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Risk factors of acute respiratory infection in Thai children

Nuanchan Prapphal*
Supatra Limudomporn* Saowani Chumdermpadetsuk*

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In order to identify risk factors of acute respiratory infection (ARI), we investigated 450 children under three years of age who received health care services at Chulalongkorn Hospital, Bangkok, Thailand, during the period September 1989 to July 1990 in a prospective case-control study. Using multiple logistic regression analysis, we found significant independent risk factors of upper respiratory infection (URI) to include the presence in the family of at least one child with concurrent ARI, the presence of over 10 people in the home, incomplete immunization, dirty water underneath the house, the use of insect repellent smoke and low family income ($p < 0.05$). The significant risk factors of lower respiratory infection (LRI) were the presence of at least one child with concurrent ARI, dirty water underneath the house, low body weight for age, incomplete immunization and the use of insect-repellent smoke ($p < 0.05$). Malnutrition and the presence of over three people sleeping in the same room were the two singificant risk factors for children with URI to develop LRI. We concluded that in addition to improving housing sanitation, increasing family income and solving the problem of overcrowding; and avoiding the use of insect-repellent smoke, there should be a campaign for complete immunization and improving children's nutritional status in order to prevent ARI in children.

Key words: *Respiratory infections, Children, Risk.*

Reprint request : Prapphal N, Department of Pediatrics, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.
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* Department of Pediatrics, Faculty of Medicine, Chulalongkorn University.

นวลจันทร์ ปราบพาล, สุภัทรา ลิ้มอุดมพร, เสาวนีย์ จำเดิมเผด็จศึก. ปัจจัยเสี่ยงต่อโรคติดเชื้อเฉียบพลันของระบบหายใจในเด็ก. จุฬาลงกรณ์เวชสาร 2536 มกราคม; 37 (1): 13-20

ได้ศึกษาปัจจัยเสี่ยงของโรคติดเชื้อเฉียบพลันของระบบหายใจในเด็กที่อายุ 1 เดือน-3 ปี ที่มารับบริการที่ภาควิชากุมารเวชศาสตร์ โรงพยาบาลจุฬาลงกรณ์ จำนวน 450 ราย ในระหว่างเดือน กันยายน 2532-กรกฎาคม 2533 โดยแบ่งเป็น 3 กลุ่ม คือ เด็กปกติ, เด็กที่เป็นโรคติดเชื้อทางเดินหายใจส่วนบน (URI) และโรคติดเชื้อทางเดินหายใจส่วนล่าง (LRI) ทำการศึกษาแบบ case control study และวิเคราะห์ข้อมูลโดยใช้ Multiple logistic regression model พบว่าปัจจัยเสี่ยงต่อการเกิด URI ที่มีนัยสำคัญทางสถิติ ($p < 0.05$) ได้แก่การที่มีเด็กคนอื่นในบ้านอย่างน้อย 1 คน กำลังป่วยเป็นไข้หวัด มีจำนวนคนในบ้านมากกว่า 10 คน เด็กได้รับวัคซีนป้องกันโรคไม่ครบตามอายุ มีน้ำขังใต้ถุนบ้าน การใช้ยากันยุงชนิดที่มีควันไฟ และรายได้ครอบครัวต่ำกว่า 5,000 บาทต่อเดือน ส่วนปัจจัยเสี่ยงที่สำคัญ ($p < 0.05$) ต่อการเกิด LRI ได้แก่การที่มีเด็กอื่นในบ้านอีก 1 คน ป่วยเป็นไข้หวัด มีน้ำขังใต้ถุนบ้าน การใช้ยากันยุงชนิดที่มีควันไฟ น้ำหนักตัวต่ำกว่าเกณฑ์ปกติและได้รับวัคซีนป้องกันโรคไม่ครบ นอกจากนี้ยังพบว่าเด็กที่เป็น URI อยู่แล้ว ถ้ามีภาวะทุพโภชนาการและนอนในห้องรวมกับผู้อื่นเกิน 3 คนขึ้นไป (การถ่ายเทอากาศไม่ดี) จะมีโอกาสเป็น LRI ได้เพิ่มขึ้น 3.19 และ 1.98 เท่าตามลำดับ การศึกษานี้ยืนยันการศึกษาอื่น ๆ เกี่ยวกับปัจจัยเสี่ยงของการเกิดโรคติดเชื้อทางเดินหายใจในเด็ก และพบว่าการที่สุขอนามัยในบ้านไม่ดีร่วมกับการใช้ยากันยุงชนิดที่มีควันจะเพิ่มอัตราเสี่ยงต่อการเกิดโรคมากขึ้น ซึ่งปัจจัยเสี่ยงนี้ควรจะหลีกเลี่ยงหรือป้องกันได้

Acute respiratory infection (ARI) is a leading cause of illness in Thai children under five years of age. It occounted for 84.2 cases per 100,000 population in 1985; since then its incidence appears to be increasing.[1] According to the Department of Infectious Disease Control, Ministry of Health, in 1990, upper respiratory tract infection (URI) was the most common illness in infants under one year of age.[2] Moreover, 65% of all pneumonia cases reported in 1988 were younger than four years of age. Severe lower respiratory tract infection (LRI) or pneumonia ranked as the second most common cause of infant mortality with a death rate of 89.5 per 100,000 population.[3] A number of those infants who survived serious LRI might have remaining morbidity requiring prolonged special health care. After the age of three years, there was a significant fall in the incidence of serious LRI with a corresponding rapid fall in morbidity and mortality.[3,4] Thus, prevention is the best means to solve ARI problems in young children.

Although a number of studies have been done to identify causes and risk factors of ARI in Thai children, the results are not quite conclusive. Further studies are still required to identify definite risk factors in order help provide appropriate preventive measures. The objective of this study is to identify significant risk factors of both URI and LRI in order to find possible preventive means to reduce the incidence, morbidity and mortality of ARI in young children.

Subjects and methods

A total number of 450 children aged between one month and three years who attended the well-baby clinic, out-patient clinic and pediatric wards of Chulalongkorn Hospital, Bangkok, Thailand, during the period September 1989-July 1990 were enrolled in this prospective, case-control study.

The inclusion criteria included :

1. Control group :
   - healthy children
   - no URI symptoms for at least three weeks prior to the study.
   - no previous history of pneumonia or severe LRI or frequent URI ($>$ 1/month)
2. study group :
   - children with a diagnosis of URI and LRI (acute bronchiolitis and pneumonia)

The diagnosis of URI and LRI based on the following clinical and radiological criteria[5]:

URI (common old, nasopharyngitis, pharyngitis)
- rhinorrhea, cough, fever $\pm$, sore throat $\mp$
- no dyspnea and normal lung sound
- negative chest x-ray (done in some cases)

LRI (acute broncholitis, pneumonia)
- cough, fever $\pm$
- dyspnea or tachypnea, chest retractions
- abnormal lung sounds (wheezing, rhonchi or crepitations)
- abnormal chest x-ray compatible with acute bronchiolitis or pneumonia

Exclusion criteria were:

1. congenital anomalies including congential heart disease
2. chronic disease, e.g. chronic lung diseases (asthma, bronchopulmonary dysplasia), cerebral palsy etc.
3. associated concurrent diseases.

The children were classifed into three groups:

Group 1-150 healthy children as the control group

Group 2-150 children with URI as the first study group

Group 3-150 children with LRI as the second study group

The parents or reliable care-takers of all 450 children were interviewed by the investigators according to prepared questionnaire. The main topics of the questionnaire included questions about host factors (birth weight, nutritional and immunization status), enviornmental factors, socio-economic status, parental education and quality of parental care.

Statistical analysis

The data obtained from the interview were analyzed by using Chi-square test with Yates' correction. In order to get more precise and less baised risk factors, multiple logistic regression was carried out to calculated adjusted odds ratio of each significant risk factor with a 95% confidence interval.

Results

Most of the 450 children were from Prakanong district, one of the urban areas of Bangkok including Klong Toey slum (control group 30.5%, URI group 27.5%, LRI group 40.4%. The remainder were from various parts of Bangkok and Samutprakarn province. The average age and sex ratio were not different among the three groups (table 1).

Table 1. Age and sex characteristics.

	Control group (N = 150)	URI group (N = 150)	LRI group (N = 150)
Age (months)			
X ± S.D.	9.6 ± 8.1	11.1 ± 6.7	10.1 ± 8.4
Male : female	1.38 : 1	1.34 : 1	1.38 : 1

Note: There was no statistically significant difference among the three groups at $\alpha = 0.05$

Univariate analysis

Body weight by age below the 50th percentile and incomplete immunization were the significant host factors for URI while body weight by age below the 3rd and 50th percentiles, lower percentage of breast-feeding and incomplete immunization were significant for LRI as compared with healthy children in the control group. (table 2)

Table 2. Presence of host factors and quality of care in URI and LRI groups as compared with healthy children.

Factors	Control group N. (%)	URI group N. (%)	LRI group N. (%)
Prematurity	1(0.7)	0(0)	0(0)
Birth weight < 2,500 gm	16(10.7)	17(11.3)	16(10.7)
Body weight by age			
< 50th percentile	52(34.7)	75(50.0)*	98(65.3)*
< 3rd percentile	11(7.3)	8(5.3)	26(17.3)*
Breast-feeding			
0.5-1 month	119(79.3)	111(74.0)	104(69.3)*
> 3 months	48(32.0)	69(46.0)	46(30.7)
Incomplete immunization for age	11(7.3)	43(25.7)*	50(33.3)*

Note : *There was a statisitically significant difference between each study group and the control group at $\alpha = 0.05$.

When considering environmental factors, both URI and LRI groups had significantly bigger percentages of poor housing sanitation (dirty water underneath the house and garbage nearby), inhaled smoke (from indoor cigarettes, use of insect repellent and use of wood stove for cooking), the presence of over 10 people, or more than three children under 10 years of age in the same house, or over three people sleeping in the same room and exposure to concurrent ARI cases in the family. (table 3)

Table 3. Presence of environmental factors in URI and LRI groups as compared with healthy children.

Factors	Control group N (%)	URI group N (%)	LRI group N (%)
Housing sanitation :			
- dirty water underneath house	30(20.0)	71(47.3)*	74(49.3)*
- garbage nearby	21(14.0)	45(30.0)*	41(27.3)*
Smoke from :			
- nearby factory	31(20.7)	61(40.7)*	31(20.7)
- cigarette in home	84(56.0)	112(74.7)*	109(72.7)*
- insect repellent	22(14.7)	64(42.7)*	65(43.3)*
- wood stove	25(16.7)	43(28.7)*	63(42.0)*
Crowding :			
> 10 people in home	2(1.3)	15(10.0)*	18(12.0)*
> 3 children in home	7(4.7)	24(16.0)*	35(23.3)*
> 3 people sleeping in the same room	36(24.0)	37(24.7)	72(48.0)*
ARI > 1 case in home	9(6.0)	53(35.3)*	66(44.0)*

Note: *There was a statistically significant difference between each study group and the control group at $\alpha = 0.01$.

For the majority of all 450 children, family income was less than 5,000 baht (US$200)/month. More families with lower income and maternal education level at or lower than primary school were found in URI and LRI groups than the control group. (table 4)

Table 4. Presence of socio-economic factors in URI and LRI groups as compared with healthy children.

Factors	Control group N (%)	URI group N (%)	LRI group N (%)
Education < 1^0 school			
- father's	40(26.7)	53(35.3)	70(52.7)*
- mother's	48(32.0)	76(50.7)*	77(51.3)*
Family income:			
< 5,000 baht/month	88(58.7)	121(80.7)*	122(81.3)*

Note: *There was a statistically significant difference between each study group and the control group at $\alpha = 0.01$.

When comparing between the LRI and URI groups, the percentages of cases with low body weight (<3^{rd} percentile), over three people sleeping in the same room and father's educational level at or less than primary school were significantly higher in the LRI group. Moveover, the LRI group was less frequently breast-fed than the URI group. (table 5)

Table 5. Factors in LRI that were significantly different from the URI group.

Factors	URI gr N (%)	LRI gr N (%)
- Body weight by age < 3rd percentile	8(5.3)	26(17.3)*
- Breast-feeding > 3 months	69(46.0)*	46(30.7)
> 3 people sleeping in the same room	37(24.7)	72(48.0)*
- Father's education ≤ 10 school	53(35.3)	79(52.7)*

Note : *There was a statistical significance at $\alpha = 0.01$.

Multiple logistic regression analysis

In the multivariate analysis using multiple logistic regression, the most significant independent risk factor for developing URI and LRI was the presence in the family of at least one child with ARI (odds ratio of 9.73 and 15.55, repectively). Body weight by age less than third percentile or underweight and overcrowding (>3 people sleeping in the same room) were the two independent risk factors for developing severe LRI in children with URI. The other independent factors for URI and LRI are shown in table 6.

Table 6. Significant risk factors by using multiple logistic regression analysis at $\alpha = 0.05$.

Factors	Odds ratio	95% C.I.
URI vs. healthy group		
- ARI ≥ 1 case in home	9.73	3.86-24.52
- > 10 people in home	5.60	1.01-31.19
- Incomplete immunization	3.39	1.57- 7.31
- Dirty water underneath the house	3.26	1.67- 6.39
- Insect-repellent smoke	2.71	1.35- 5.43
- Family income < 5,000 baht/month	2.29	1.14- 4.61
LRI vs. healthy group		
- ARI ≥ 1 case in home	15.55	6.02-40.13
- Dirty water underneath the house	4.60	2.12- 9.99
- Body weight by age < 50th percentile	4.37	2.13- 8.95
- Incomplete immunization	2.93	1.21- 6.80
- Insect-repellent smoke	2.88	1.35- 6.14
LRI vs. URI		
- Body weight by age < 3rd percentile	3.19	1.24- 8.24
- > 3 people sleeping in the same room	1.98	1.07- 3.66

Discussion

Previously reported factors potentially responsible for increasing the incidence and severity of ARI in children could be classified into host factors, quality of perental care and environmental factors.

The significant host factors reported from western countries included low birth weight, prematurity, young age group (<3 years old), congenital malformation especially cardiac diseases, cystic fibrosis, poor nutritional status, vitamin A deficiency, immune deficiencies especially Ig A or IgG subclass deficiencies and chronic lung diseases after injury during infancy, e.g. bronchopulmonary dysplasia.[4,6-8] A study of 256 children who died of pneumonia during the year 1982-1987 at the Children's Hospital, Ministry of Public Health, Bangkok, also showed that low birth weight, young age (<1 year old), measles and congenital malformations were significant risk factors for pneumonia death.[9] Another study of Mahidol University in 1986-1987 found that chronic malnutrition and maternal history of allergy significantly contributed to the increased incidence of ARI in children under five years of age in Din Daeng, one of the central Bangkok areas.[10] Our study could not demonstrate that low birth weight and prematurity increased the incidence and severity of URI and LRI in young children as reported in other studies. However, low body weight for age was the single independent host factor for development of severe LRI both in previously healthy children (odds ratio 4.37, 95% CI = 2.13-8.95) and children with URI (odds ratio 3.19, 95% CI = 1.24-8.24).

Poor quality parental care in terms of not providing complete immunization resulted in a higher risk for the development of both URI (odds ratio 3.39, 95% CI = 1.57-7.31) and LRI (odds ratio 2.93, 95% CI = 1.21-6.80). Not breast-feeding, which was proven as an important risk factor of ARI caused by respiratory syncytial virus,[11] seemed to be significant for the development of LRI by univariate analysis, but it was not statistically significant with multiple logistic regression analysis. This might be due to the small sample size or the fact that the majority of our studied population were breast-fed.

A large number of environmental risk factors had been reported and the results were different in various places.[10,12,15] However, it was agreed that parental smoking, exposure to infection by having older siblings and early admission to a day care nursery were the important risk factors of ARI in young children.[12,13,14] Maternal cigarette-smoking was associated with an increase of 20-35% in the rate of respiratory illnesses, while paternal smoking was associated with smaller but still substantial increases.[15] In addition, a recent study in American Indian children demonstrated that the use of a wood-burning stove and exposure to respiratory illness were independently associated with higher risk of LRI in children ≤ 24 months of age.[16] In Thai children, concurrent measles infection was associated with higher mortality rate of pneumonia; crowded living conditions (>7 people in home) was previously reported to increase the incidenc of ARI.[9,10] Our results confirmed that concurrent exposure to an ARI case at home was the most significant risk factor of URI and LRI in previously normal children. It also confirmed that overcrowed living conditions (>10 people in the home) increased risk for development of URI. Moreover, physically close contact between family members (>3 people sleeping in the same room) was also a significant risk factor of LRI in children with previous URI. (table 6)

We also investigated that poor housing sanitation in terms of dirty water underneath the house and frequent use of insect or mosquito-repellent smoke were associated with higher risk for ARI. The use of insect-repellent smoke is quite common among Thai families in slum areas; however, its use never been discribed as a risk factor of ARI. The irritating and/or allergenic effect of such fumigation might predispose these children to ARI. The significance of this finding should be further investigated.

Low socio-economic status (family income <5,000 baht/moth or US$200/month) was also a significant risk factor of URI, as previously described.[10,17]

Conclusion

Our study confirmed the finding of previous studies that low body weight for age, overcrowding and low family income were independently associated with higher risk of ARI in Thai children as well as children in other developing countries. The additional significant risk factor for both URI and LRI included incomplete immunization, concurrent exposure to an ARI case at home, dirty water underneath the house and frequent use of insect-repellent smoke. Moderate to severe malnutrition and close contact between family members or suboptimal room ventilation (>3 sleeping in the same room) were the two significant factors for

children with URI to develop LRI. In order to prevent ARI in young children, co-operation between the governmental and non-governmental organizations concerned should be carried out to improve housing sanition, water supply, drainage and to increase family income as well as to solve the problem of overcrowding. The medical personnel who take care of children can help by campaigning for complete immunization, especially against diphtheria, pertussis and early measles, for improving the nutritional status of families and discouragings the use of insect repellent fumigation in addition to cigarette smoking.

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