

Multilevel Analysis on the Bio-psycho-social and Environment Factors Affecting the Risk of Pneumonia in Infants

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ABSTRACT

Background: Pneumonia is an illness of the main causes of pain and death in toddler in the world. The incidence of pneumonia in Indonesia has increased, from 2007 about 2.1% and in 2013 about 2.7%. Pneumonia in toddler in Indonesia is an issue that is important to do the actions of prevention and control of pneumonia. This study was aimed to investigate the factors bio-psycho-social to the risk of pneumonia in toddlers.

Subjects and Method: This was an analytical observational study with case control design, carried out on 2 August to 16 September 2016. A total of 140 subjects in Banjarnegara, Central Java, were selected by fixed disease sampling. The dependent was pneumonia in infants. The independent variables were exposure to CO, H₂S, family income, maternal education, household smoke exposure, sanitary home, chain-smoking family activity, anxiety. The data was collected by using a questionnaire, check list and recording and analyzed by using Logistic regression.

Results: There was influence of exposure of CO (OR= 1.46; 95% CI= 0.17 to 21; p= 0.970), H₂S (OR= 0.53; 95% CI= 0.98 to 2.92; p= 0.412), family income (OR= 1.90; 95% CI= 0.78 to 4.65; p= 0.365), maternal education (OR= 1.75; 95% CI= 0.72 to 4.25; p= 0.474), household smoke exposure (OR= 5.63; 95% CI= 2.27 to 13.95; p= 0.001), home sanitation (OR= 6.23; 95% CI= 2.61 to 14.84; p=0.001), smoking activity (OR= 3.19; 95% CI= 1.33 to 7.66; p= 0.020) and the incidence of pneumonia toddlers. There was the influence of anxiety to pneumonia in toddler (OR= 16; 96% CI= 6.87 to 37.75; p< 0.001). There was the influence of contextual conditions to pneumonia in toddler (ICC = 36.97%; role of thumb 5 to 8% likelihood ratio p= 0.008; 95% CI= 0.45 to 8.17).

Conclusion: There is the influence of exposure to CO, H₂S, family income, maternal education, household smoke exposure, home sanitation, smoking activity. There is the influence of anxiety of pneumonia in toddler. The condition has influence contextual variations toddler pneumonia incident, so it is noteworthy.

Keywords: bio-psycho-social, environmental factor, pneumonia toddlers

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BACKGROUND

Early childhood stage is a period of growth and development that should be concerned. In this stage the growth is slowing down, whereas development of gross motor and fine motor is increasing (Depkes, 2006). Early childhood age group is sensitive to nutrition needs and diseases. WHO (2010) explain that pneumonia is an infectious disease that becomes one of the leading causes of death worldwide. Pneumonia is a light

lung infection (alveoli) that is caused by fungi, virus, bacteria, chemical exposure, and indirect influence from other diseases, therefore pneumonia is included as acute disease (Kemenkes RI, 2011).

Annually pneumonia accounts for 1.6 million deaths or 14%, it becomes number 4 after measles 1%, AIDS 2% dan malaria 8% (WHO, 2010). Pneumonia is categorized as a serious threat for industrialized and developing countries. Countries that focus on

pneumonia incidents every year are India (43 million), China (21 million), Pakistan (10 million), and 6 million in Bangladesh, Indonesia dan Nigeria (WHO, 2008).

Pneumonia incidents was increasing in 2007 (2.1%) escalates to (2.7%) in 2013, it made the second place of the causes of death in Indonesia after diarrhea. Central Java has increasing number of pneumonia incidents in 2012 (24.74%) to 2013 (25.85 %). Banjarnegara regency is a regency with the most number of toddlers who suffer from pneumonia and keep on increasing, in 2013 there were 7,555 patients, 2014 there were 7,532 patients and it was treated 45.5 %; in 2015 there were 10,059 patients and 46.6% was treated.

Batur sub-district is one of sub-districts in Banjarnegara regency that lays in the highest region compared to other sub-districts that is in 2,065 masl. It has two Puskesmas (Community Health Center), those are Puskesmas Batur 1 and Puskesmas Batur 2 that possess high rate of pneumonia incidents in Banjarnegara Regency. Incident rate of pneumonia in 2014 was 349 toddlers and it was increasing in 2015 to 687 toddlers with pneumonia.

Environmental condition of Batur Sub-district consists of some regions that are exposed with various level of CO₂, SO₂, H₂S, and CO, some regions are high, others are low. Measuring effort to determine gas spots with high and low concentration had been conducted by Geological Agency-Center for Volcanology and Geological Hazard Mitigation, which aimed to give information toward the condition of surrounding society (Supriyati, 2007).

Poor environmental condition and house arrangement such as insufficient lighting (including ultraviolet light), insufficient ventilation, humid rooms, overly dense rooms, and exposure of household smoke inside the house such as the usage of fire

wood for cooking in kitchen is one of the causes of pneumonia incidents on toddlers (Ezzati dan Kammen, 2001).

Health behavioral factor is at risk to contagious diseases, such as clean and healthy behavior in Banjarnegara Regency is still low especially in Puskesmas Batur 1 the number of participants who carry out CHB is only 48.5%. John Bordon elaborates epidemiology triangle (*host, agent dan environment*), which are connected to pneumonia such as low birth weight history, insufficient breastfeeding, immunization status, home sanitation, air pollution both inside and outside the house also Vitamin A deficiency (Hananto, 2004 dan Rudan, 2008).

Prevention effort in eliminating pneumonia on toddlers has been carried out by Indonesian government through immunization (*Difteri Pertusis Tetanus* and *campak*) and non immunization (Exclusive breastfeeding, good nutrition intake, environment improvement, clean and healthy behavior as well as avoiding the exposure of smoke from cigarette and kitchen (Misnadiarly, 2008).

Based on the description above it may be concluded that pneumonia on toddlers in Indonesia is an important issue to be resolved by controlling it from various factors also considering micro and macro levels, which determine the condition of patients' surrounding environment. HL Bloom elaborates that health is affected by healthcare service, individual, life style and environment.

The purpose of the study was analyzing the effect of CO₂, SO₂, CO and H₂S exposure, household smoke exposure, home sanitation, family income, maternal education and family smoking activity toward the risk to pneumonia incidents on toddlers with multilevel analysis approach

SUBJECTS AND METHOD

The study was an observational analytic with case control design. The study was conducted in Batur Sub-district, Banjarnegara Regency on 1 August 2016 to 14 September 2016. The independent variables were Co, H₂S, family income, maternal education, household smoke exposure, home sanitation, smoking activity, and toddlers' anxiety. The dependent variable was toddlers' pneumonia. The targeted research population was toddlers in Banjarnegara Regency region. Source population (accessible population) of the study was toddlers in Batur sub-district Banjarnegara Regency.

A total sample of 140 toddlers aged 2 month to <5 years old were selected by

Table 1. Characteristics of research subjects

Characteristics	Criteria	Frequency	Percentage (%)
Toddlers' age	2 months - < 5 years	140	100
Mothers' age	< 20 years	13	9.28
	20 – 35 years	125	89.28
	> 35 years	2	1.44
Education	Primary Level	85	60.72
	Secondary Level	55	39.28
Occupation	Farm laborer	33	23.58
	Farmer	3	2.14
	Self employed/ merchant	2	1.42
	Factory/ Industrial Laborer	27	19.29
	Unemployed	75	53.57

The comparison between pneumonia and non pneumonia study subjects was balance that is 50%:50%. Most study subjects are not exposed to CO₂ (ppm) there were 140 study subjects (100%), there were 140 study subjects (100%) who were not exposed to SO₂ (ppm), there were 125 study subjects (89.3%) exposed to low CO (0.1-50 ppm), there were 116 study subjects (82.9%), exposed to low H₂S (0.1-20 ppm).

There were 77 study subjects (55%) exposed to household smoke, there were 73 study subjects (52.1%) owned good home sanitation, there were 80 study subjects (57.1%) whose family income was less than

fixed disease sampling with comparison of 1:1 between group with disease (case) and without disease (control). Data collection techniques used were questionnaires, checklist, and medical record. The data were analyzed by using Logistic Regression Analysis with Multilevel approach using Stata 13 program.

RESULTS

1. Characteristics of Study Subjects

The result of research subjects characteristics in table 1 shows that 140 research subjects possess various distributions. Research variable descriptions are elaborated based on characteristics, criteria, frequency, and percentage

Regional Minimum Wage (Rp. 1.265.000) there were 75 study subjects (53.6%) unemployed, there were 85 study subjects (60.7%) had primary level education background (low), there were 89 research subjects (63.6%) who had smoking family members and most of the toddlers, that were 79 study subjects (56.4%) were anxious when they got pneumonia.

2. Bivariate Analysis

Research variables were toddler pneumonia CO₂ exposure, SO₂ exposure, H₂S exposure, CO exposure, household smoke exposure, home sanitation, family income, maternal education, family smoking activity and

toddlers' anxiety level were analyzed by Chi Square.

Table 2. Bivariate analysis result

Independent Variables	OR	p	CI 95%	
			Upper Limit	Lower Limit
CO Exposure	1.16	0.785	0.39	3.39
H ₂ S Exposure	1.00	1.00	0.41	2.40
Household Smoke Exposure	3.98	<0.001	1.96	8.07
Home Sanitation	4.47	<0.001	2.19	9.10
Family Income	3.33	0.001	1.65	6.72
Maternal Education	1.94	0.057	0.97	3.87
Smoking Activity	2.57	0.008	1.26	5.25

3. Logistic Regression Multivariate Analysis with Multilevel Approach

Table 3. The result of logistic regression analysis with multilevel approach of biopsychosocial and environmental factors toward the risk of pneumonia incidents on toddlers

Independent Variables	OR	CI(95%)		p
		Lower Limit	Upper Limit	
Fixed Effect				
CO Exposure	1.46	0.17	12.13	0.970
H ₂ S Exposure	0.53	0.98	2.92	0.412
Household smoke exposure inside the house	5.63	2.27	13.95	<0.001
Home sanitation	6.23	2.61	14.84	<0.001
Family Income	1.90	0.78	4.65	0.365
Maternal Education	1.75	0.72	4.25	0.474
Family smoking activity	3.19	1.33	7.66	0.020
Random Effect				
Neighborhood area				
Var (constant)	1.92	0.45	8.17	
Conformity of ICC (<i>Intraclass Correlation</i>)				
Model	36.97%			
Likelihood Ratio Test p = 0.008				

The influence in multivariate manner elaborates the effect of bio- psychological and environmental factors to pneumonia incidents on toddlers

Table 3 shows that ICC= 36.97%, the indicator shows that the area condition of each neighborhood has contextual influence toward the variation of toddlers pneumonia occurrence as much as 36.97%. The figure is bigger than the standard figure of *role of thumb* which is by 5-8%, therefore the contextual influence of neighborhood area condition presented by multilevel analysis is important to concern about. The

table shows the *likelihood ratio*= 0.008 that means there is statistically significant difference between model that does not consider contextual influence and model that consider contextual influence, in this term is the area condition of each neighborhood.

DISCUSSION

1. The Influence of CO and H₂S Exposure toward Pneumonia Incidents on Toddlers

The study result showed that toddlers who lived in environment that is exposed to CO

and H₂S were likely to have bigger risk to catch pneumonia compared to toddlers who lived in environment that was not exposed to CO and H₂S. The CO₂ and SO₂ exposure resulted in there was no exposure at all in the toddlers residential. It indicated that there was no H₂S effect, however there was effect of CO exposure to toddler pneumonia incident and it was not significant.

It is in accordance with Soemirat (2015) statement, which elaborate that poor home condition may disturb body health, as the result of insufficient oxygen within the air, whereas carbon dioxide is increasing.

Factors that may increase the risk of pneumonia were such as toddlers' characteristics, home condition, the source of air pollution inside and outside as well as residential density. Toxic gas such as carbon-monooxide (CO) may cause asphyxia effect in which bind hemoglobin (COHb) that generates the disruption of oxygen stream inside body, since there is too much carbon dioxide.

The exposure of CO₂, SO₂, CO dan H₂S around the house was below normal limit with safe distance was at about 1000 meter from crater, even CO₂ and SO₂ did not spread around people housing, only around the crater as the process of natural phenomenon. Whereas CO and H₂S were also categorized as below normal so that it did not rapidly affect health. CO₂, SO₂, CO and H₂S do not spread too highly since CO₂, SO₂, CO and H₂S will be decomposed by sunlight therefore they do not give any effect to health (Surip, 2016). Timbang Crater is one of the Craters in Dieng that has high concentration of CO₂ exposure as much as 1.8% volume or 18,000 ppm, H₂S concentration is as much as 0.6 ppm dan SO₂ is as much as 0.2 ppm.

Based on that matters it can be concluded that there was an effect of CO₂ and H₂S exposure to pneumonia incidents on

toddlers. Therefore the result of the study is in accordance with the previous study and the existing theory.

2. The Influence of Household Smoke Exposure inside the House toward Pneumonia Incident on Toddlers

Study result showed that toddlers who lived in a house that was exposed by household smoke were likely to have five times bigger risk to pneumonia compared to toddlers who lived in a house that was not exposed to household smoke inside the house. The smoke might come from the use of fire wood for cooking.

The study result is in accordance with the study made in Birmingham (England) which states that the increasing risk to pneumonia may come from the exposure of fuel burning smoke, and there are some evidences that the use of stove may reduce smoke exposure. The study made by Maskey *et al.*, (2012) in Nepal states that around 87% of households used solid biomass as the main source of fuel, and as many as 1,284 caught acute respiratory tract infection and pneumonia.

The study by Pribadi (2008) conveys houses that use firewood to cook have OR value 6.8 times in increasing the risk of pneumonia incidents on toddlers. According to Depkes (2012), indoor air pollution such as the use of mosquito coil, cooking fuel, and the existence of smoker may increase the risk to pneumonia incidents on toddlers.

Batur sub-district is a region with low temperature and the average Dieng family usually using stove and firewood for cooking, besides they also have habit of using charcoal hearth to warm house temperature, that is usually done at night during family time. It obviously increases air exposure toward body condition especially for toddlers who are more vulnerable. Charcoal as well as firewood contains carbon mono-

xide, organic gas, particulate matter, and nitrite oxide, that may increase health disruption toward body, such as respiration problem.

There were seven questions to know the effect of smoke exposure inside house toward pneumonia incidents on toddlers, that get the higher score was number 6 about kitchen lighting, it fitted with most home sanitation condition that were categorized as unhealthy. Insufficient lighting in kitchen area generates the growth of germs. There were quite a lot who answered "yes" for the first question that was the absence of ventilation in the kitchen. It obviously increased the risk of respiration problems, since insufficient ventilation leads to disrupted air flow.

Based on that matter it can be concluded that there was the influence of household smoke to pneumonia incidents on toddlers. Thus, the result is in accordance to the previous study and the existing theory.

3. The Influence of Home Sanitation toward Pneumonia Incident on Toddlers

The result of the study shows that toddlers living in a house with poor home sanitation were likely to have risk six times bigger to catch pneumonia compared to toddlers living in a house with good sanitation. The study result was in accordance with a study by Pribadi (2008), that elaborates physical environment of a house which does not meet health requirements may support the occurrence of disease transmission and ailment such as pneumonia. Physical environment risk factors in the study have OR value 7.4 times in increasing the risk of pneumonia incidents on toddlers. Government has stipulated a regulation on housing health requirements that is Stipulation of Health Minister No. 829/MENKES/SK/VII/1999 about Housing Health Requirement

Based on the study by Azhar and Perwitasari (2013), condition of physical environment that does not meet the health requirement and the behavior of using fuel may increase the risk of diseases such as TB, cataract and pneumonia. In Indonesia housing proportion that meets the requirement of healthy house is still low, that is 24.9%.

Based on AHPHA (*American Public Health Association*) it suggests to use ventilation as the effort to reduce the emergence of indoor air pollution as well as outdoor. There were 13 statements to know the condition of people's home sanitation, the highest result is on statement no. 5 and 12 that show the occurrence of object which blocks air flow at the window and bedroom which is occupied by two or more people. The occurrence of objects that block air flow leads to the decreasing of oxygen level, increasing of carbon dioxide, musty smell, increasing room temperature, and generates the increasing humidity. the use of bedroom by more than two people increases the risk to catch pneumonia by 1.8 times bigger.

Based on the above elaboration it can be concluded that there was an influence of home sanitation to pneumonia incidents on toddlers. Therefore the result is in accordance with the previous study and the existing theory.

4. The Influence of Family Income toward Pneumonia Incidents on Toddlers

The result of the study shows that there was an influence and it was insignificant between family income and pneumonia incidents on toddlers. Toddlers who were living with family with low income were likely to have two times bigger risk compared to toddlers who were living with high income. The result of the study is in accordance with the study conducted by Becker et al.,

(2006) which concludes that social economy status is not related to pneumonia incidents. The study conducted by Kosai et al (2015) also states that there is a significant relationship between social economy status with the increasing risk of pneumonia on toddlers.

In this study most of the respondents were unemployed, meaning to say they were housewives, and some others were farm laborers and industrial laborers, therefore occupation and income were a whole unity to support buying power of a family. The requirements for a healthy house are not necessarily met by expensive price, for example to build a safe and comfortable house, cold brick wall can be substituted by wood and supported by the activity to clean the house and open the windows regularly.

Based on the above elaboration it can be concluded that there was an influence of family income to pneumonia incidents on toddlers. Therefore the result is in accordance with the previous study and the existing theory.

5. The Influence of Maternal Education toward Pneumonia Incidents on Toddlers

The result of the study shows that there was an influence and it was insignificant between maternal level of education with pneumonia incidents on toddlers. Toddlers whose mothers had primary or lower education background had 1.75 times bigger risk to suffer from pneumonia compared to toddlers whose mother had secondary or higher education background. The result of the study by Herman (2002) elaborates that education does not have any significant relationship with pneumonia incidents with the value of OR is 1.1.

Based on education background in Batur Sub district with the total number of research subjects was 140, 65 of them had high education, the rest had low education

background. It did not create extensive gap in term of education. One's knowledge is the result of education which is not obtained only from formal education, however non formal education may also improve society's knowledge. One's background may influence the attitude and behavior based on the knowledge they have.

Health education for the prevention of pneumonia on toddlers is one of the efforts to prevent pneumonia on toddlers. The nature of health education is an activity or effort to deliver health messages to society, groups and individuals to obtain better knowledge about health. Information obtained either from formal or non formal education may give immediate impact so that it results in knowledge change or improvement.

Based on the above elaboration it can be concluded that there was the influence of maternal education toward pneumonia incidents on toddlers. Therefore the result is in accordance with the previous study and the existing theory.

6. The Influence of Family Smoking Activity toward Pneumonia Incidents on Toddlers

The study result show that toddlers who live with smoking family members are likely to have three times bigger risk to catch pneumonia compared to toddlers who live with non smoking family member. Macro environment that may influence toddlers' health may get affected by disease or maternal behavior such as smoking as active smoker, so that toddlers may get exposed by smoke (smokers)

The result of the study is in accordance with the study in France and the study by Duta (2009) in India which gives strong evidence that one of the causes of indoor air pollution is cigarette smoke that contains ultrafine particle which cause acute respiratory tract infection on toddlers. Another

study that show the significant relationship between smoking and pneumonia on toddlers is a study by Gertudris (2012) with value of $p=0.03$ and OR value is 1.8.

Toxic and carcinogenic materials within cigarette smoke have the similar effect on both active and passive smokers. It generates irritation effect on respiratory tract for the content of sulfur dioxide, ammonia, and formaldehyde (Hidayat et al., 2012).

Based on the elaboration above then it can be concluded that there was the influence of family smoking activity to pneumonia incidents on toddlers. Therefore the result is in accordance with previous study and the existing theory.

7. The Influence of Pneumonia on Toddlers to Toddlers' Level of Anxiety

The result of the study shows that toddlers who suffer from pneumonia had high level of anxiety compared to toddlers who did not suffer from pneumonia. Toddlers with pneumonia were likely to have 16 times bigger risk to endure anxiety than toddlers without pneumonia. Agustinus (2015), states that whenever sort of breath, heart beats fast, dry mouth, and sweaty palm occur then it will lead to anxiety reaction.

Based on the above elaboration it can be concluded that there was the influence of pneumonia to toddlers' level of anxiety. Therefore it is in accordance with the previous study and theory.

8. The Influence of Neighborhood Condition toward Pneumonia Incidents on Toddlers

The result of multilevel analysis showed that ICC= 36.97%, the indicator showed that the area condition of each neighborhood had contextual influence toward the variation of pneumonia incidents on toddlers.

Gordon theory in the book Candra, (2007) shows the interaction between bac-

teria (*agent*), human (*host*) and environment, the environment outside the individual (*host*) play important role in the increasing of pneumonia on toddlers. Based on the findings in the field neighborhood area affected the incidents of pneumonia on toddlers, since the housing condition of each neighborhood was different, the distance between houses in some neighborhood was quite far, so that the air flow to each house was better than those with narrow space between houses and populated, in which the lighting was often blocked by other houses.

In addition, prevention toward diseases conducted by each neighborhood was different; in the neighborhood with high awareness toward health the people would affect the surrounding to be aware of health also. People who lived in the neighborhood with less awareness toward health were likely to get affected and unaware of their negative behavior.

It can be concluded that there were influences of CO₂, H₂S exposure, family income, maternal education, household smoke exposure, home sanitation, family smoking activity. There was influence of toddlers' pneumonia toward toddlers' anxiety. Condition of each neighborhood had contextual influence toward the variation of pneumonia incidents on toddlers, therefore it needs to be noticed.

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Journal of Epidemiology and Public Health (2016), 1(1): 1-10
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