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Determinants of Pneumonia Status in Under-Five Children in Indonesia

Intan Putri Ananda[1*], Budyanra[1]

[1]Polytechnic Statistics of STIS, Jakarta

ABSTRACT

Background: Pneumonia is a communicable disease that causes the largest under-five children death in the world. Meanwhile, Indonesia contributed 19.000 cases of under-five deaths due to pneumonia in 2018. Pneumonia can inhibit the growth and development in under-five children, cause decreased lung function or even lead to death. The pneumonia symptoms is less specific and almost the same as the flu or a common cough, makes this disease difficult to detect and difficult to treat optimally. This study was aimed to determine variables that affect the pneumonia in under-five children in Indonesia in 2018.
Methods: This study used descriptive analysis and multilevel binary logistic regression. It used secondary data from the Riskesdas 2018, publication of Profil Kesehatan Indonesia 2018, and official website of Badan Pusat Statistik
Result: The results indicated that in 2018, there were about 6.4 percent of under-five children who experienced pneumonia. The age of under-five children, gender, nutritional status, maternal education level, type of residence, house's ventilation, and poverty rate per province significantly affected the status of pneumonia in under-five children in Indonesia.
Conclusion : This study was expected to be able to increase public awareness about pneumonia in under-five children and can prevent under-five deaths due to pneumonia. Further research can use more up-to-date primary data and can also focus on provinces that have high rates of pneumonia in under-five children.

Keywords: Pneumonia; under-five children; multilevel binary logistic regression.

Corresponding author, 211709754@stis.ac.id

Introduction

Under-five period is crucial in the process of growth and development of a child. At this time, children are vulnerable to nutritional and health problems, including communicable diseases because of their immature immune system.[1] This vulnerability requires under-five children to get proper protection and care so they are not exposed to diseases that can inhibit their growth and development or even cause death.

The health condition of under-five children in Indonesia still needs more attention. Based on the results of the 2017 Indonesian Demographic and Health Survey (IDHS), the under-five mortality rate (Angka Kematian Balita/AKBa) in Indonesia reached 32 per 1,000 live births[2]. It is realized that still far from the target of the Sustainable Development Goals (SDGs) to reduce under-five mortality to at least as low as 25 per 1,000 live births by 2030. Therefore, one of the efforts that can be done to reduce AKBa in Indonesia is to prevent under-five deaths due to communicable disease. There are several types of communicable diseases that can inhibit growth and development in under-five children, and one of them is pneumonia. This statement is supported by the fact that pneumonia is included as one of the specific goals listed in The integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD). The specific goal is to reduce the under-five mortality rate due to pneumonia to less than 3 per 1,000 live births by 2025.[3]

Pneumonia is an acute respiratory infection in the lung (alveoli) caused by various microorganisms such as viruses, fungi, and bacteria.[4] In people with pneumonia, the alveoli fill with pus and fluid that restricts breathing, making breathing more difficult and painful. Pneumonia can cause a long-term decrease in the function of lungs of under-five children or even lead to death.[5] UNICEF found that pneumonia is responsible for more than 800 thousand deaths of under-five children every year in the world.[6] The pneumonia symptoms is less specific and almost the same as the flu or a common cough, makes this disease difficult to detect and difficult to treat optimally.

Similar to the high number of under-five deaths due to pneumonia in the world, Indonesia is also experiencing this. In 2018, UNICEF released 15 countries with the highest estimated number of under-five deaths due to pneumonia in the world, where Indonesia was ranked 6th with 19,000 cases of under-five deaths.[6] On the other hand, China ranks 7th with 18,000 under-five deaths. Given that China's population is five times larger than Indonesia's, it indicates that Indonesia is still having problems in handling cases of pneumonia in under-five children, causing the death due to this disease to be quite high. Based on the publication of Riskesdas 2013 and Riskesdas 2018 by the Indonesian Ministry of Health, it can be seen that the prevalence of pneumonia by age group in 2013 and 2018 showed a similar pattern.[7,8] The prevalence of pneumonia in the age group less than 1 year and the age group 1-4 years actually increased, while the others decreased. With the increase in the prevalence of pneumonia in under-five children in the past 5 years, pneumonia in under-five children needs serious attention and treatment in order to be able to overcome the health problems and prevent under-five deaths due to pneumonia.

Pneumonia has been around for a long time, prompting some experts to research it. Anwar and Dharmayanti (2014) conducted a study on factors related to the incidence of pneumonia in under-five children in Indonesia, which showed that the gender, type of residence, mother's education, ownership index quintile, kitchen location, presence/habit of opening room windows, and ventilation bedroom is the most important factor in the incidence of pneumonia in under-five children.[9] Meanwhile, Machmud's (2009) research used a multilevel analysis, namely the individual level, household level, and district/city level for pneumonia under-five, which found that poverty was the cause of the high risk of pneumonia ini under-five children at the household level.[10] Machmud (2009) also explained that structured poverty is the root of a person's inability to have a higher education, get a better home environment, better access to knowledge, all of which actually increase the risk of pneumonia in under-five children.[10] In

line with this, the research conducted by Luthfiyana et al. (2018) found contextual effects such as rural poverty conditions related to the incidence of under-five pneumonia[11]. In addition, Hartati's research (2011) showed that children under five who live at home with family members who have smoking habits are at greater risk of developing pneumonia. compared to children under five who do not live at home with family members who have a smoking habit, after controlling for variables of age, breast milk (ASI), and nutritional status.[12]

Based on the description of the background above, this study aims to obtain an overview of the pneumonia status in under-five children and analyze the variables that affect the pneumonia status in under-five children in Indonesia in 2018. Regarding the problem of pneumonia in under-five children, there is an interaction between under-five children and their community. Hence, this study proposes a new approach by employing multilevel binary logistic regression to capture the impact of explanatory variables at the individual and regional level on under-five pneumonia status.

Methods

The study used a modified framework from the triangle of epidemiology and H.L. Blum theory to analyze determinants of pneumonia in under-five children in Indonesia.[13,14] The determinants was from several factors, such as host, life style, environment, and medical care services factors. The determinants of host factors such as age, gender, and nutritional status of under-five children. Meanwhile, the life style factor was represented by presence of household members smoking in house. The environment factor consisted of maternal education, type of residence, house's ventilation, and poverty rate per province. Medical care services factor was represented by the ratio of standard Puskesmas per 100,000 population per province. This framework also distinguishes between individual and regional level determinants.

This study was a cross-sectional study to find determinants of pneumonia status in under-five children. The unit of analysis in this study was children aged 0 to 59 months in 34 provinces throughout Indonesia in 2018, while the number of samples in this study was 87,241 under-five children. Riset Kesehatan Dasar (Riskesdas) 2018, Profil Kesehatan Indonesia 2018, and official website of Badan Pusat Statistik were used for this study. Riskesdas 2018 was research that collects basic data and health indicators that represent national, provincial, and district/city areas with a cross sectional and descriptive design, conducted every 5 years. It was carried out in 34 provinces in Indonesia with target sample of 300,000 households from 30,000 census blocks (*Blok Sensus*/BS) using the PPS (probability proportional to size) method using linear systematic sampling, with Two Stage Sampling.

All statistical analyses were performed using STATA 15 and SPSS program. The descriptive analysis was presented by tables and thematic maps. Meanwhile, inferential analysis used multilevel binary logistic regression with a random intercept model. The use of a multilevel binary logistic regression model in this study is based on the a hierarchical structure data and response variables consisting of two categories (binary). The multilevel model with random intercept was chosen because this study was assumed that the effect of each explanatory variable on the response variable was the same for each region. The stages of analysis in multilevel binary logistic regression are :

1. Testing the significance of random effect.
2. Calculating the Intraclass Correlation Coefficient (ICC).
3. Parameter estimation using Maximum Likelihood Estimator (MLE) method.
4. Testing for the significance of the perameter simultaneously.
5. Testing for the significance of the perameter partially.
6. Calculating and interpreting the odds ratio.

Result

Descriptive analysis

There were 6.4% under-five children who experienced pneumonia. It meant that of 100 under-five children in Indonesia, about 6 to 7 of them had pneumonia. If it was reviewed based on the province of origin of under-five children, the percentage of pneumonia status in under-five children varied in each region as shown in Figure 2. The province with the highest percentage of pneumonia status in under-five children in Indonesia was East Nusa Tenggara which was recorded at 12.51%. Meanwhile, the province with the lowest percentage of pneumonia status in under-five children in Indonesia was Jambi, which was recorded at only 3.29%.

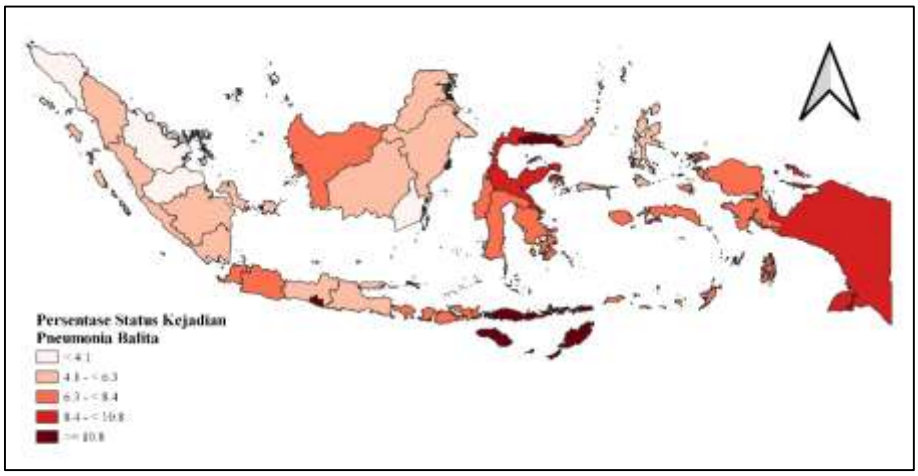

Figure 1. The percentage of the pneumonia status in under-five children in each region in Indonesia of 2018

Furthermore, the overview of the pneumonia status in under-five children based on individual explanatory variables is presented in Table 1.

Based on Table 1, it can be seen that under-five children who experienced pneumonia in 2018 were found to be the most in children with characteristics: aged 0-24 months, male, poor nutrition, mothers with less than senior high school education, living in rural areas and having inadequate ventilation in house.

The pneumonia status in under-five children is presumed to be influenced not only by individual characteristics but also by the characteristics of group where the under-five children lived, in this case, the province. The poverty rate and the ratio of standard puskesmas per 100,000 population per province are used as contextual variables in this study.

Table 1. Percentage of pneumonia status in under-five children based on the categories of individual variables.

Variables	Pneumonia status	
	Yes (%)	No (%)
Age		
25-59 months	6.3	93.7
0-24 months	6.6	93.4
Gender		
Female	6.2	93.8
Male	6.7	93.3
Nutritional status		
Good	6.3	93.7
Poor	7.5	92.5
Household members smoking in house		
No	6.4	93.6
Yes	6.4	93.6
Maternal education		
≥ senior high school	5.6	94.4
< senior high school	7.2	92.8
Type of residence		
Urban	6.3	93.7
Rural	6.6	93.4
House's ventilation		
Adequate	5.4	94.6
Inadequate	6.9	93.1

The highest poverty rate in Indonesia is in Papua Province. In Papua, 27.74 percent of

population have expenses below the poverty line. This value is very different from the proverty rate in DKI Jakarta, where only 3.57 percent of population are below the poverty line.

The province with the smallest ratio of standard puskesmas per 100,000 population was Papua with a score of 0.44 units. This means that 1 unit of standard puskesmas in Papua is intended to serve about 250,000 population. This figure is very small compared to the ratio of standard puskesmas in Gorontalo, which is the highest ratio of standard puskesmas in Indonesia, namely 6.35 units per 100,000 population.

Inferential Analysis

The influence of the individual variables and the contextual variables were analyzed through multilevel binary logistic regression. The first stage of the multilevel binary logistic regression analysis is testing for the significance of the random effect. Based on the output of STATA 15, the LR test statistics value is 449.11. this value is greater than $\chi^2_{(0,05;1)} = 3.84$, it shows that with a 95 percent confidence level, there is a variation among provinces. It means the two-level (multilevel) binary logistic regression model is more suitable than the one-level binary logistic regression model with the data. Meanwhile, the resulting ICC value is 0.0318. it meand that 3.18 percent of the diversity In the pneumonia status in under-five children in Indonesia is caused by differenced in provincial characteristics.

Furthermore, testing for parameter significance is carried out to check whether the explanatory variables simultaneously significantly influence the pneumonia status in under-five children. The ratio of the likelihood value of the model without explanatory variables and the model with explanatory variables gives the value of $G = 186.9 > \chi^2_{(0,05;9)} = 16.9$. It can be said that with a 95 percent confidence level, there is at least one explanatory variable that significantly influances the pnuemonia status in under-five children.

Testing for the significance of the variables simultaneously is then followed by a partial test to identify which explanatory variables significantly influence the pneumonia status in under-five children. The Wald test statistical value is calculated. If the $|W| > Z_{0,05/2} = 1.96$ then the corresponding explanatory variable significantly influences the pneumonia status in under-five children. The Wald test results are shown in Table 2.

Table 2. Results of parameter estimation and partial test

Explanatory Variables	Estimate	Standard error	Wald	p-value	Odds Ratio
Constant	-3,3580	0.1629	-20,61	0.000*	0.035
Individual Level					
Age					
25-59 months (*ref*)					
0-24 months	0,0747	0.0284	2,63	0.009*	1.078
Gender					
Female (*ref*)					
Male	0,1263	0.0282	4,48	0.000*	1.135
Nutritional status					
Good (*ref*)					
Poor	0,2029	0.0384	5,28	0.000*	1.225
Presence of household members smoking in house					
No (*ref*)					
Yes	-0,0382	0.0293	-1,30	0.192	0.963
Maternal education					
≥ senior high school (*ref*)					
< senior high school	0,2199	0.0306	7,20	0.000*	1.246
Type of residence					
Urban (*ref*)					
Rural	0,0756	0.0322	2,35	0.019*	1.079
House ventilation	0,1863		6,09	0.000*	1.205

Adequate (*ref*)					
Inadequate		0.0306			
Contextual Level					
Poverty rate (per province)	0,0213	0.0092	2,32	0.020*	1.022
Ratio of standard Puskesmas per 100.000 population (per province)	0,0057	0.0410	0,14	0.889	1.006

Note : *) significant at $\alpha = 0.05$; (*ref*) reference category

Based on Table 2, it is found that age, gender, nutritional status, maternal education, type of residence, house ventilation, and poverty rate significantly influence the pneumonia status in under-five children in Indonesia in 2018. The multilevel binary logistic regression model that is formed based on parameter estimates in Table 2 is as follows:

$$\ln\left[\frac{\widehat{\pi_{ij}}}{1-\widehat{\pi_{ij}}}\right] = -3.3580 + 0.0747\ Age_{ij}^{*} + 0.1263\ Gender_{ij}^{*} + 0.2029\ Nutrition_{ij}^{*} - 0.0382\ Smoke_{ij} + 0.2199\ Education_{ij}^{*} + 0.0756\ Residence_{ij}^{*} + 0.1863\ Ventilation_{ij}^{*} + 0.0213\ Poverty_{j}^{*} + 0.0057\ Puskesmas_{j} + \widehat{u_{0j}}$$

Note: *) significant at $\alpha = 0{,}05$

$\widehat{u_{0j}}$ refers to random effect.

Discussion

Based on the partial test, age significantly influences the pneumonia status in under-five children. Children aged 0-24 months tend to experienced pneumonia 1.078 times than children aged 25-59 months. Children aged 0-24 months are more susceptible to pneumonia than those aged over 2 years, which is caused by the immune system in younger children is not perfect yet and the respiratory tract is relatively narrow.[12]

The gender of under-five children has a significant effect on the pneumonia status in under five children in Indonesia with a regression coefficient of 0.1263 and odds ratio of 1.135. This means that boys have a greater tendency to experience pneumonia, which is 1.135 times compared to girls. This finding is in accordance with research conducted by Rasyid (2013) and Anwar and Darmayanti (2014)[9,15]. There are differences in body resistance in boys and girls, as well as differences in the diameter of the respiratory tract, where boys have a smaller diameter than girls, making it possible that boys are more at risk of experiencing pneumonia[16].

Under-five children with poor nutrition have a tendency of 1.225 times greater to experience pneumonia than good nutrition children. The results obtained in this study are not different from other studies, such as research by Hartati et al. (2012) who also concluded that under-fives with less nutrition tend to have pneumonia up to 6.52 times greater than under-fives with good nutritional status[17]. Malnutrition, especially in under-five children, results in a decrease in the body's immune system, thus enabling children with poor nutrition to be more at risk of various diseases, including pneumonia.

Mothers with high education tend to have higher knowledge, understanding, and awareness, especially regarding health problems and disease prevention, so that high maternal education will be in line with optimal care for their toddlers to avoid pneumonia. The results obtained in this study are also generally not different from other studies. The odds ratio value for the maternal education level variable is 1.246. This means that under-five children from mothers with less than high school education have a 1.246 times greater tendency to experience pneumonia than under-five children from mothers with high school education and above. Low maternal education can lead to errors in applying the information obtained regarding child care, which in turn can endanger the health of under-five children in the long term[18]. The higher the education of the mother, the better her knowledge of normal development in toddlers. On the other hand, if the mother's education is low, it is almost certain that the mother's knowledge about the development of under-five children is also minimal, making it possible for under-five children not to get

optimal care and are susceptible to pneumonia[19].

Type of residence significantly influences the pneumonia status in under-five children. There is 1.079 times greater tendency for under-five children who live in rural areas to experience pneumonia compared to under-five children who live in urban areas. This finding is in accordance with the statement of Anwar and Dharmayanti (2014) that the area where under-five children live is closely related to housing conditions, residential density, and the use of fuel which is generally different in rural and urban residents, which can increase the risk of health problems in under-five children(9). In addition, health workers and health facilities in rural areas which are generally inadequate are also the reasons for the increased risk of under-five children experiencing health problems. Dense housing, houses without ceilings, with unsafe floors and walls, the use of unsafe cooking fuels, and inadequate health facilities commonly found in rural communities, make it possible for under-five children living in rural areas to be more at risk of experiencing pneumonia.

Ventilation has an important role in ensuring the quality and adequacy of air circulation in the room of the house, so that it will provide an adequate supply of fresh air that can prevent the risk of developing diseases in under-five children. The results obtained in this study are also not different from other studies. The odds ratio value listed in Table 2 for the house's ventilation variable is 1.205. This means that under-five children who live in houses with inadequate ventilation have a greater tendency, namely 1,205 times to experience pneumonia than children who live in houses with adequate ventilation. This is in line with the research of Anwar and Dharmayanti (2014) and Jayanti et al. (2018)[9,20]. The insufficient supply of fresh air due to inadequate ventilation in the house can interfere the physiological function of the respiratory organs of the household members[12]. Therefore, a house with inadequate ventilation allows its occupants to be more at risk of experiencing pneumonia.

Then, for the poverty rate, every one percent increase in the poverty rate in a province will increase the tendency of under-five children to experience pneumonia by 1.022 times. Based on this finding, it can be proven that the economic conditions in the environment around the under-five children's residence also play a role in increasing the tendency to have pneumonia. The poverty condition of an area causes the community to be unable to meet nutritional needs, have houses with proper sanitation, access health facilities, and have an impact on unhealthy environmental conditions. In addition, the lack of prevention efforts against the occurrence of a disease in the community can increase the risk of complex health problems, including pneumonia in under-five children[11]. Living in environment where the majority of people are poor can also cause psychosocial stress, which can lead to negative behavior, as well as a negative impact on the health of the surrounding community, such as smoking behavior[21,22].

Conclusions

Based on the results of this study, it can be concluded that there were about 6.4 percent of under-five children in Indonesia in 2018 experienced pneumonia and the highest percentage of under-five children experiencing pneumonia is in East Nusa Tenggara. The pneumonia status in under-five children in Indonesia in 2018 is influenced by the age, gender, nutritional status, maternal education, type of residence, and house ventilation as individual variables. While the poverty rate per province significantly affects the pneumonia status in under-five children as a contextual variable.

Therefore, the government through relevant agencies is expected to conduct socialization and education about pneumonia in under-five children to public, especially for households with under-five children. It aims to increase public awareness about pneumonia in under-five children and can prevent under-five deaths due to pneumonia. On the other hand, considering the vulnerability of children aged 0 to 24 months and having poor nutritional status to be exposed to pneumonia, parents should be

more optimal in monitoring the conditions and nutritional intake of under-five children regularly. Parents should also pay attention to the ventilation conditions in house.

Further research can use more up-to-date primary data through independent surveys and can also focus on provinces that have high rates of pneumonia in under-five children, such as the Province of East Nusa Tenggara.

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