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Original Article

The role of indoor air pollution and other factors in the incidence of pneumonia in under-five children

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ABSTRACT

Background The World Health Organization has asked for a special attention to the relation between pneumonia and indoor air pollution, i.e., household biomass fuel smoke, cigarette smoke, and mosquito coil smoke, especially in developing countries.

Objective To analyze the role of indoor air pollution and other factors as risk factors for pneumonia in under-five-year children.

Methods This case-control study was carried out from August until December 2000 at Public Health Centers in Banjarnegara, Kebumen, Jepara, and Pekalongan districts. All children qualifying pneumonia classification as recommended by WHO in IMCI (Integrated Management of Childhood Illness) were defined as cases and without pneumonia as controls. Severe pneumonia and no pneumonia (as classified in IMCI) were excluded. Statistical analysis was done using bivariate and logistic regression.

Results There were three hundreds and five children with pneumonia and 289 children without pneumonia. By bivariate analysis, biomass fuel smoke (OR=3.25; 95%CI 1.50;7.07) and cigarette smoke exposure from other family members (OR=1.63; 95%CI 1.11;2.38) were risk factors for pneumonia, while mosquito coil smoke (OR=1.13; 95%CI 0.79;1.69) was not. History of wheezing (OR=2.60; 95%CI 2.7;8.55), malnutrition (OR=2.60; 95%CI 1.33;5.07), and male sex (OR=1.47; 95%CI 1.06;2.04) were other risk factors.

Conclusions Household biomass fuel smoke and cigarette smoke were risk factors for pneumonia. Other variables as risk factors were history of wheezing, male sex, and malnutrition **[Paediatr Indones 2004;44:25-29].**

Keywords: *pneumonia, risk factors, indoor air pollution, household biomass fuel smoke, cigarette smoke, mosquito coil smoke.*

Pneumonia is still a major health problem and a leading cause of childhood mortality in developing countries.[1] Among children under five years of age, three to five million deaths had been attributed to ARI (Acute Respiratory Infection) annually, of which 75% were caused by pneumonia.[2] Indonesian demographic health survey reported that the prevalence of pneumonia in 1991 was 9.8% and in 1994 was 10%.[3] Pneumonia may be caused by virus, bacteria, or both. *Respiratory Syncytial Virus (RSV)* is the most common agent of pneumonia, especially in children aged between 6 months and 2 years, while in children more than 2 years of age, it was *Parainfluenzae* virus, *Influenzae A and B* virus, and *Adenovirus. Streptococcus pneumoniae* and *Haemophilus influenzae* are the major bacterial causes of pneumonia in children although *Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Mycoplasma pneumoniae* are also common.[2,4] Although all agree that pneumonia is an inflammation condition, it is difficult to find a universal definition of pneumonia. That is why this study used WHO classification as recommended by the Integrated Management of Childhood Illness (IMCI). [5-7]

The environment has an important role as a risk factor in the incidence of pneumonia. Pio (1986)

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found three risk factors for pneumonia: low birth weight infant, malnutrition, and air pollution.[8] A study in Sri Lanka found that malnutrition, history of wheezing, low birth weight infant, passive smokers, male sex, sleeping more than one person in a bed, no exclusive breast feeding, and having domestic animals in house as risk factors for pneumonia.[9] A study in Kenya found children who have more than 5 siblings, children who have low educated parents were at risk to have pneumonia.[10] Shah *et al* from India suggested to decrease the incidence of pneumonia by intervention in children's nutrition, family and socioeconomic condition, mother¢s ability in reading, ventilation, and household biomass fuels.[11] Chun-Yuh Yan *et al* and Smith *et al* found that indoor air pollution is a risk factor for pneumonia and lower respiratory infection.[12,13] Indoor air pollution consists of household biomass fuel smoke, cigarette smoke, and mosquito coil smoke exposure. This study aimed to evaluate the role of indoor air pollution and other factors as risk factors for pneumonia in under-five children.

Methods

This was a case-control study to evaluate indoor air pollution (household biomass fuel smoke, cigarette smoke, and mosquito coil smoke exposure) and other variables as risk factors for pneumonia in under-five children.

The study was conducted at Puskesmas Banjarnegara I, Klampok, and Madiraja I (Banjarnegara District), Puskesmas Kedung, Jepara and Bangsri (Jepara District), Puskesmas Karanganyar I, Kebumen, Pejagoan and Prembun (Kebumen District), Puskesmas Kajen, Kedungwuni, and Sragi (Pekalongan District) between August until December 2000. Some staffs of the Puskesmas had been trained for IMCI before.

All under-five children admitted to Puskesmas with pneumonia classification according to IMCI were considered as cases. While under-five children who did not meet the pneumonia classification and came to the same Puskesmas were assigned as controls. Children with severe pneumonia or severe disease classification were excluded from this study. Estimated minimal sample size was calculated by case-control Episcope 10.0 program with $Z\alpha=1.960$, $Z\beta=1.28$ (power=90%), OR=2, and P=10% (exposure frequencies). Variables included were pneumonia as the dependent variable and household biomass fuel smoke, cigarette smoke, and mosquito coil smoke exposure as the independent variables. Other variables such as, socioeconomic condition and children's condition (sex, number of siblings, history of wheezing, malnutrition, and ventilation) were also analyzed.

Pneumonia was defined if there were cough, difficult breathing, and fast breathing according to IMCI (2–12 months of age: $\geq$50/minute, 1–5 years of age: $\geq$40/minute), no sign of general danger, no chest indrawing, no stridor in calm children. Household biomass fuel smoke exposure was defined if children were exposed to household biomass fuel smoke for more than 3 hours/day in 3 months. Cigarette smoke exposure was defined if one or both parents and other family members smoke > 5 cigarettes in the house in the last 3 months. Mosquito coil smoke exposure was defined if children were exposed to mosquito coil smoke every night for 3 months. Number of siblings was classified as <6 or $\geq$6 in one house or <3 or $\geq$3 children in a bed during sleep. History of wheezing was established if there was wheezing breath sounds during expiration. Malnutrition was defined if body weight by age was very low (below the most bottom curve/red line at *kartu menuju sehat*/growth chart). Ventilation was considered present if a house had vent-holes. Socioeconomic condition was determined based on questionnaire.

Results

By Episcope 10.0 program we found 308 respondents for each case and control group. Because of limited time, we found only 305 respondents for case and 289 for control group, consisted of 331 boys and 263 girls. The spans of age were 2-12 months (172 children) and 13-60 months (422 children). One hundred and eighty-three children (30.9%) came from Banjarnegara, 122 (20.7%) from Jepara, 157 (26.6%) from Kebumen, and 129 (21.8%) from Pekalongan.

Data were divided into three groups: indoor air pollution (**Table 1**), child condition (**Table 2**), and socioeconomic condition (**Table 3**). Statistical analysis was done by bivariate analysis(**Table 4**).

Discussion

The use of household biomass fuels (dung, crop residue, wood, kerosene) for daily cooking causes release of bulk of emission into living area. Bivariate analysis showed that children exposed to household biomass fuel smoke had three-fold risk to have pneumonia compared to those not exposed (OR=3.25; 95%CI 1.50;7.07). It was in accordance with studies in Gambia, Kenya, Tanzania, India, Nigeria, Pakistan and Nepal. [9,10,13-15,17] Thomas *et al* in their study in animals concluded that biomass smoke exposure will alter local and systemic immune response for bacteria.[18] We found that cigarette smoke exposure from father or mother was risk factors for pneumonia which was not in accordance with previous studies.[3,19] Our study also showed that cigarette smoke exposure from other family members was also a risk factor for pneumonia (OR=1.63; 95%CI 1.11;2.38).

TABLE 1. DISTRIBUTION OF INDOOR AIR POLLUTIONS AS RISK FACTORS FOR PNEUMONIA

			Pneumonia		Control	
No.	Indoor air pollutions	Category	n	(%)	n	(%)
1.	Cigarette smoke from other family members	yes	240	(79.9)	203	(70.7)
		no	61	(20.3)	84	(29.3)
2.	Cigarette smoke from father	yes	225	(93)	180	(88.7)
		no	17	(7)	23	(11.3)
3.	Cigarette smoke from mother	yes	12	(5)	7	(3.5)
		no	227	(95)	192	(96.5)
4.	Mosquito coil smoke	yes	198	(69)	182	(66.4)
		no	89	(31)	92	(33.6)
5.	Household biomass smoke	yes	294	(97)	261	(90.9)
		no	9	(3)	26	(9.1)

TABLE 2. DISTRIBUTION OF CHILD CONDITIONS AS RISK FACTORS FOR PNEUMONIA

			Pneumonia		Control	
No.	Child condition	Categories	n	(%)	n	(%)
1.	Malnutrition	yes	31	(12.4)	13	(5.1)
		no	234	(87.6)	240	(94.9)
2.	Number of siblings	≥6	39	(12.8)	48	(16.7)
		≤5	266	(87.2)	240	(83.3)
3.	Number of children sleeping in one bed	≥3	277	(74.4)	207	(71.6)
		≤2	78	(25.6)	82	(28.4)
4.	History of wheezing	yes	64	(22.6)	16	(5.7)
		no	219	(77.4)	263	(94.3)

TABLE 3. DISTRIBUTION OF SOCIOECONOMIC CONDITION AS RISK FACTORS FOR PNEUMONIA

			Pneumonia		Control	
No.	Socioeconomic	Categories	n	(%)	n	(%)
1.	Father 's job	farm worker	205	(69.7)	187	(68)
		employee	89	(30.3)	88	(32)
2.	Mother's job	farm worker	252	(85.1)	240	(87)
		employee	44	(14.9)	36	(13)
3.	Source of water	well water	28	(9.4)	23	(8.1)
		not well water	271	(90.6)	262	(91.9)
4.	Defecation	lavatory	117	(39)	101	(35.3)
		river	183	(61)	185	(64.7)
5.	Floor	non cement	91	(30.2)	87	(30.4)
		cement	210	(69.8)	199	(69.6)
6.	Vent-hole	present	45	(15.3)	36	(12.9)
		absent	250	(84 .7)	244	(87.1)

TABLE 4. BIVARIATE ANALYSIS OF RISK FACTORS

No.	Risk factors	Bivariate analysis	
		Odds ratio	(95%CI)
1.	Cigarette smoke from other family member	**1.63**	**(1.11;2.38)**
2.	Cigarette smoke from father	1.69	(0.88;3.26)
3.	Cigarette smoke from mother	1.45	(0.56;3.76)
4.	Mosquito coil smoke	1.13	(0.79;1.60)
5.	Household biomass smoke	**3.25**	**(1.50;7.07)**
6.	Malnutrition	**2.60**	**(1.34;5.07)**
7.	Number of siblings ³6	0.73	(0.46;1.16)
8.	Children who sleep together in a bed ³ 3	1.15	(0.80;1.66)
9.	Male	**1.47**	**(1.06;2.04)**
10.	History of wheezing	**4.80**	**(2.70;8.55)**
11.	Father's job: farm worker	1.08	(0.76;1.55)
12.	Mother's job: farm worker	1.16	(0.72;1.87)
13.	Water source: not well water	1.18	(0.66;2.10)
14.	Defecation: river	1.17	(0.84;1.64)
15.	Floor: non cement	0.99	(0.70;1.41)
16.	No vent-hole	1.22	(0.76;1.17)

Cigarette smoke will decrease cilia function, destroy ciliated epithelial cells which will be changed to squamous cells, and decrease both local and systemic humoral/cellular immunity.[19,20] In this study, by bivariate analysis, mosquito coil smoke was not a risk factor for pneumonia but according to Smith *et al* it has a tendency as a risk factor for asthma.[13] Male sex was 1.5 times at risk for pneumonia (OR=1.47; 95%CI 1.06;2.04) compared with female, which was the same with studies done in Sri Lanka and Argentina.[9,16] It might be due to the smaller diameter of respiratory tract in boys compared to girls or the difference in sex-linked body resistance. Children with malnutrition was 2.6 times at risk for pneumonia (OR=2.6; 95%CI 1.34;5.07). Some studies reported that malnutrition will decrease immunologic capacity for responding to infection including pneumonia, disturb granulocyte function, decrease complement function, and cause micronutrient deficiency.[10,21] Children with history of wheezing were found 4.8 times at risk for pneumonia compared to children without (OR= 4.8; 95%CI 2.70;8.55), which was in accordance with a previous study.[9] Children with history of wheezing have risks for respiratory tract defect, disturbed mucus integrity and ciliated cell, and decreased local and systemic humoral/cellular immunity.[22]

We concluded that household biomass fuel and cigarette smoke were risk factors for pneumonia. Other variables as risk factors for pneumonia were history of wheezing, male sex, and malnutrition.

References

1. World Health Organization (WHO). Program for the control of acute respiratory infections. Clinical signs and etiological agents of pneumonia, sepsis and meningitis in young infants. Report of meeting. Geneva, 2124. November 1989. WHO/ARI, 1990;90:14.
2. Organisasi Kesehatan Dunia (WHO). Dasar pemikiran tatalaksana pneumonia pada anak di sarana kesehatan dasar. 1994.
3. I Putu Tri Yasa. Peran paparan asap rokok pada pneumonia anak [thesis]. Denpasar: Department of Child Health, Medical School, Udayana Univ.; 1999.
4. Claesson BA, Trollfors B, Brolin I, Granstrom M, Henrichsen J, Jodal U, *et al.* Etiology of community-acquired pneumonia in children based on antibody responses to bacterial and viral antigens. Pediatr Infect Dis J 1989;8:856-62.
5. Departemen Kesehatan RI, WHO, and UNICEF. Buku Bagan Manajemen Terpadu Balita Sakit (MTBS) Indonesia. Jakarta: Departemen Kesehatan RI; 1997.
6. Tim PMPT-IDAI. Buku Pedoman Pendidikan Medik Pediatrik Terpadu (PMPT). Penilaian dan klasifikasi anak sakit umur 2 bulan sampai 5 tahun. Jakarta: PP-IDAI; 1998.
7. World Health Organization, Department of Child and Adolescent Health and Development (CAH). IMCI (Integrated Management of Childhood Illness). Unicef; 2001.

8. Pio A. Acute respiratory infections in developing countries. An international view. Pediatr Infect Dis. 1986;5:179-83.

9. Dharmage SC, Rajapaksa LC, Fernando DN. Risk factor of acute lower respiratory tract infections in underfive years of age. Southeast Asian J Trop Med Public Health 1996;27:107-10.

10. Ballard TJ, Neuman CG. The effect of malnutrition, parenteral literacy and household crowding on acute lower respiratory infections in young Kenyan children. J Trop Pediatr 1995;41:8-13.

11. Shah N, Rammankutty V, Premila PG, Sathy N. Risk factors for severe pneumonia in children in South Kerala : a hospital-based case-control study. J Trop Pediatr 1994 ;40:201-6.

12. Chun-Yuh Yang, Jeng-Fen Chiu, Hui-Fen Chiu, Wen-Yao Kao. Damp housing condition and respiratory symptom in primary school children. Pediatr Pulmonol 1997;4:73-7.

13. Smith KR, Samet JM, Romeu I, Bruce N. Indoor air pollution in developing countries and acute lower respiratory infection in children. Thorax 2000;55:414-7.

14. O Dempsey T, McArdle TF, Morris J, Lloyd-Evan N, Baldeh I, Laurence BF, *et al.* A study of risk factors for pneumococcal disease among children in rural area of West Africa. Int J Epidemiol 1996;25:885-93.

15. Robin LF, Less PS, Winget M, Steinhoff M, Moulton LH, Santhosam H, *et al.* Wood-burning stoves and lower respiratory illness in Navajo children. Pediatr Infect Dis J 1996;15:859-65.

16. Cergueiro MC, Murtagh P, Halac A, Avilla M, Weissenbachert M. Epidemiologic risk factors for children with acute lower respiratory tract infection in Buenos Aires, Argentina: a match case control study. Rev Infect Dis 1990;12:S1021-8.

17. Amstrong JR, Campbell H. Indoor air pollution exposure and lower respiratory infection in young Gambian children. Int J Epidemio 1991;20:424-9.

18. Thomas PT and Zelikoff JT. Air pollutants: modulators of pulmonary host resistance against infection. In: Holgate ST, Samet JM, Koren HS, Maynard RL, editors. Air pollution and health. San Diego: Academic Press 1999;357-9.

19. Kosove D. Smoke-filled room and lower respiratory disease in infants. S Afr Med J 1982;61:622-4.

20. Victora CG, Fuch SC, Flores JAC, Fonsech W, Kirkwood B. Risk factor for pneumonia among children in a Brazilian metropolitan area. Pediatrics 1994;93:977-85.

21. Tupasi TE. Nutrition and acute respiratory infections (ARI) in childhood. Proceeding of an International Workshop; Sydney: Australia; 1984. p. 68-71.

22. Kabesch M, Von Mutius E. Epidemiology and public health. In: Silverman M, editor. Childhood asthma and other wheezing disorder. 2nd ed. London: Arnold Publisher; 2002. p. 9-22.