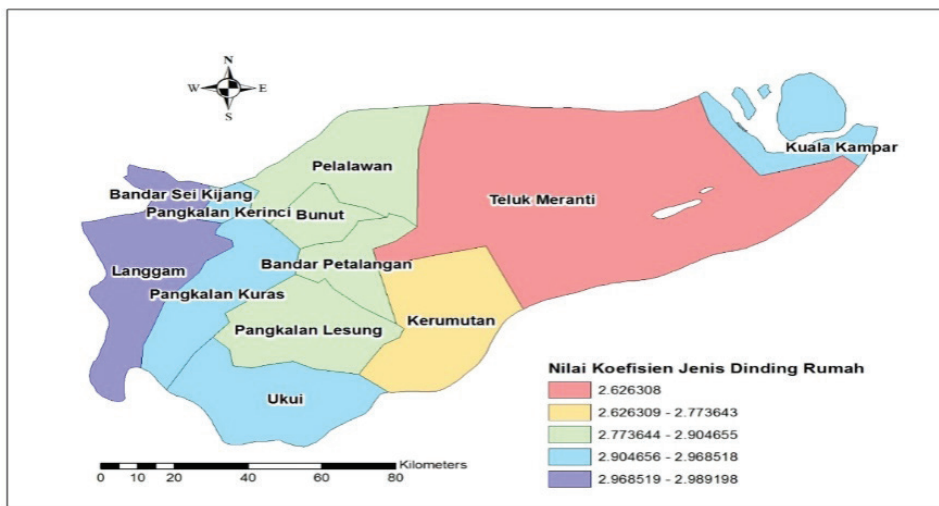


Figure 2. Distribution of Pneumonia in toddlers based on the type of wall of the house

The results of research Li and Sun (2014) said the use of wood in the house can increase the prevalence of respiratory infections in children, especially wood whose quality is not good and thin because it can remove volatile organic compounds in the room. Compared to cement, construction materials including, laminated wood, real wood, and wallpaper positively increase pneumonia risk factors. Composite wood materials emit formaldehyde and have been identified as a source of emissions that worsen indoor air quality<sup>(18)</sup>.

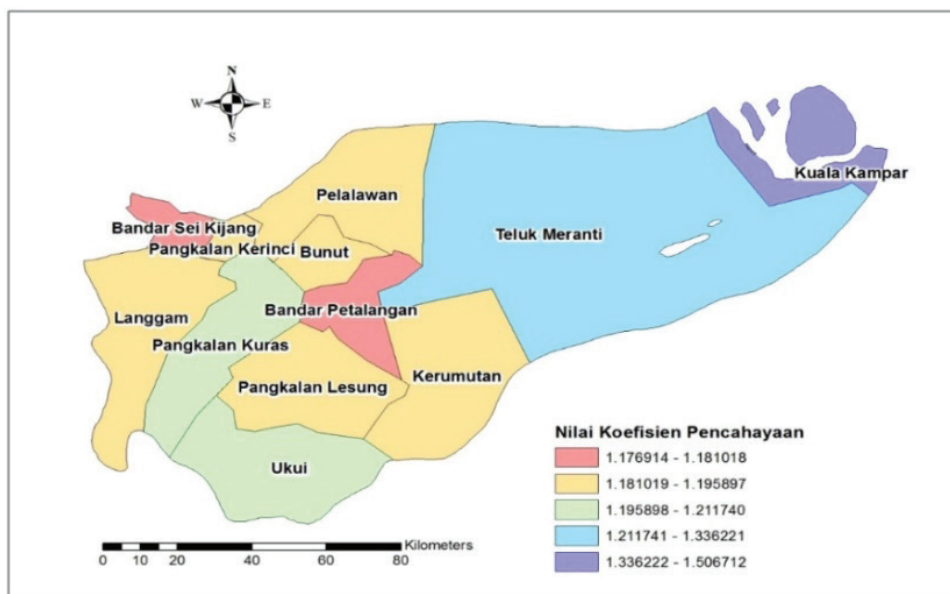


Figure 3. Distribution of Pneumonia in toddlers based on lighting

Rahmiza <sup>(18)</sup> states that there is a significant relationship between lighting and pneumonia genesis in toddlers. Toddlers who live in homes with inadequate light have a 4.117 times greater risk of developing pneumonia compared to toddlers who live in homes with lighting that meets the requirements. Dust mites and molds support the humid environment. Many mushrooms that produce toxins and irritants that affect respiratory health <sup>(20)</sup>.

A research done by Bornehag et al. mention the problems associated with humidity in the building is strongly associated with respiratory infections in children and adults. Humidity and fungi at home are significant with increased respiratory infections <sup>(21)</sup>. Measures against housing risk factors can help prevent pneumonia in children <sup>(18)</sup>. A study of children under 5 years at a teaching hospital in Nepal found that the incidence of pneumonia was four times greater in children living in households with smoking parents <sup>(22)</sup>.

Exposure to indoor air pollution increases the risk of pneumonia in children, which causes around one million deaths globally. Exposure to solid fuels, carbon monoxide (CO) shows a significant relationship with pneumonia in children under 5 years <sup>(23)</sup>. Studies in Vietnam show that children in Vietnam are exposed to ETC (Environmental Tobacco Smoking) which results in 44,000 excess hospitalizations due to pneumonia each year among children <5 years old <sup>(24)</sup>.

The results of the study Supriatin <sup>(25)</sup> states there is a significant relationship between birth weight with the incidence of ARI in toddlers. LBW toddlers do not have enough nutrition and protein for the formation of the immune system, so if a toddler breathe unhealthy air will be susceptible to respiratory infections. The results of the study by Ramazeni <sup>(26)</sup> estimated that 19% of children born with low birth weight in developing countries have pneumonia.

Economic and educational characteristics are also found to be lower in rural areas. The effect of measles immunization on pneumonia based on economic status can be seen that children who get measles immunization and middle-income family members are better protected from pneumonia than children who are immunized against measles and belong to low-income families <sup>(27, 28)</sup>.

## Conclusion

1. The highest frequency of pneumonia distribution in toddlers by region in 12 Districts of Pelalawan Regency is the highest in the District of Pelalawan.
2. The spread of pneumonia in toddlers is based on the type of wall of the house, areas with high risk are Meranti Bay District and Crowds Sub-District.
3. The spread of pneumonia in toddlers based on lighting does not meet the requirements is the District of Bandar Seikijang and Bandar Petalangan.
4. The spread of pneumonia in toddlers based on house humidity that does not meet the requirements is Meranti Bay and Kuala Kampar Districts.
5. The spread of pneumonia in toddlers based on the presence of smoker behavior in the house is Kuala Kampar District.
6. The spread of pneumonia in toddlers based on a history of low birth weight is in the Subdistrict of Meranti
7. The spread of pneumonia in toddlers based on incomplete immunization status is Kuala Kampar District

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