Comparison of risk factors for recurrent respiratory infections between urban and rural preschool children in Yiwu, China

Yan Zou, Hong-Xing Jin, Rong-Shan Wang, Hai-Feng Li, Pei-Gang Jin
Hangzhou, China

Background: **Many studies have shown an association between the risk of increased recurrent respiratory infections and socioeconomic and fostering factors, but often only a few risk factors have been studied. This study aimed to identify and compare such factors between urban and rural preschool children.**

Methods: **Case control studies were conducted in Yiwu urban and rural areas respectively in Zhejiang Province. A structured questionnaire was used to collect information on influencing factors such as socioeconomic factors, fostering factors, and housing conditions. The chi-square test was used to compare the distribution of some health related factors between urban and rural children. Risk factor analyses were also made in urban and rural children respectively. Univariate and multivariate analyses were made using the binary logistic regression.**

Results: **Multivariate analysis showed that maternal age (OR=0.94, 95%CI: 0.89-0.99), asthma (OR=2.34, 95%CI: 1.22-4.48), rickets (OR=5.03, 95%CI: 2.10-12.05), snack (OR=1.62, 95%CI: 1.19-2.20), traffic mode (OR=1.38, 95%CI: 1.03-1.86), living with patients with chronic respiratory system disease (OR=1.79, 95%CI: 1.02-3.15), and indoor passive smoking (OR=1.46, 95%CI: 1.02-2.10) were the influencing factors for recurrent respiratory infections in urban children. Rickets (OR=3.77, 95% CI: 1.13-12.65) and passive smoking (OR=2.33, 95% CI: 1.17-4.65) were the influencing factors for recurrent respiratory infections in rural children.**

Conclusions: **Public health measures against risk factors should be taken to prevent the occurrence of recurrent respiratory infections in urban and rural children respectively.**

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Key words: **children;**
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Introduction

Except those in the neonatal period, acute respiratory infections are the leading causes of death among children under 5 years old and estimated to be responsible for 1.9 to 2.2 million childhood deaths annually throughout the world.[1] In 8.795 million deaths in children younger than 5 years in the world in 2008, deaths due to infectious diseases, largely pneumonia, accounted for 68%.[2] The incidence of respiratory tract infections in children is extremely high in both industrialized and developing countries. Studies have shown an association between the risk of increased recurrent respiratory infections and socioeconomic and fostering factors, but often only a few risk factors have been studied at a time. The objective of this study was to determine risk factors for recurrent respiratory infections in urban and rural preschool children, and special emphasis was placed on the role of socioeconomic factors, fostering factors, and housing conditions.

Methods

Study area and population

Yiwu, located in the central part of Zhejiang Province, covers an area of 1105 km^2 with 6 towns and 7 sub-districts and has 716 000 local residents. The study was conducted in Yiwu from June 2009 to September 2010. Preschool children aged 3-5 years were selected

Author Affiliations: Zhejiang Provincial Center for Disease Control and Prevention, Hangzhou, China (Zou Y, Jin PG); Yiwu Women and Children's Hospital, Yiwu, Zhejiang Province, China (Jin HX, Wang RS); Children's Hospital, Zhejiang University School of Medicine, Hangzhou, China (Li HF)

Corresponding Author: Pei-Gang Jin, Zhejiang Provincial Center for Disease Control and Prevention, Hangzhou 310051, China (Email: zouyan0573@sina.com)

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with simple random sampling according to the book provided by nurseries, and the sample size was estimated according to the prevalence rate of recurrent respiratory infections. Children with congenital disease, hereditary disease, tumor, or a history of surgery were excluded from this study. Children using immunosuppressive agents or hormonal drugs were also excluded.

Case definitions

Diagnosis was made by a physician according to hospital records of children. Based on the clinical concept and management of recurrent respiratory tract infections in children of 3-5 years old in 2008, a child with upper respiratory infection at least 6 times or lower respiratory infection at least 2 times per year was defined as a patient with recurrent respiratory infection.[3] The interval between every two infections should be at least 7 days. If upper respiratory infections were less than 6 times annually, lower respiratory infections could be added to meet the diagnostic criteria.

Data collection

To determine the influencing factors in preschool children with recurrent respiratory infections, structured questionnaires were addressed by their mothers or guardians. The information on influencing factors included age, gender, birth characteristics, socioeconomic factors, fostering factors, and housing conditions. Rickets was defined by trained investigators according to clinical symptoms, serum calcium, phosphorus, and alkaline phosphatase. Fine nursery care was defined as fostering the baby at a fixed time and location and with a definite quantity of stuff.

A medical doctor and a registered nurse who was familiar with anthropometric measurements of infants were trained for 2 days before the questionnaire investigation. The investigation was conducted between June 2009 and September 2010. All of the women (men) who took part in the study should provide their informed consent for participation.

Statistical analysis

The Chi-square test was used to compare the distribution of some health-related factors between urban and rural children. A P value less than 0.05 was considered statistically significant.

Risk factor analyses were made in urban and rural children respectively. Univariate and multivariate analyses were made using the binary logistic regression. Each risk factor was analyzed separately in a univariate model. A multivariate regression model was constructed. The SPSS16.0 software was used for the logistic model, and forward likelihood ratio was chosen as a method of analysis. P=0.05 was used for inclusion in the model, whereas P=0.10 for exclusion from the model. The confidence level was 95% for all the analyses.

Results

Study population and risk factor analyses

Totally 684 urban children and 161 rural children were investigated. Among 684 urban children, 161 were diagnosed with recurrent respiratory infection, thus 161 patients and 523 controls were included in the case control study. Among 161 rural children, 49 were diagnosed with recurrent respiratory infection, thus 49 patients and 112 controls were included in the case control study. The height was 104.6±10.3 cm and 102.8±10.9 cm in urban and rural children respectively (t=1.951, P=0.051). The weight of the children was 17.3±4.3 kg and 16.8±4.2 kg respectively (t=1.469, P=0.142). Maternal age was 27.5±3.8 years and 26.8±4.5 years in urban and rural areas respectively (t=1.712, P=0.088). The birth weight of the children was 3.3±0.6 kg and 3.4±0.7 kg in urban and rural areas, respectively (t=-1.898, P=0.058).

Related social factors and fostering factors were compared between urban and rural preschool children (Tables 1 and 2). Between urban and rural children, there were significant differences in such factors as occupation, monthly income, parents education, vaccination, snack, education mode, daily amount of drinking water, type of drinking water, afternoon nap, and nursery care.

Risk factors in urban children with recurrent respiratory infections

The height was 104.6±10.6 cm and 104.5±9.2 cm in the patient and control groups respectively (t=-0.168, P>0.05). The weight was 17.3±4.4 kg and 17.3±4.2 kg respectively in the two groups (t=-0.002, P>0.05). Maternal age was 27.7±3.7 years and 26.8±4.1 years in the patient and control groups respectively (t=2.551, P=0.011). The birth weight of the children was 3.3±0.5 kg and 3.4±0.7 kg in the two groups (t=-0.889, P=0.374).

The results of univariate risk factor analyses in urban children are shown in Tables 3 and 4. A number of factors (delivery, asthma, rickets, snack, type of drinking water, traffic mode, living with chronic respiratory system disease patients, passive smoking, frequently sweeping) were significantly associated with recurrent respiratory infections.

The variables were chosen with P value less than 0.10 shown by univariate analyses. The multivariate

Table 1. Comparison of related social factors between urban and rural preschool children in Yiwu, China, 2009-2010

Characteristics	Urban area (%)	Rural area (%)	χ^2	*P*
Parents' occupation			46.995	<0.001
Brain work	379 (55.4)	44 (27.3)		
Physical force work	80 (11.7)	43 (26.7)		
Both	225 (32.9)	74 (46.0)		
Monthly income (RMB)			25.394	<0.001
<1000	25 (3.7)	17 (10.6)		
≥1000	160 (23.4)	56 (34.8)		
≥3000	254 (37.1)	45 (28.0)		
≥6000	245 (35.8)	43 (26.7)		
Education, father			69.992	<0.001
Junior school	123 (18.0)	68 (42.2)		
Senior school	192 (28.1)	61 (37.9)		
College	369 (53.9)	32 (19.9)		
Education, mother			45.843	<0.001
Junior school	159 (23.2)	62 (38.5)		
Senior school	198 (28.9)	69 (42.9)		
College	327 (47.8)	30 (18.6)		

Table 2. Comparison of fostering factors between urban and rural preschool children in Yiwu, China, 2009-2010

Characteristics	Urban area (%)	Rural area (%)	χ^2	*P*
Vaccination			9.929	0.002
Yes	623 (91.1)	133 (82.6)		
No	61 (8.9)	28 (17.4)		
Education mode			5.062	0.080
Parents centered	132 (19.3)	41 (25.5)		
Child centered	118 (17.3)	33 (20.5)		
Both	434 (63.5)	87 (54.0)		
Snack			5.370	0.068
Occasionally (≤1 time per week)	312 (45.6)	66 (41.0)		
Regularly (2-3 times per week)	324 (47.4)	75 (46.6)		
Frequently (>3 times per week)	48 (7.0)	20 (12.4)		
Daily amount of drinking water			11.235	0.004
≤100 mL	129 (18.9)	48 (29.8)		
100-300 mL	445 (65.1)	97 (60.2)		
≥300 mL	110 (16.1)	16 (9.9)		
Type of drinking water			11.157	0.004
Drink	159 (23.3)	58 (36.0)		
Plain boiled water	483 (70.6)	95 (59.0)		
Fresh fruit juice	42 (6.1)	8 (5.0)		
Afternoon nap			3.985	0.046
Yes	531 (77.6)	113 (70.2)		
No	153 (22.4)	48 (29.8)		
Taking care			23.950	<0.001
Fine	97 (14.2)	20 (12.3)		
Comparatively fine	441 (64.5)	77 (47.8)		
Common	146 (21.3)	64 (39.8)		

equation model consisted of the following variables: maternal age (OR=0.94, 95%CI: 0.89-0.99, *P*<0.05), asthma (OR=2.34, 95%CI: 1.22-4.48, *P*<0.01), rickets (OR=5.03, 95%CI: 2.10-12.05, *P*<0.01), snack (OR=1.62, 95%CI: 1.19-2.20, *P*<0.01), traffic mode (OR=1.38, 95%CI: 1.03-1.86, *P*<0.05), living with patients with chronic respiratory disease (OR=1.79, 95%CI: 1.02-3.15, *P*<0.05), and passive smoking (OR=1.46, 95%CI: 1.02-2.10, *P*<0.05).

Risk factors in rural children with recurrent respiratory infections

The height of the children was 102.4±10.6 cm and 103.9±11.6 cm in the patient and control groups respectively (*t*=-0.792, *P*>0.05). The weight of the children was 16.6±4.2 kg and 17.2±4.2 kg respectively in the two groups (*t*=-0.801, *P*>0.05). Maternal age was 26.9±4.7 years and 26.5±4.0 years in the patient and control groups respectively (*t*=0.517, *P*=0.606). The birth weight of the children was 3.4±0.5 kg and 3.6±0.9 kg in the two groups (*t*=-1.763, *P*=0.080).

The results of the univariate risk factor analyses in rural children are shown in Tables 3 and 4. Rickets, sleeping habit, and passive smoking were significantly associated with recurrent respiratory infections. The variables were chosen with a *P* value less than 0.10 shown by the univariate analyses. The multivariate equation model consisted of rickets (OR=3.77, 95%CI: 1.13-12.65, *P*<0.05) and passive smoking (OR=2.33, 95%CI: 1.17-4.65, *P*<0.05).

Discussion

In the present study, a number of factors were found to be different between urban and rural children, which may be related to the influence of social and environmental factors, health behaviors, and level of awareness concerning certain health conditions. Family conditions of children such as parents' education, occupation, and income in urban areas were superior to those of children in rural areas. The urban children may be fostered more carefully. Limited by apartment building with small floor space, urban children easily suffer from recurrent respiratory infections.

Maternal age is associated with recurrent respiratory infections. A study[4] showed that compared with children whose mothers were 30 years old or more, children whose mothers were aged 26-30 years had an adjusted odd ratio (OR) of 1.16 for developing asthma, children whose mothers were 21-25 years old had an OR of 1.25, and those whose mothers were 20 years old or less had an OR of 3.48. In a study on Norweigian mothers and children, no low gestational age was

found to be associated with middle ear infection.[5] In our study, maternal age was a slight protective factor for recurrent respiratory infections with an OR of 0.94 (95% CI: 0.89-0.99) in urban children. Because of socio-economic differences and health awareness, maternal age was not found to be an influencing factor in rural children.

Asthma was reported to be a risk factor for respiratory infection in early life, and the atopic or asthmatic background is a marked predisposing factor for the development of recurrent respiratory infection.[6] Respiratory syncytial virus (RSV) prophylaxis in non-atopic children decreases by 80% in the relative risk of recurrent wheezing but does not have any effect on infants with an family history of atopy. This finding suggests that RSV predisposes to recurrent wheezing in an atopy-independent mechanism.[7] Our study finds that asthma is associated with the risk of recurrent respiratory infections in urban children; however, this association was not found in rural children (P=0.582).

In the present study, rickets was a risk factor for recurrent respiratory infections both in urban and rural children. Vitamin D deficiency is considered to be linked to various infectious diseases.[8] A case-control study[9] on the association between acute lower respiratory tract infection and vitamin D status in infants and young children revealed an inverse association between 25(OH)D and the odds of hospitalization for acute respiratory infection. Another study[10] found that newborns with sub-clinical vitamin D deficiency may suffer from acute respiratory infection. Moreover, immunomodulatory properties of

Table 3. Risk factors for recurrent respiratory infections in preschool children in urban and rural area, Yiwu, China, 2009-2010

Characteristics	Urban area				Rural area			
	Patient (%)	Control (%)	χ^2	P	Patient (%)	Control (%)	χ^2	P
Age (y)			6.782	0.072			0.223	0.974
≤3	22 (13.7)	102 (19.5)			13 (26.5)	28 (25.0)		
≤4	57 (35.4)	138 (26.4)			11 (22.4)	29 (25.9)		
≤5	35 (21.7)	136 (26.0)			12 (24.5)	26 (23.2)		
>5	47 (29.2)	147 (28.1)			13 (26.5)	29 (25.9)		
Delivery			5.148	0.023			0.084	0.771
Spontaneous labor	86 (53.4)	224 (42.8)			23 (46.9)	57 (50.9)		
Abdominal delivery	75 (46.6)	299 (57.2)			26 (53.1)	55 (49.1)		
Asthma			11.827	0.001			0.303	0.582
Yes	23 (14.3)	31 (5.9)			6 (12.2)	9 (8.0)		
No	138 (85.7)	492 (94.1)			43 (87.8)	103 (92.0)		
Rickets			28.679	<0.001			4.767	0.029
Yes	21 (13.0)	12 (2.3)			7 (14.3)	5 (4.5)		
No	140 (87.0)	511 (97.7)			42 (85.7)	107 (95.5)		
Snack			21.316	<0.001			2.294	0.318
Occasionally	60 (37.3)	249 (47.6)			16 (32.7)	50 (44.6)		
Regularly	76 (47.2)	248 (47.4)			27 (55.1)	48 (42.9)		
Frequently	25 (15.5)	26 (5.0)			6 (12.2)	14 (12.5)		
Type of drinking water			11.119	0.004			0.783	0.676
Drink	40 (24.8)	119 (22.8)			17 (34.7)	32 (28.6)		
Plain boiled water	102 (63.4)	379 (72.5)			27 (55.1)	70 (62.5)		
Fresh fruit juice	19 (11.8)	22 (4.8)			6 (12.2)	10 (8.9)		
Sleeping habit			5.099	0.078			6.616	0.037
With adults	117 (72.7)	334 (63.9)			30 (61.2)	70 (62.5)		
By himself or herself	22 (13.7)	81 (15.5)			13 (26.5)	14 (12.5)		
Both	22 (13.7)	108 (20.6)			6 (12.2)	28 (25.0)		
Afternoon nap			2.984	0.084			0.069	0.793
Yes	117 (72.7)	414 (79.2)			34 (69.4)	80 (71.4)		
No	44 (27.3)	109 (20.8)			15 (30.6)	32 (28.6)		
Traffic mode			13.229	0.001			4.768	0.092
Car	93 (57.8)	371 (70.9)			31 (63.3)	82 (73.2)		
Walking	48 (29.8)	123 (23.5)			15 (30.6)	18 (16.0)		
Bicycle	20 (12.4)	29 (5.4)			3 (6.1)	12 (11.7)		
Taking care			5.390	0.068			0.086	0.958
Fine	20 (12.6)	79 (15.1)			6 (12.2)	14 (12.5)		
Comparatively fine	97 (60.2)	345 (66.0)			23 (46.9)	55 (49.1)		
Common	44 (27.3)	99 (18.9)			20 (40.8)	43 (38.4)		

vitamin D was found to influence the severity of acute lower respiratory infection disease.[11] Since vitamin D has important immunomodulatory effects, interventions for improving maternal-infant vitamin D status could reduce the incidence of recurrent respiratory infection.

Quality protein maize improves the nutritional status of pre-school children with mild or moderate malnourishment, but it has no effect on diarrhea or respiratory infections.[12] In our study, snacks were found be a risk factor for recurrent respiratory infections with an OR of 1.62 (95%CI: 1.19-2.20) in urban children. This is possibly due to components or additives in snack other than protein.

In the present study, passive smoking was a risk factor for recurrent respiratory infections both in urban and rural children with an OR of 1.46 (95%CI: 1.02-2.10) and 2.33 (95%CI: 1.17-4.65) respectively. Passive smoking is considered one of the most serious and most common health hazards for children. Exposure to passive smoking is associated with an increased susceptibility to respiratory infection. It was reported that smoke exposure is specific to the IFN-gamma-producing $CD8^+$ cells in adenoids and may contribute to the increased susceptibility to the recurrence of respiratory infections.[13] Home remained the source of second-hand smoke exposure to children, and smoke-free legislation was associated with an unexpected reduction in cotinine level in children.[14] Our study indicates that urgent measures against passive smoking should be taken and health care providers should reinforce the counseling about adverse effects of smoking on environment. In health education, health-care providers should inhibit passive smoking; if impossible, breast-feeding is encouraged to facilitate protection against the effects of passive smoking. Breast milk has unique anti-infective properties including protection against pathogens, stimulation of the immune system and the factor inhibiting colonization of Gram-negative species.[15-17]

In the present study, traffic mode was significant in multivariate analysis of urban children with an OR of 1.38. Possibly going out by car could avoid air pollution. Outdoor air pollution exposure increases the incidence of upper and lower respiratory infections in children.[18] Living with patients with chronic respiratory system disease was found to be a risk factor for recurrent respiratory infection in urban children because of the poor indoor living condition in city. Indoor airborne pollution such as personal communication and indoor environmental pollution has negative influences on respiratory infection in children.[19,20] The urban apartment building is always with limited floor space and the crowded housing conditions support the invasion of parasites, infectious diseases, and viral infections. Exposure to pesticides may induce chronic diseases in children because of accumulation or mixing of various chemicals while increasing the risk of recurrent respiratory infections. Domestic animals were also reported to be a factor inducing recurrent respiratory infections.[21] In this study, however, the mentioned factors were found to have little influence on children in urban and rural areas.

Table 4. Housing conditions as risk factors for recurrent respiratory infections in preschool children in urban and rural area, Yiwu, China, 2009-2010

Characteristics	Urban area				Rural area			
	Patient (%)	Control (%)	χ^2	*P*	Patient (%)	Control (%)	χ^2	*P*
Per capita living space (m^2)			3.149	0.207			0.359	0.839
≤10	6 (3.7)	17 (3.3)			2 (4.1)	5 (4.5)		
10-30	64 (39.8)	170 (32.5)			14 (28.6)	37 (33.0)		
≥30	91 (56.5)	336 (64.2)			33 (67.3)	70 (62.5)		
Living with chronic respiratory system disease patient			4.241	0.039			0.002	0.964
Yes	22 (13.7)	43 (8.2)			6 (12.2)	14 (12.5)		
No	139 (86.3)	480 (91.8)			43 (87.8)	98 (87.5)		
Passive smoking			4.764	0.029			5.369	0.020
Yes	86 (53.4)	226 (43.2)			31 (63.3)	47 (42.0)		
No	75 (46.6)	297 (56.8)			18 (36.7)	65 (58.0)		
Frequent sweeping			7.499	0.006			0.003	0.954
Yes	124 (77.0)	452 (86.4)			40 (81.6)	91 (81.3)		
No	37 (23.0)	71 (13.6)			9 (18.4)	21 (18.7)		
Pesticide using frequently in the room			1.652	0.199			0.615	0.433
Yes	18 (11.2)	82 (15.7)			3 (6.1)	13 (11.6)		
No	143 (88.8)	441 (84.3)			46 (93.9)	99 (88.4)		
Pet in the room			0.007	0.934			0.023	0.881
Yes	8 (5.0)	29 (5.5)			5 (10.2)	14 (12.5)		
No	153 (95.0)	494 (94.5)			44 (89.8)	98 (87.5)		

In conclusion, rickets and passive smoking are risk factors for recurrent respiratory infections in urban and rural children. Maternal age, asthma, snack, traffic mode, and living with patients with chronic respiratory system disease were also risk factors for recurrent respiratory infections only in urban children. In urban and rural areas, the risk factors for recurrent respiratory infections were different because of the influence of social and environmental factors, health behaviors, and awareness concerning certain health conditions. These findings have major public health implications as the influence factors are possible targets for intervention.

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