Available online: http://journal.ipb.ac.id/index.php/jgizipangan ***J. Gizi Pangan, February 2021, 16(Supp.1):89-98***
Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019
ISSN 1978-1059 EISSN 2407-0920

The Role of Exclusive Breastfeeding in Reducing Pneumonia Prevalence in Children Under Five

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ABSTRACT

The objective of this study is to determine the role of exclusive breastfeeding on pneumonia in children under five years old in the Bogor district. The design of this study is a case control study design on 107 children under five with pneumonia (cases), and 107 children under five without pneumonia (controls) using multivariate logistic regression analysis. Living with smokers at home, indoor air pollution, mothers' level of education, immunization status, and nutrition status of the children were considered as covariates. The study showed that children who had not been exclusively breastfed had 6.699 times a higher risk (95% CI:3.204–14.007) to get pneumonia than children who had not been exclusively breastfed after being controlled by covariates. Interventions through promotion campaigns on exclusive breastfeeding, anti-smoking programs, use of stoves with perfect burst, mother empowerment, immunization, and improving nutrition status should be applied in every family to decrease morbidity and mortality caused by pneumonia in children under five.

Keywords: children under five years, exclusive breast feeding, pneumonia

INTRODUCTION

Pneumonia remains to be the number one killer in children under five years old around the world, including Indonesia. Pneumonia is considered as a communicable disease that is preventable and treatable. The Global Action Plan for Prevention and Controlling of Pneumonia (GAPP) has set out a 90% coverage target by 2015 for three interventions: vaccination; exclusive breastfeeding; and access to health care facilities (IVAC 2012).

Significant evidence have revealed three categories of risk factors, namely definite, likely, and possible risk factors. Non-exclusive breastfeeding is considered as a definite risk factor of pneumonia. Studies have consistently shown that children who are exclusively breastfed for six months experience less morbidity from gastrointestinal and respiratory infection than those who are partially breastfed for less than six months. Children who are exclusively breastfed for six months show age-appropriate growth in both developing and developed countries (Kramer & Kakuma 2012).

Based on the 2012 Indonesia Basic National Health Survey, pneumonia is the leading cause of mortality of children under five after diarrhea (Ministry of Health Republic of Indonesia 2012). The case fatality rate among infants (<1 year of age) is 0.21% higher compared to the case fatality rate among children under five (1–4 years of age), which is 0.08%. The coverage of pneumonia detection among children under five is still far from the national target (70%), reaching only 23.95% in 2011. The coverage of pneumonia detection by province shows that West Java province (39.11%) had the third highest pneumonia case detection among children under five after DKI Jakarta (45.68%), with the highest being West Nusa Tenggara province (72.76%) (Ministry of Health Republic of Indonesia 2012). Bogor district is located in West Java Province. The Health Profile of Bogor District reports that the average pneumonia case detection per sub district was 320 cases, ranging from 237 to 1297 cases among all the subdistricts in Bogor. The prevalence of exclusive breastfeeding in Bogor district was 54.01% in 2012, far from the national target (80%) for the year 2014 (Health Department Bogor District 2012). The high prevalence of pneumonia may be related to the low prevalence of exclusive breastfeeding in Bogor district. Children who are exclusively

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breastfed for six months have adequate nutrition to increase their natural immunity, especially against lower respiratory tract infections such as pneumonia (Lamberti *et al.* 2013). This study aims to identify the role of exclusive breastfeeding in reducing pneumonia prevalence among children under five in the Bogor district.

METHODS

Design, location, and time

A case control study was conducted to identify the role of exclusive breastfeeding in reducing pneumonia prevalence among children under five years old after assessing several covariate variables in this association. The covariate variables were child characteristics such as age, gender, Diphtheria, Pertussis, and Tetanus (DPT) immunization, measles immunization, Bacille Calmette-Guerin (BCG) immunization, nutritional status, birth weight; socio demographic data of the mothers such as the mother's level of education, knowledge, and occupation; and environment factors such as whether living with smokers at home and indoor air pollution. The study was conducted from February to June 2013 in the Bogor district.

Sampling

The population of this study were children under five who visited Public Health Centers in the Bogor District with their mothers. The sample was children under five from the selected Public Health Centers in Bogor district. Four Public Health Centers were selected among the ten Public Health Centers in the Bogor district based on the highest number of pneumonia cases in 2012. Pneumonia cases were defined as children under five who had pneumonia and had been diagnosed as having pneumonia by a medical doctor from the selected Public Health Centers. Control was defined as those who did not have pneumonia and were not diagnosed as suffering from a serious illness by a medical doctor from the same Public Health Center as the pneumonia cases. Control was taken on the same day or the day after the cases were acquired. The sampling method was done by purposive sampling until the minimum sample size was met. Sample size was calculated using the formula for case control study design with 95% confident interval ($Z\alpha$=1.96) and 80% strength ($Z\beta$=0.84), OR=2.2. The required sample size was 107 cases and 107 controls. Controls were matched with cases by age. The Ethics Committee for Health Research, Faculty of Public Health, Diponegoro University has approved this research in the form of Ethical Approval No. 227/EC/FKM/2013, and written informed consent was obtained from each participant.

Data collection

The types of data collected were primary data related to the covariate variables. Interviews were conducted using a modified questionnaire from the Basic Health Research questionnaire (Riskesdas), the Indonesian Health Demographic Survey (IDHS), the University of Indonesia Environmental Health Survey, and the Gadjah Mada University Research Institute for Community Health and Nutrition (LPKGM).

The method of data collection was carried out through structured interviews with the mothers where their children were selected as samples (for both cases and controls). In addition, measurements and observations were also carried out to obtain data on body weight, length/height, and immunization history.

Data collection was carried out by the researchers assisted by four community nutrition IPB University students. The interviewer was given training on data collection methods and techniques in accordance with the research objectives. In order to avoid bias caused by the interviewer, the interviewer was blinded about the hypothesis of this study.

Data analysis

The data analysis used was univariate, bivariate, stratification, and multivariate using logistic regression with SPSS version 16.

RESULTS AND DISCUSSION

Characteristics of cases and controls

Most of the cases and controls were in the 1–2 year-old age group, which was higher for the pneumonia cases at around 68.2% compared to the controls, which was 65.4%. For the 3–5 year-old age group, cases numbered to 31.8%, which was lower than the controls (34.6%). These differences were not statistically significant different. Most of the cases and controls were boys, at 62.6% among cases and 41.1% among

controls. The proportion of girls among the cases was 37.4% and 58.9% for the controls. The differences of the proportion between boys and girls among the cases and controls were statistically different (Table 1).

Table 2 illustrates that 27.1% of the cases were wasted, while only 11.2% of the controls were wasted. The difference of the proportion of wasting between the cases and controls were statistically significant different. 11.2% of the children in the cases were low birth weight babies, while among controls only 3.7% were considered as low birth weight babies. These differences were not statistically significantly different.

The cases had a significant higher proportion of low educated mothers (90.7%) compared to the controls, which had 66.4% (Table 3). These differences between cases and controls were statistically significant different. Approximately 52% of the mothers of the cases had ample knowledge about pneumonia and 48.6% among the controls' mothers. Among the cases, 13.1% of their mothers were working, while only 6.5% of the controls' mothers were working. The differences between cases and controls who had knowledgeable and working mothers were not statistically significantly different.

In terms of environmental factors, it was shown in Table 4 that among the cases 90.7% had smokers living at home, while it was 78.5% for the controls. These differences were statistically significant different. It was also shown that 28% of the cases were exposed to indoor air pollution at home and was lower for the controls at about 9.3% and was statistically significantly different.

Association of exclusive breastfeeding and pneumonia

The association of exclusive breastfeeding and pneumonia was analyzed by bivariate analysis 80.40% of those who were not exclusively breastfed had pneumonia, while only 19.60% of those who were exclusively breastfed had pneumonia. These differences were statistically significantly different. Those who were not exclusively breastfed were 4.3 times more likely to have pneumonia compared to those who were (Table 5).

Multivariate analysis was conducted to see the association between exclusive breastfeeding and pneumonia by controlling it with covariate variables. There were 7 covariate variables of children characteristics, 3 covariate variables of the socio demographic of mothers and 2 covariate variables of environmental factors.

For the process of selecting the variables for multivariate analysis, 10 variables were generated that fulfilled the condition of $p \leq 0.25$. These variables were history of DPT immunization, history of measles immunization, history of BCG immunization, nutritional status, sex of child, birth weight, mother's education level, mother's occupation, whether these are smokers at home and exposure to indoor air pollution. Table 6 below shows the full model of multivariate analysis.

Table 1. Distribution of children in the case and control groups based on age group and gender

Variable	Cases		Control		Total		p
	n=107	%	n=107	%	n=214	%	
Age group (years)							
1–2	73	68.20	70	65.40	143	66.80	0.772
3–5	34	31.80	37	34.60	71	33.20	
Gender							
Boy	67	62.60	44	41.10	111	51.90	0.003
Girl	40	37.40	63	58.90	103	48.10	

Table 2. Distribution of children in the cases and controls based on nutritional status

Variable	Cases		Control		Total		p
	n=107	%	n=107	%	n=214	%	
Nutritional status							
Wasting	29	27.10	12	11.20	41	19.20	0.005
Normal and overweight	78	72.90	95	88.80	173	80.80	

The next step was to assess whether these covariate or independent variables were confounding variables toward the association of the main independent variables, namely exclusive breastfeeding and pneumonia. A confounder was defined if the delta of the OR (Odds Ratio) was greater than 10%. Table 7 below shows the analysis results of the confounder variables of the covariate variables.

The first step was to exclude covariate variables which had the lowest OR or were less significant by assessing the confident interval. In this study, the history of BCG immunization was less significant. The OR after this variable was excluded at 6.954, so the delta or the difference with the OR of the full model was 0.20% and was less than 10%, therefore this variable was considered as a non-confounder and will be excluded from the model. Another example was smokers at home, when these variables were excluded the OR become 5.160, so the delta OR of the OR full model was 25.95% and was greater than 10%, therefore smokers at home was considered as a confounding variable and should again be included in the model. By analyzing all the covariate variables, it was shown that there were 4 covariate variables that were defined as confounder variables. Smokers at home, indoor air pollution, mother's education, and history of DPT immunization were defined as potential confounders toward the association of exclusive breastfeeding and pneumonia.

Table 3. Distribution of children of cases and control based on the mothers' socio- demographic characteristics

Variable	Cases		Control		Total		p
	n=107	%	n=107	%	n=214	%	
Level of education							
Low	97	90.70	71	66.40	168	78.50	0.000
High	10	9.30	36	33.60	46	21.50	
Has knowledge about pneumonia							
Less	51	47.70	55	51.40	106	49.50	0.682
Good enough	56	52.30	52	48.60	108	50.50	
Mother's occupation							
Working	14	13.10	7	6.50	21	9.80	0.168
Not working	93	86.90	100	93.50	193	90.20	

Table 4. Distribution of children of cases and controls based on environmental factors

Variable	Cases		Control		Total		p
	n=107	%	n=107	%	n=214	%	
Whether there were smokers at home							
Yes	97	90.70	84	78.50	181	84.60	0.020
No	10	9.30	23	21.50	33	15.40	
Whether there was indoor air pollution							
Yes	30	28.00	10	9.30	40	18.70	0.001
No	77	72.00	97	90.70	174	81.30	

Nutritional status was considered as a potential variable toward the association of exclusive breastfeeding and pneumonia, so nutritional status was also included in the final model with the other four potential confounders. The final model of this study is shown in Table 8 by analyzing the multivariate logistic regression and using the backward method procedure.

From the multivariate analysis we can conclude that the children who were not exclusively breastfed were 6.7 times more likely to develop pneumonia compared to those who were, after controlling with nutritional status, smokers at home, indoor air pollution, mother's education and history of DPT immunization.

Children who are exclusively breastfed will get adequate nutrition that can increase their immunity. Better immunity can reduce the risk of respiratory infections and can accelerate the healing process of children when exposed to respiratory diseases.

Adequate nutrition is one step to increase a child's natural immunity, starting with offering exclusive breastfeeding for the first six months of life. WHO recommends exclusive breastfeeding for the first six months of life which should continue until the second year of life; this is recognized internationally as an optional way to feed babies (Kramer & Kakuma 2012). The universal implementation of this recommendation can prevent 13% of mortality of under-fives annually mainly through the prevention of diarrhea and pneumonia (Lamberti *et al.* 2013). Breastfeeding is an important preventive action for reducing the mortality rate of children under five, because breastmilk is the most important source of active and passive immunity toward the vulnerable early years of infant life.

Breastmilk has several major protein components such as antibodies against microbes. The immune content of milk changes over time as the child gets older. IgA, as an anti-inflammatory factor and immunologically active cells, provides additional support for immature immune systems in the early stages of lactation. After this period, breast milk continues to adapt to the baby's growth

Table 5. Association of exclusive breastfeeding and pneumonia

Variable	Cases		Control		Total		OR (95% CI)	p
	n	%	n	%	n	%		
Breastfed								0.000
Not exclusively	86	80.40	52	48.60	138	64.50	4.332 (2.355–7.967)	
Exclusively	21	19.60	55	51.40	76	35.50	1.00 (ref)	

Table 6. Full model multivariate analysis

Variable	p	OR	95% CI
Breastfeeding	0.000	6.968	3.189–15.221
History of DPT immunization	0.016	10.046	1.547–65.228
Mother's education	0.005	4.678	1.582–13.833
Indoor air pollution	0.002	4.509	1.740–11.687
Smokers at home	0.007	4.121	1.463–11.602
Mother's occupation	0.053	3.690	0.983–13.850
Low birth weight	0.121	3.566	0.715–17.773
Nutritional status	0.025	2.980	1.150–7.725
Sex	0.006	2.736	1.326–5.649
History of measles immunization	0.610	0.731	0.220–2.433
History of BCG immunization	0.110	0.187	0.024–1.459

DPT: Diphtheria, Pertussis, and Tetanus; BCG: Bacille Calmette-Guerin

and needs regarding its protective protection against pneumonia (Palmeira & Carneiro-Sampaio 2016).

This case control study showed that children who had not been exclusive breastfed were 6.7 times more likely to get pneumonia after controlling with nutritional status, living with smokers at home, exposure to indoor air pollution, mother's education, and history of DPT immunization. Exclusive breastfeeding as a form of nutritional intervention should be implemented to reduce the prevalence of pneumonia in children under five. There have been limited intervention trials and observational studies that showed the benefit of exclusive breastfeeding on the reduction of the risk of pneumonia. A randomized control intervention trial with a one year follow up had been conducted to assess the effects of breastfeeding promotion programs on exclusively breastfeeding toward respiratory infection among infants in the Republic of Belarus.6 As to the various types of respiratory tract infections, it was shown that there was approximately 15% decrease in the intervention group, but due to the higher number in the control group, it was not statistically significant different. This result is consistent with the study by Lamberti *et al.* (2013), which explains that partially breastfed children have a higher risk of death due to pneumonia (Relative risk (RR):2.50; 95% CI:1.03–6.04) compared to exclusively breastfed children 0–5 months of age, and the same trend was observed among predominantly and non-breastfed children in the same age category.

Tobacco constituents can reach infants through breast milk or by inhalation. Recent studies have shown that tobacco constituents such as nicotine and also its major metabolite cotinine had been detected in the breastmilk of mothers who were smokers, as well as among passive smokers. In a case control study conducted by Pandolfi *et al.* (2019), it was found that mothers who smoked had a higher risk of contracting respiratory viral infections (OR 2.55; 95% CI:1.33–4.89) compared to controls. Another study also found that children of mothers who smoke have increased risk of severe respiratory syncytial virus infection, morbidity, mortality, and hospitalization for respiratory tract

Table 7. Analysis results of confounder variables of covariate variables

Variable	OR reduce	OR full model	95% CI	Delta OR (%)	Result
Breastfeeding	6.968	6.968	3.189–15.221		
Without history of BCG immunization variable	6.954	6.968	3.202–15.105	0.20	Non confounder
Without history of measles immunization variable	6.602	6.968	3.088–14.115	5.25	Non confounder
Without gender variable	6.498	6.968	3.081–13.706	6.75	Non confounder
Without nutritional status variable	6.463	6.968	3.110–13.430	7.25	Non confounder
Without low birth weight variable	6.501	6.968	3.157–13.391	6.70	Non confounder
Without mother's occupation variable	6.726	6.968	3.271–13.830	3.47	Non confounder
Without smoker variable	5.160	6.968	2.600–10.239	25.95	Confounder
Without indoor air pollution variable	4.665	6.968	2.433–8.945	33.05	Confounder
Without mother's education variable	4.300	6.968	2.299–8.044	38.29	Confounder
Without DPT immunization variable	4.332	6.968	2.355–7.967	37.83	Confounder

DPT: Diphtheria, Pertussis, and Tetanus; BCG: Bacille Calmette-Guerin

infections and other infectious diseases (Metzger *et al.* 2013). The association of maternal smoking and respiratory conditions can be viewed from mothers who smoke expose their babies to nicotine which interferes with the development of their child's lungs and breathing conditions (McEvoy & Spindel 2017). The same risk was also shown in a study by Hartati, where children under five who lived with family members who smoke were 2.34 (1.02–4.94) more likely to get pneumonia compared to other children under five who did not have smokers in their home (Hartati 2011). Meta-analysis studies of secondhand smoke on respiratory infections suggest that the presence of smokers in the home can expose infants to cigarette smoke and increase the risk of lower respiratory infections among infants. The odds ratios were 1.22 (95% CI:1.10–1.35) for parental smoking, 1.62 (95% CI:1.38–1.89) if both parents smoked and 1.54 (95% CI:1.40–1.69) for any household member who were smokersc (Jones *et al.* 2011). Our case control study showed that the OR was higher, where the children in this group were 4.4 (95% CI:1.695–11.446) times more likely to get pneumonia if there were smokers at home compared with not having any at home.

Besides smoking, indoor air pollution is also one of the major determinants of risk factors for pneumonia. High air pollution could cause

Table 8. Final model of multivariate analysis

Variable	B	p	OR	95% CI
Breastfeeding	1.902	0.000	6.699	3.204–14.007
Smokers at home	1.483	0.000	4.404	1.695–11.446
Indoor air pollution	1.494	0.000	4.455	1.802–11.016
Mother's education	1.054	0.000	2.869	1.194–6.893
History of DPT immunization	1.157	0.000	3.180	1.210–8.353
Nutritional Status	1.328	0.000	3.775	1.518–9.390
Constant	-4.011	0.000	0.018	

DPT: Diphtheria, Pertussis, and Tetanus

excess deaths specifically due to respiratory infection and it was noted that infants and children had a higher risk compared to other groups. The risk of air pollutants on respiratory infection could be explained by a specific and non-specific host defense mechanism of the respiratory system against microbial pathogens. A number of pollutants from the indoor and outdoor environment had been found to adversely affect the component of host defense mechanisms against bacterial pathogen microorganism. Evidence studies have defined a different approach of indoor air pollution that consistently showed the risk of indoor air pollution toward respiratory tract infections. Burning solid fuels for cooking, heating, and lighting represents exposure to Indoor Air Pollution (IAP) which contributes significantly to the global burden of disease and death, and affects women and children in developing countries (Gall *et al.* 2013). Our case control study showed that the OR was 4.45 (95% CI:1.80–11.02) times more likely to develop pneumonia for children who are exposed to indoor air pollution compared to those who are not. Air pollution in this study was defined by cooking practices using wood and other materials that produce smoke or stoves in the kitchen.

Children who had low educated mothers had an OR that was 2.87 (95% CI:1.19–6.89) times more likely to get pneumonia. This finding was also similar to a study in Pakistan, where the mother's knowledge is very much essential in preventing and treating pneumonia as she is closer to her children and can be the first to notice changes in their child's health (Eliyas *et al.* 2018). Better literacy rate among mothers was the reason for the low association of pneumonia with known risk factors (Gothankar *et al.* 2018).

This case control study showed that 24.3% of the cases had only been partially immunized for DPT. Those who were partially DPT immunized had a 3.18 (95% CI:1.21–8.35) times higher risk to get pneumonia compared to those were fully immunized. In term of nutritional status, there was a higher proportion of wasting among the cases compared to the control children. The OR was 3.77 (95% CI:1.58–9.39) times more likely to get pneumonia among wasted children compared to children with normal nutritional status. These results were similar to a case control study conducted in South Halmahera. It was shown that nutrition status was significantly related to the incidence of pneumonia (p=0.019; OR=13.872). This meant that children under 5 years old who were malnourished-underweight had 13.872 times a greater risk in getting pneumonia than those with normal-overweight nutrition status. This case control study in South Halmahera showed that malnutrition was the most important risk factor for pneumonia (Wicaksono 2015). There is a need to encourage people to achieve

normal nutritional status and increase physical activity to reduce cases of pneumonia in urban communities (Setyowati *et al*. 2020).

CONCLUSION

Children who were not exclusively breastfed had 6.7 times a higher risk to get pneumonia (95% CI:3.2–14.0) compared to children were, after controlled by cooking stoves at home, mother's level of education, immunization status, and nutrition status. Interventions through exclusive breastfeeding promotion programs, anti-smoking programs, the use of a perfect burning stove, mother empowerment, DPT and measles immunization, improvements in nutritional status must be implemented in every family to reduce morbidity and mortality due to pneumonia in children under five.

ACKNOWLEDGEMENT

The author would like to give appreciation to all the respondents for their cooperation during data collection. We would also like to thank all who have assisted in collecting the data of respondents.

AUTHOR DISCLOSURES

The authors have no conflicts of interest to report.

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