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Risk Factors for Pneumonia Hospitalization in Children

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ABSTRACT

This study aims to investigate the risk factors of pneumonia hospitalization in children through logistic regression analysis to reduce children mortality rate due to the pneumonia. The study included 3470 individuals who involved in National Longitudinal Survey of Youth. We firstly conduct a univariate analysis for examining the significance effect of each covariate involved in pneumonia hospitalization by applying Wald test, Fisher Exact test, and Chi-square test. We then proceed to the logistics regression analysis for assessing the impact of the significance risk factors of pneumonia hospitalization simultaneously. The results show that the pneumonia hospitalization in children is significantly associated with the age child had pneumonia, mother's age, smoking during pregnancy, number of siblings and month of child was weaned. The best-fitted logistic regression model then is obtained for predicting children hospitality rate due to pneumonia. Perhaps the finding of this study may help in reducing the disease burden of children due to pneumonia.

Keywords: Pneumonia hospitalization, Logistic regression, Risk factor

INTRODUCTION

Pneumonia is a kind of infection in the tiny air sacs of lungs, called *alveoli*. It may cause the tendency of harder in breathing due to the inflammation and fluid-filled lungs. It also defined as an acute infection of the lung parenchyma by one or co-infecting pathogens (Mackenzie, 2016). As stated in Merriam Webster Medical Dictionary (2016), pneumonia is defined as an acute disease that is marked by inflammation of lung tissue accompanied by infiltration of alveoli and often bronchioles with white blood cells (as neutrophils) and fibrinous exudate. It also characterized by fever, chills, cough, difficulty in breathing, fatigue, chest pain, and reduced lung expansion caused by an infectious agent (as a bacterium, virus, or fungus).

As reported by the World Health Organization (2016), pneumonia accounts for 16% of all deaths of children under 5 years old, killing 920 136 children in 2015. The signs and symptoms of pneumonia might be present among healthy children due to the infection outside the hospital, called as Paediatric community-acquired pneumonia (Pabary and Lynn, 2013). Schrock et al. (2012) stated that symptoms of pneumonia in children could be recognized by abdominal pain, headache, and arthralgia pain, cough and fever. They recommended supportive care by controlling weight-appropriate doses of antipyretics and analgesics, such as acetaminophen or ibuprofen. Aspirin was not recommended for children because of the risk of Reye syndrome.

In 2013, the WHO and United Nations Children's Fund (UNICEF) delivered the integrated Global Action Plan for Pneumonia and Diarrhea (GAPPD), which presented a framework for reducing preventable child deaths due to diarrhea and pneumonia by 2025. The GAPPD highlights a "protect, prevent, treat" approach, including proven effective interventions. However, the plan suggests that the sustainable development aim to ending preventable child deaths by 2030 will remain improbable unless deaths due to childhood pneumonia are significantly reduced (Lancet, 2017).

Hence, more knowledge on the risk factors affecting the pneumonia hospitalization in children is needed to reduce the deaths from childhood pneumonia. This study aims to investigate the risk

factors of pneumonia hospitalization in children through logistic regression analysis to reduce children mortality rate due to the pneumonia. The paper is organized as follows: the description of the used data and the methodology details are presented in the next section; the results of multivariate logistic regression analysis are discussed in detail in the following sections; the conclusions are given in the final section.

METHODOLOGY

The data used in this study consists of 3470 individuals involved in the study of for National Longitudinal Survey of Youth in1995. The data records thirteen independent variables, and their details are described as the below table.

Table 1: The description of pneumonia hospitalization data

Variable	Label	Description
pneumonia hospitalization	hospital	not hospitalized = 0 hospitalized = 1
urban environment of the mother	urban	no = 0 yes =1
alcohol used by mother during pregnancy	alcohol	no drink = 0 <1 drink = 1 1-2 drinks = 2 3-4 drinks = 3 >4 drinks = 4
smoking during pregnancy	smoke	none = 0 ≤1 pack/day = 1 >1 pack/day = 2
poverty level of the mother	poverty	no = 0 yes =1
region of the country	region	northeast = 1 south = 2 west = 3 north central = 4
child birth weight	bweight	≤5.5 lbs = 0 >5.5 lbs = 1
race of the mother	race	white= 1 black = 2 other = 3
age of the child had pneumonia	chldage	1-12 years old
age of the mother	mthage	14-29 years old
education of the mother	education	0-19 years
number of siblings of the child	nsibs	0-6 siblings
month the child was weaned	wmonth	0-28 months
month the child on solid foods	sfmonth	0-18 months

In statistical analysis, we initially carry out a univariate analysis for investigating the significance effect of each covariate involved in the pneumonia hospitalization of children by conducting Wald test, Fisher Exact test, and Chi-square test at the significant level of 0.2. Furthermore, we proceed to the logistics regression analysis by including all the significant covariates for assessing the

impact of the significance risk factors of pneumonia hospitalization simultaneously. The covariate is significant when the *p*-value less than 0.05.

RESULTS

In univariate analysis, Wald test, Fisher Exact test, and Chi-square test are carried out to identify the significant covariates of pneumonia hospitalization in children. As presented in Table 1, the results of Wald test show that all the considered covariates: age child had pneumonia, age of the mother, years of mother's education, number of siblings, month of child was weaned and month of child on solid foods, are significantly associated with the pneumonia hospitalization in children at the significant level of 0.2. It is noticed that the increases in child age had pneumonia, the age of the mother, years of mother's education, month of child was weaned and month of child on solid foods decrease the rate of pneumonia hospitalization, respectively. On the other hand, the pneumonia hospitalization in children is more likely to occur when the number of siblings is increasing.

Table 1: Significance of Pneumonia Hospitalization Covariates using Wald Test

Factor	β value	Wald	*p*-value	Odds ratio (95% CI)
Age child had pneumonia	-0.357	117.323	< 0.001*	0.700 (0.656, 0.746)
Age of the mother	-0.117	6.720	0.010*	0.890 (0.814, 0.972)
Years of mother's education	-0.190	13.435	0.000*	0.827 (0.748, 0.916)
Number of siblings	0.308	7.157	0.070**	1.360 (1.086, 1.704)
Month of child was weaned	-0.260	9.243	0.002*	0.771 (0.652, 0.912)
Month of child on solid food	-0.403	9.674	0.002*	0.668 (0.518, 0.861)

* significant level = 0.05; ** significant level = 0.1; *** significant level = 0.2

Meanwhile, the results of Fisher Exact test in Table 2 display that alcohol during pregnancy is not significantly affect the rate of pneumonia hospitalization in children at significance level of 0.2. It is observed that there is no difference in the proportion of pneumonia hospitalization either taking alcohol during pregnancy or not taking alcohol during pregnancy. The hospitalization rate for those who have no drink of alcohol (2.15%), at one time drink of alcohol (2.24%) and more than four times drink of alcohol (2.21%) are almost same. Subsequently, alcohol during pregnancy is not recommended to be considered in the multivariate logistic regression analysis.

Using Chi-square test, Table 3 indicates that smoking during pregnancy, child birth weight, urban environment and region of the country are significantly associated with the rate of pneumonia hospitalization in children at $\alpha = 0.05$. These significant covariates are also included when conducting the multivariate logistic regression analysis.

Table 2: Significance of Pneumonia Hospitalization Covariates using Fisher Exact Test

Factor	Subgroup	Study cases (%)	Hospitalization (%)	*p*-value
Alcohol during pregnancy	No drink	2229 (64.24%)	48 (2.15%)	0.971
	<1 drink	626 (18.04%)	14 (2.24%)	
	1-2 drinks	301 (8.67%)	5 (1.66%)	
	3-4 drinks	178 (5.13%)	3(1.69%)	
	>4 drinks	136 (3.92%)	3 (2.21%)	

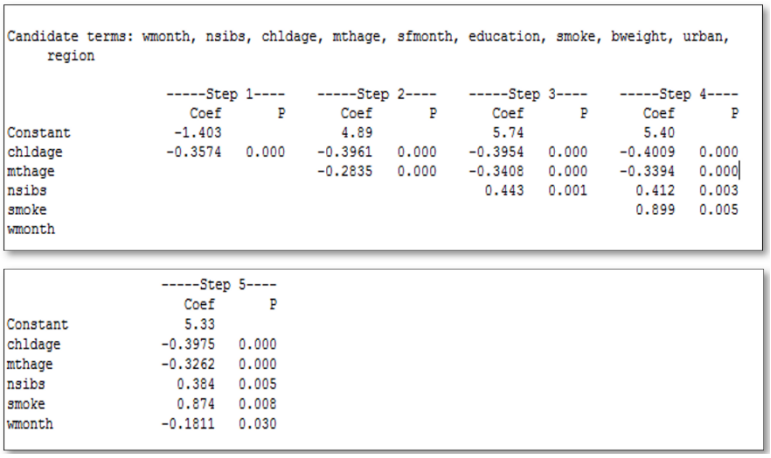
* significant level = 0.05; ** significant level = 0.1; *** significant level = 0.2

Table 3: Significance of Pneumonia Hospitalization Covariates using Chi-square Test

Factor	Subgroup	Study cases (%)	Hospitalization (%)	*p*-value
Urban environment	Yes	2639 (76.05%)	49 (1.86%)	0.071**
	No	81 (23.95%)	24 (2.89%)	
Smoking during pregnancy	None	2285 (65.85%)	34 (1.49%)	0.002*
	≤1 pack/day	838 (24.15%)	28 (3.34%)	
	>1 pack/day	347 (10.0%)	11 (3.17%)	
Region of country	Northeast	517 (14.9%)	13 (2.51%)	0.139***
	South	1396 (40.23%)	26 (1.86%)	
	West	689 (19.86%)	9 (1.31%)	
	North central	868 (25.01%)	25 (2.88%)	
Poverty of the mother	Yes	3200 (92.22%)	66 (2.06%)	0.560
	No	270 (7.78%)	7 (2.59%)	
Child birth weight	>5.5 lbs	1248 (35.97%)	37 (2.96%)	0.008*
	≤5.5 lbs	2222 (64.03%)	36 (1.62%)	
Race of the mother	White	1933 (55.71%)	42 (2.17%)	0.848
	Black	957 (27.58%)	18 (1.88%)	
	Other	580 (16.71%)	13 (2.24%)	

*significant level = 0.05; **significant level = 0.1; ***significant level = 0.2

In multivariate logistics regression analysis, all the significant covariates in the previous univariate tests are considered for assessing the impact of the significance risk factors of pneumonia hospitalization simultaneously. The best-fitted model then is obtained via stepwise model selection. The results in Figure 1 show that the covariates of age child had pneumonia, age of the mother, number of siblings, month of child was weaned and smoking during pregnancy are the significant risk factors of pneumonia hospitalization in children.



Candidate terms: wmonth, nsibs, chldage, mthage, sfmonth, education, smoke, bweight, urban, region

	Step 1		Step 2		Step 3		Step 4	
	Coef	P	Coef	P	Coef	P	Coef	P
Constant	-1.403		4.89		5.74		5.40	
chldage	-0.3574	0.000	-0.3961	0.000	-0.3954	0.000	-0.4009	0.000
mthage			-0.2835	0.000	-0.3408	0.000	-0.3394	0.000
nsibs					0.443	0.001	0.412	0.003
smoke							0.899	0.005
wmonth								

	Step 5	
	Coef	P
Constant	5.33	
chldage	-0.3975	0.000
mthage	-0.3262	0.000
nsibs	0.384	0.005
smoke	0.874	0.008
wmonth	-0.1811	0.030

Figure 1: Results from Stepwise Model Selection Procedure

CONCLUSION

In this study, the multivariate logistic regression analysis is carried out for identifying the risk factors of pneumonia hospitalization in children. We firstly investigate the association of thirteen considered independent variables in the rate of pneumonia hospitalization by using Wald test, Fisher Exact test, and Chi-square test. Those associated covariates in the univariate analysis then are used in conducting the multivariate logistic regression analysis for assessing the impact of the significance risk factors of pneumonia hospitalization simultaneously. Finally, the best-fitted logistic model is obtained through stepwise model selection approach. It is observed that that age child had pneumonia, age of the mother, number of siblings, month of child was weaned and smoking during pregnancy are the significant risk factors of pneumonia hospitalization in children. Perhaps the results of this study may contribute to predict the pneumonia hospitalization rate in future.

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REFERENCES

Lancet T. (2017), The Case for Action on Childhood Pneumonia. *Lancet*, 390-2122.

Mackenzie, G. (2016), The Definition and Classification of Pneumonia. *Pneumonia*, **8(1)**.

Merriam, W. (2016), *Merriam-Webster's Medical Dictionary*. Springfield, MA. Merriam-Webster, Inc.

Pabary, R. and Balfour-Lynn, I. M. (2013), Complicated Pneumonia in Children. *Breathe*, **9(3)**: 210-222.

Schrock, K. S., Hayes, B. L., & George, C. M. (2012), Community-Acquired Pneumonia in Children. *American Family Physician*, **86(7)**.

UNICEF. (2013), *End Preventable Deaths: Global Action Plan for Prevention and Control of Pneumonia and Diarrhoea*. World Health Organization; Geneva, Switzerland.