



Spatial and Epidemiological Analysis of the Incidence of Under-5 Pneumonia in Bangka Belitung

Syariifaturrahmatudzakiyyah¹, Najmah^{2*}, Andri Nurtito³, Evaluasi⁴, M. Rais Haru⁵, Deby Mahariska⁶, Enni Restiyani⁷

^{1,2}Sriwijaya University

^{3,4,5,6,7} Bangka Belitung Provincial Health Office

najmah@fkm.unsri.ac.id

ABSTRACT

Bangka Belitung has the second highest prevalence of pneumonia in Indonesia in 2019 and there will be an increase in cases in 2022. Pneumonia is a disease caused by Streptococcus pneumoniae or pneumococcal bacterial infection which can cause death, especially in developing countries. This research aims to look at the distribution and epidemiology of toddler pneumonia in Bangka Belitung Province in 2023. Using descriptive methods with a quantitative approach using an ecological design with a sample size of 1,157. This research uses secondary data obtained from routine monthly ISPA reports for pneumonia cases, immunization data from the Sehat IndonesiaKu Application (SIK) and manual recaps, population density data obtained from data listed in the monthly ISPA and BPS Bangka Belitung Province routine reports. The research results show that the Incidence Rate in 2023 is 784.8 per 100,000 children under five with a CFR and UFR of 0. The highest cases occur in areas with high population density and include low PCV immunization. The proposed cases are 50.6% male and 49.4% female, while the proportion aged < 1 year is 24.2% and 1 - < 5 years is 75.8%. The results of the Chi-Square Test are an age p-value of 0.255 and a gender p-value of 0.960. It was concluded that there was no relationship between the characteristics of toddlers and pneumonia, namely gender and age of toddlers

Keywords : *Pneumonia, Toddler, Mapping, Epidemiology, Spatial Analysis*

1. INTRODUCTION

Pneumonia is a disease caused by infection and inflammation of the lower respiratory organs, which can be caused by several microorganisms as agents, namely viruses, bacteria, fungi and parasites that cause abnormalities in the respiratory system, especially lung function (Fathin & Kusumawati, 2022). Pneumonia is a disease caused by *Streptococcus pneumoniae* or pneumococcal bacterial infection that can cause death, especially in developing countries.

Children aged 1-5 years and older people aged ≥ 65 years are at higher risk of pneumococcal bacterial infection. Pneumococcal bacteria can be spread through the air by coughing or sneezing until someone says or by touching a given object contaminated by droplets of human fluid who is infected. People who develop pneumonia will present with many different symptoms including fever, chills, cough, shortness of breath and chest pain.

Infectious agents such as *mycoplasma* (fungi), viruses, bacteria and aspiration of

* Najmah

Tel.: -

Email: najmah@fkm.unsri.ac.id

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foreign substances in the form of *consolidation* (cloudy spots) and *exudates* (fluids) in the lungs cause this (Khasanah, 2017). Acute infections that affect the lungs or more precisely the alveoli due to microorganisms as the cause are called pneumonia (Kemenkes RI, 2019). Pneumococcus (*Streptococcus pneumoniae*) and Hib (*Haemophilus influenzae* type B) are the most common bacteria causing pneumonia. While RSV (Respiratory syncytial virus) is the most commonly encountered causative virus.

The World Health Organization (WHO) states that the leading cause of death among children under 5 years old is pneumonia. 16% of deaths of children <5 years old were caused by this disease, with 920,136 under-five deaths or >2,500/day or an estimated 2/minute under-five deaths in 2015. (Profil Kesehatan Indonesia, 2017). The prevalence of pneumonia in 2018 was 4.0%. According to WHO, pneumonia contributed to 14% of under-five deaths worldwide in 2019. According to Indonesia's 2020 Health Profile data, the prevalence of under-five pneumonia was 3.55 per 100 under-fives.

Pneumonia ranks as the third leading cause of death among under-fives with a coverage of 9.4% according to the 2016 Balitbangkes Sample Registration System Survey. Indonesia is ranked in the top 10 out of 15 countries with high under-five and child mortality due to pneumonia. Bangka Belitung's pneumonia prevalence was ranked the 2nd highest in Indonesia in 2019. (Profil Kesehatan Indonesia, 2019). Pneumonia in Bangka Belitung experienced an increase in cases in 2022 (2,676 cases) after a significant decrease in cases from 2018-2021. (Dinkes, 2023).

Geographic Information System (GIS) is one of the geospatial technologies used in various fields including health to epidemiology. (Sari et al., 2023) conducted a study related to the distribution trend map of pneumonia toddlers in 2021 in Kapanewon Mergangsan and analyzed pneumonia risk factors based on population density and rainfall aspects. Similar research was conducted because there has been no related research in the Bangka Belitung region with additional variables in the form of toddler characteristics and epidemiological

calculations that were not carried out in previous studies.

Conducting spatial analysis can make it easier for health staff to troubleshoot pneumonia in under-fives using *Geographic Information System (GIS)*. Epidemiologic calculations were also conducted from pneumonia surveillance data collected by health authorities. The objectives of the study were to determine the distribution of pneumonia in children under five years of age in districts and cities in Bangka Belitung province by 2023 based on population density and PCV immunization coverage, assess morbidity and mortality rates with epidemiological calculations and determine the relationship between the characteristics of children under five, namely, gender and age of children under five to the incidence of pneumonia.

2. RESEARCH METHOD

Descriptive research with a quantitative approach is an ecological research design approach whose unit of analysis is the population. The population data in this study were all cases of pneumonia in children under five years of age from 2018 to 2023 recorded and reported by the Bangka Belitung Provincial Health Office with a sample of all pneumonia cases that occurred in 2023 during the January-June period in 7 districts/cities in Bangka Belitung with a total of 1,157 cases. This study used secondary data obtained from the routine monthly ARI reports from January 2023 to June 2023 that were manually inputted by the ARI program holder at the Bangka Belitung Provincial Health Office who served as the subject of this study while the object of the study was the under-five pneumonia data in the ARI report at the Bangka Belitung Health Office in 2023. Immunization coverage data was obtained from the Healthy IndonesiaKu Application (ASIK) which was inputted by health facilities that performed services and manual data processing was still carried out. Population density data was obtained from data listed in the routine ISPA report and BPS Bangka Belitung Province. Data were processed with the Quantum GIS application to create a case distribution map and IBM SPSS

Statistics 23 to process data and look for relationships between research variables with bivariate analysis, namely the Chi-square test. With the analyzed data presented in the form of tables, graphs and distribution maps based on districts / cities in Bangka Belitung Province..

3. RESULTS AND DISCUSSION

3.1 Result

Map of the Distribution of Under-5 Pneumonia Cases in Bangka Belitung Province in 2023 by Municipality and PCV Immunization (Pneumococcal Conjugate Vaccine)

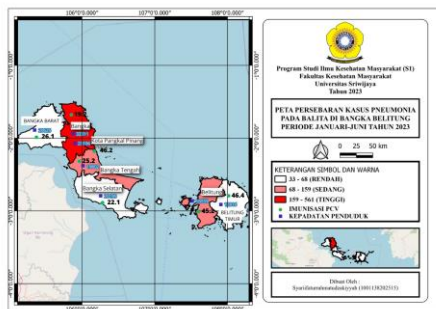


Figure 1: Pneumonia distribution map for January-June 2023.

The distribution areas of under-five pneumonia are distinguished by 3 color categories. The red color symbolizes areas with high cases, areas with moderate cases are symbolized by pink and areas with low cases are symbolized by white. From the mapping results, 2 districts/cities with high cases, 2 districts with moderate cases and 3 districts with low cases were identified. In each mapping area there is PCV (*Pneumococcal Conjugate Vaccine*) immunization coverage which is symbolized by round green.

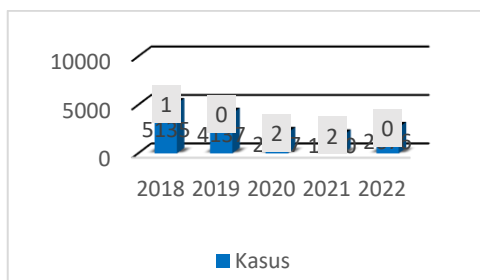


Figure 2: Number of under-five pneumonia cases in 2018-2022

The graph above shows consecutive cases for 5 years within a period of 1 year obtained from data from the P2P section of the Bangka Belitung Provincial Health Office. From the graph, it is known that the highest incidence was in 2018 (5,135 cases) and the lowest in 2021 (1,890 cases). while cases that resulted in death occurred in 2018, 2020 and 2021 with a total of 5 deaths.

Table 1. Calculation of Epidemiology of Pneumonia from January to June 2023

Rate	Formula	Value	Rate/1000 population	Rate/100,000 population
Incidence rate (IR)	$\frac{\text{Number of Cases}}{\text{Number of Toddlers} \times K}$	$\frac{1.157}{147.413 \times K}$	7,8 cases per 1.000 toddler	784,8 cases per 100.000 toddler
Under-Five Mortality Rate (UFMR)	$\frac{\text{Number of Deaths}}{\text{Number of Toddlers} \times K}$	-	0	0
Case fatality rate (CFR)	$\frac{\text{Number of Deaths}}{\text{Number of Cases} \times K}$	-	0	0

Based on Table 1, it is known that the *incidence rate* of Bangka Belitung pneumonia cases in 2023 for the January-June period is 784.8 per 100,000 children under five. While the previous 5 years the *incidence rate* was 3,750.4 (2018), 3,002.4 (2019), 1,544.4 (2020), 1,347.7 (2021) and 1,858.5 (2022). *Incidence rates* tended to decrease from 2018-2021, but increased again to 510.8 per 100,000 children under five in 2022. *Mortality* and CFR of pneumonia among children under five in Bangka Belitung in 2023 for the January-June period amounted to 0. CFR in 2020 increased to 12.67 per 100,000 children under five in 2021 and decreased to 0 in 2022. Meanwhile, the UFMR in 2018 was 0.73 per 100,000 children under five and increased in 2021 to 1.44 per 100,000 children under five and continued to decline until 2022. Determination of the ups and downs of the *Incidence Rate, Under-Five Mortality and Case Fatality Rate* to 2023 cannot be determined because the time period used is not even 1 year.

Table 2: Characteristics of children with pneumonia from January to June 2023

Characteristics of Toddlers	Classification of Pneumonia				f	%
	Pneumonia		Severe pneumonia			
	f	%	f	%		
Age						
< 1 th	27 3	23, 6	7	0,6	28 0	24, 2
1 - < 5 th	86 4	74, 7	13	1,1	87 7	75, 8
Gender	f	%	f	%	f	%
Male	57 5	49, 7	10	0,8 6	58 5	50, 6
Female	56 2	48, 6	10	0,8 6	57 2	49, 4

Based on Table 2, it is known that pneumonia was more prevalent among toddlers aged 1 - <5 years with a total of 877 toddlers. And based on gender, male toddlers had more pneumonia with a total of 585 toddlers (50.5%).

Table 3. Associations of Characteristics of Toddlers with Pneumonia from January to June 2023

Characteristics of Toddlers	OR (95% CI)	P-Value
Age		
< 1 th	1,704 (0,673 - 4,314)	0,255
1 - < 5 th		
Gender		
Male	1,023 (0,423 - 2,477)	0,960
Female		

The results in Table 3 show that the percentage of children under five with pneumonia was 23.6% aged < 1 year and 74.7% aged 1 - < 5 years. While children under five with severe pneumonia showed a percentage of 0.6% aged < 1 year and 1.1% aged 1 - < 5 years. The results of the calculation by gender of under-fives in the table below show that male under-fives, totaling 575 under-fives, suffered more pneumonia, while under-fives with severe pneumonia showed a balance of 10 cases for each gender.

3.2. Discussion

Based on the results obtained, it is known that in the 5-year period (2018 - 2022), in 2021

the lowest pneumonia case finding was 1,890 cases. In 2022, it increased to 2,676 cases. Meanwhile, in the 5-year period (2018-2022), 5 deaths of under-five pneumonia were also reported, namely in 2018 1 death, 2019 0 death, 2020 2 deaths and 2021 2 deaths. While in 2022 there were no reported deaths. So it can be concluded that in the Bangka Belitung Islands Province in the 5-year period (2018-2022) the number of cases of under-five pneumonia was 15,985 cases with 5 deaths of under-five pneumonia.

Population Density

Based on the mapping results, the proportion of under-five pneumonia cases from highest to lowest was Bangka Regency 48.49% (561 cases), Pangkalpinang City 16.50% (191 cases), Central Bangka Regency 13.74% (159 cases), Belitung Regency 7.43% (86 cases). South Bangka District 5.88% (68 cases), West Bangka 5.09% (59 cases) and East Belitung 2.85% (33 cases). Based on the highest and lowest incidence of pneumonia, it is known that the areas with the highest number of cases have the highest population density compared to other areas as well as the lowest number of cases. The population density is also known to be low, with 323,106 residents for Bangka Regency and 128,157 for East Belitung Regency, 10% of which are children under five years of age. A study by (Sari et al., 2023) that examined the risk factors of pneumonia in terms of population density and rainfall through mapping produced data that the highest pneumonia occurred in areas with high population density. In a study by (Husna et al., 2022) mentioned that the incidence of pneumonia had a relationship with population density (p-value = 0.003). So, it can be concluded that high cases of pneumonia among under-fives were found in areas with high population density, namely Bangka District with 561 cases out of 32,311 people under the age of five.

PCV Immunization (Pneumococcal Conjugate Vaccine)

Based on the mapping, it is known that all data on the coverage of under-fives have received 3 doses of PCV immunization. The lowest PCV immunization status coverage (19.2%) was in areas with high pneumonia

rates, namely Bangka District, while the highest coverage (46.4%) was in areas with low pneumonia rates. As is known, PCV immunization is a new type of vaccine that entered Indonesia in 2017 with West Lombok and East Lombok districts as the first areas to get this vaccine and began to enter Bangka Belitung in 2018-2020 for distribution to all districts / cities which functions to prevent pneumococcal bacterial infections. This immunization is carried out in 3 stages, namely, ages 2, 3 and 12 months. Because of the uneven distribution and relatively new, it is possible that not many people know about this vaccine. As in a study by (Saputri et al., 2020) 71.6% of the total respondents had never heard of this immunization. Based on the results, it can be concluded that high pneumonia rates occur in areas with low PCV immunization coverage, namely Bangka Regency with a PCV immunization coverage of 19.2% with a total of 561 cases until June 2023. This could be due to the vaccine being relatively new and unfamiliar among the community, especially parents of infants and toddlers. This variable also has a relationship with the previous variable, namely population density, where the same area has high cases occurring with high population density and low immunization coverage.

Age of Toddler

Toddlers aged 1 - < 5 years (75.8%) experienced more pneumonia than toddlers aged < 1 year (24.2%). Another supporting research by (Rigustia, 2019) stated that 7 out of 30 cases occurred in toddlers aged < 12 months, and the rest occurred in the age group of 12 - 48 months. However, this study contradicts (Dwi Rahayu et al., 2014), whose research results stated that children aged 0-12 months experienced more pneumonia, namely 62 cases compared to children aged 1-5 years, namely 24 cases, so it was concluded that toddlers aged 1 - < 5 years experienced more pneumonia. In a simple analysis, this can happen because children aged 1 - < 5 years have entered school age and can be more active outside with less supervision from parents, making it easier to be exposed to factors that cause pneumonia.

Gender

Male toddlers had more pneumonia with a total of 585 people (50.6%), while female toddlers had 572 people (49.4%). Similar results to research (Firdaus et al., 2021) male toddlers had more pneumonia. This is due to differences in hormonal factors, activeness and immunological responses between women and men, and the narrower respiratory tract of men. Research by (Sangadji et al., 2022) stated that there was a significant relationship between gender and the incidence of pneumonia in toddlers. Several studies have shown that some respiratory diseases are influenced by physical differences in the anatomy of the respiratory tract of boys and girls. In general, boys' respiratory tracts are smaller than girls', which may increase the frequency of respiratory diseases. The study is not in line with (Afriani et al., 2021) which states that the frequency of pneumonia is more prevalent in women, with a total of 44 cases (59.5%) while in men there were 30 cases (40.5%). Based on the results, it was concluded that male toddlers experienced more pneumonia. One of the factors that can influence this is that the male under-five population is larger than the female population. According to data from the Central Bureau of Statistics, the number of male toddlers in Bangka Belitung was 78,971.

Relationship between age and under-five pneumonia

The results of this study using bivariate analysis of the Chi-Square test showed a p-value of 0.255, which means that there is no association between the age of toddlers and the incidence of pneumonia in Bangka Belitung Province during January-June 2023. Toddlers aged 1 - < 5 years had a 1.704 times risk of pneumonia compared to toddlers aged < 1 year (OR = 1.704; 95% CI: 0.673 - 4.314).

However, this study contradicts (Firdaus et al., 2021) where the bivariate results showed a p-value of 0.033, which means that pneumonia has a relationship with age. (Firdaus et al., 2021) believe that age affects the body's immunity and toddlers are still in the process of growth and development. The immune response in toddlers tends to be less reactive characterized by a lack of systemic response. (Wahyuni et al., 2020).

According to the researchers, age is not the only risk factor for pneumonia in toddlers. Because anyone can get pneumonia, especially the elderly aged > 65 years who are as vulnerable as toddlers with decreased immunity.

Relationship between Gender and Under-5 Pneumonia

Bivariate results with the Chi-Square test obtained a p-value of 0.960 ($p > 0.05$). Therefore, it was concluded that there was no significant relationship between gender and the incidence of pneumonia among under-fives in Bangka Belitung during January-June 2023. Male toddlers had 1.023 times the risk of developing pneumonia compared to female toddlers (OR = 1.023; 95% CI: 0.423 - 2.477). The results of this study were supported by research from (Firdaus et al., 2021) which showed that, the results of bivariate analysis with a p-value of 0.532 ($p > 0.05$) which means there is no association between gender and the degree of pneumonia.

(Sangadji et al., 2022) stated that there was a significant relationship between gender and the incidence of pneumonia in toddlers (p-value 0.027). Different parenting patterns between women and men are due to the fact that most parents believe that male toddlers are physically stronger and the majority of parents smoke. Based on the results, it was concluded that the gender variable had no association with the incidence of pneumonia. The reason that could be one of the factors is that there is gender equality that makes parents consider boys and girls as equally important, no one is preferred considering the immunity of male toddlers is stronger than female toddlers.

CONCLUSIONS

From the results and discussion, it can be concluded that the highest number of pneumonia cases among children under five in Bangka Belitung from January to June 2023, symbolized in red, occurred in Bangka Regency with 561 cases and the lowest number of cases, symbolized in white, occurred in East Belitung Regency with 33 cases. The Incidence Rate of pneumonia cases among children under five years of age in Bangka Belitung Province from

January to June 2023 was 784.8 cases per 100,000 children under five. The CFR and UFR were 0. With the highest number of cases in the male gender (585) and female gender (572), while pneumonia in the age group of children under 1 year old (280) and children under 1 - < 5 years old (877). The highest immunization coverage (46.4%) was in low pneumonia areas and the lowest immunization coverage (19.2%) was in high pneumonia areas. Based on the results of the bivariate analysis, it was concluded that there was no association between age (p-value 0.255; OR 1.704) and gender (p-value 0.960; OR 1.023) with the incidence of pneumonia among under-fives in Bangka Belitung Province during January-June 2023. 4 deaths were recorded in 2020 and 2021, while no deaths were recorded in 2023. Even so, it is expected that prevention and control will continue to be carried out to reduce the number of cases that rose in 2022.

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