Original Article

Epidemiological survey and analysis of asthma in children aged 0-14 years old in urban and rural areas of Chengdu region

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Objectives: To investigate the prevalence and incidence of asthma among children aged 0-14 years, with different living environments, economic levels, and sanitary conditions, in the urban and rural areas of Chengdu, China, and their influential factors.

Methods: Children aged 0-14 years who were selected from urban, suburban, and rural areas of Chengdu were included in the study. The subjects were selected from all children aged 0-14 years in schools, kindergartens, and communities by random, cluster and non-proportional sampling. Parents were surveyed by questionnaire to find out suspected cases, which were then confirmed by inquiry and physical examination in the departments of respiratory medicine. All the obtained data were analyzed using SPSS statistical software.

Results: A total of 12,082 children from the urban areas, 5,677 from suburban areas, and 5,590 from the rural areas were included in the study. Of all the subjects, 551 (4.56%) had confirmed asthma, 150 (2.64%) had cough variant asthma (CVA), and 142 (2.54%) had suspected asthma. The prevalence rate of asthma was significantly higher in the urban areas than in the suburban and rural areas. The correct rate of diagnosis of asthma and CVA was highest in the urban areas, followed by the suburban and rural areas. Use of antibiotics and systemic corticosteroids was most common in the rural areas, followed by the suburban and urban areas, but this pattern was reversed for use of inhaled corticosteroids and leukotriene modifier. All the results in the three areas demonstrated that sex, age, age at which the first attack occurred, respiratory tract infection, inhalation/intake of allergens, and genetic factors were significantly associated with asthmatic attack.

Conclusions: Population density, living environment, medical and health resources and economic level are associated with the prevalence and treatment of asthma.

Keywords: Epidemiology; asthma; children

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Bronchial asthma (or asthma) is one of the most common chronic respiratory diseases in children. Globally, the past decades have witnessed the rapid development of socioeconomy, sciences, and technology; unfortunately, the prevalence of asthma has also gradually increased. Up to now two large-scale epidemiological surveys on childhood asthma have been conducted in China (1,2); however, both of them were focused on children living in big cities, and few data concerning the prevalence of asthma among children living in the same area but with different living conditions, different economic levels, and different sanitation environments have been reported. Therefore, in our current study, we conducted an epidemiological survey on asthma using cluster sampling method among 0-14-year-old children in Chengdu, capital of Sichuan Province, from September to December 2010.

Table 1 Asthma cases in three areas [n (%)]

Groups	n	Asthma	Cough-variant asthma	Suspected asthma
Urban area	12,082	485 (4.01)	66 (0.55)	97 (0.81)
Suburban area	5,677	137 (2.41)	13 (0.23)	32 (0.56)
Rural area	5,590	133 (2.38)	9 (0.16)	21 (0.31)

Subjects and methods

Subjects

By adapting the protocol developed by the Task Force on the Third National Epidemiological Survey on asthma among 0-14-year-old children, we selected children aged 0-14 years who were born during the period from July 1, 1996 to June 61, 2010) from urban (Qingyang District of Chengdu), suburban (Chengguan Town of Jintang County), and rural (Zhuhao Town of Jintang County) areas of Chengdu as subjects in our projects. According to the sample size calculation formula ($N = U\alpha^2 \times \pi \times (1-\pi)/\delta^2$) and the total child populations in these three areas, the sample sizes were 12,000, 6,000, and 6,000 in the urban, suburban, and rural areas. Based on the total child populations and the percentages of children in different age groups, the sample size for each age group was calculated. Finally, the subjects were selected from all children aged 0-14 years in schools, kindergartens, and communities by random, cluster, and non-proportional sampling. The diagnosis of asthma in these children was based on the Guidelines for the Diagnosis and Treatment of Asthma in Children (2008 edition) (3). The diagnoses included confirmed asthma, cough variant asthma (CVA), and suspected asthma.

Survey methods

The protocol, survey steps, and questionnaires used in the Third National Epidemiological Survey on asthma among 0-14-year-old children were adapted in our study. Before the initiation of the survey, all the investigators received adequate training in the "2010 Workshop on National Epidemiological Survey on Asthma in Children". The investigators registered all the sampled populations firstly, and then distributed the screening forms to the parents; after these forms were collected, suspected children with wheezing, cough, repeated respiratory tract infection, or a history of bronchitis were identified. Respiratory specialist physicians who had received uniform training carried out comprehensive inquiry and physical examinations using the standard questionnaires, and then made the final diagnosis and completed the asthma questionnaires. During the survey, special supervisors are assigned for organization, supervision, and quality control.

Statistical analysis

Database was established using the Epi Info software for data entry and logical checks. Statistical analysis of the data was performed using SPSS software. Measurement data are described using percentages, and chi square test is applied for inter-group comparisons. $P<0.05$ was considered significantly different.

Results

General conditions

Prevalence

It was expected that 12,270, 5,886, and 5,821 children should have been surveyed in the urban, suburban, and rural areas, and actually 12,082 (98.47%), 5,677 (96.45%), and 5,590 (96.03%) children were surveyed. The majority of the surveyed populations were Han children, followed by other ethnic groups including Tibet, Hui, Manchu, and Korean. A total of 993 children with related diseases were screened in these three areas (*Table 1*). Except children with suspected asthma, the cumulative incidence rates in the urban, suburban, and rural areas were 4.56%, 2.64%, and 2.54%, respectively ($\chi^2=65.025$, $P<0.01$); notably, the cumulative incidence rate in the urban area was significantly higher than those in the suburban and rural areas ($P<0.01$). Except cases that had not except exacerbations for more than two years, the prevalence of asthma in these three areas was 3.58%, 1.81%, and 2.08%, respectively.

Asthma in male and female children

The prevalence rates of asthma were significantly higher in males than in females in all three areas (all $P<0.01$) (*Table 2*).

Asthma in children of different age groups

The prevalence rates of asthma were relatively high in the 3-10-year-old age group in all three areas, and then gradually declined as the children become older (*Table 3*).

Previous diagnoses

During our current survey, 68.4% (377/551), 43.3% (65/150), and 28.2% (40/142) of the pediatric patients had previously been diagnosed as with asthma or CVA (χ^2=88.99, P<0.01). The correct rate of diagnosis of asthma and CVA was highest in the urban areas, followed by the suburban and rural areas.

Table 2 Prevalence rate of asthma in males and females in three areas [n (%)]

Groups	Male		Female	
	n	Prevalence	n	Prevalence
Urban area	6,096	352 (5.77)	5,986	199 (3.32)
Suburban area	2,839	81 (2.85)	2,838	69 (2.43)
Rural area	2,844	88 (3.09)	2,746	54 (1.97)
χ^2 value	45.114			
P value	<0.001			

Asthma attacks

Triggers for an acute asthma attack

The main trigger for an acute asthma attack among these children was respiratory tract infections (91.3%), followed by climate change (43.8%). Only a small proportion of the attacks were caused by pollen allergy (6.6%) (*Table 4*).

Age of the first asthma attack

Infants and young children under four years old had the highest rate of the first asthma attack in all three areas (76.6%, 81.3%, and 77.5%), which declined with age (*Table 5*).

Timing and predilection seasons

The timing of the acute attacks showed no specific rule among most asthma children in all these three areas. Asthma attack was more common in autumn, winter, and during seasonal changes. Children living in the urban area were significantly more likely to experience asthma attacks in autumn and winter than those in suburban and rural areas (P<0.05) (*Tables 6*,*7*).

Disease courses

Till the end of our current survey, the asthma attacks/exacerbations were found in 33 (6.0%), 14 (9.3%), and 17 (12.0%) pediatric patients in the urban, suburban, and

Table 3 Asthma in children of different age groups [n (%)]

Age (years)	Urban area		Suburban area		Rural area	
	n	Prevalence	n	Prevalence	n	Prevalence
0-	296	0 (0)	146	1 (0.68)	56	0 (0)
1-	354	6 (1.69)	255	3 (1.18)	87	2 (2.30)
2-	583	21 (3.60)	256	3 (1.17)	76	1 (1.32)
3-	724	52 (7.18)	379	17 (4.49)	206	11 (5.34)
4-	689	56 (8.13)	452	23 (5.09)	476	21 (4.41)
5-	753	62 (8.23)	394	25 (6.35)	451	7 (1.55)
6-	926	48 (5.18)	464	8 (1.72)	319	10 (3.13)
7-	1,009	55 (5.45)	411	9 (2.19)	438	11 (2.51)
8-	1,065	49 (4.60)	455	14 (3.08)	521	15 (2.88)
9-	1,250	54 (4.32)	530	16 (3.02)	521	20 (3.84)
10-	1,318	50 (3.79)	500	9 (1.80)	596	13 (2.18)
11-	1,270	36 (2.83)	363	7 (1.93)	564	10 (1.77)
12-	1,253	39 (3.11)	301	4 (1.33)	750	14 (1.87)
13-	476	21 (4.41)	536	8 (1.49)	446	6 (1.35)
14-15	116	2 (1.72)	235	3 (1.28)	83	1 (1.20)

Table 4 Triggers of asthma attacks in three areas [n (%)]

Group tastes	n	Respiratory tract infection	Climate change	Foods	Irritative	Sports	Pollen
Urban area	551	498 (90.4)	272 (49.4)	76 (13.8)	186 (33.8)	130 (23.6)	44 (8.0)
Suburban area	150	131 (87.3)	70 (46.7)	16 (10.7)	59 (39.3)	29 (19.3)	10 (6.7)
Rural area	142	141 (99.3)	72 (50.7)	18 (12.7)	50 (35.2)	32 (22.5)	2 (1.4)
Total	843	770 (91.3)	414 (43.8)	110 (13.0)	295 (35.0)	191 (22.7)	56 (6.6)

Table 5 Age of the first asthma attack of children in three areas [n (%)]

Group	n	Below 4	4-7-year-old	7-14-year-old
Urban area	551	422 (76.6)	99 (18.0)	30 (5.5)
Suburban area	150	122 (81.3)	19 (12.7)	9 (6.0)
Rural area	142	110 (77.5)	21 (14.8)	11 (7.8)

Table 6 Timing of asthma attacks in three areas [n (%)]

Group	n	Morning	Afternoon	Before sleep	Midnight	Irregular
Urban area	551	68 (12.3)	9 (1.6)	102 (18.5)	132 (24.0)	240 (43.6)
Suburban area	150	34 (22.7)	2 (1.3)	17 (11.3)	28 (18.7)	69 (46.0)
Rural area	142	21 (14.8)	4 (2.8)	0 (0)	23 (16.2)	94 (66.2)
χ^2 value		10.09	1.11	33.08	4.99	23.43
P value		<0.01	>0.05	<0.05	>0.05	<0.01

Table 7 Predilection seasons of asthma attacks in three areas [n (%)]

Group	n	Autumn and winter	Spring and summer	Transitions of seasons	Throughout the year	Irregular
Urban area	551	177 (32.1)[a]	55 (10.0)	161 (29.2)	10 (1.8)	148 (26.9)
Suburban area	150	31 (20. 7)	23 (15.3)	50 (33.3)	2 (1.3)	44 (29.3)
Rural area	142	18 (12.7)	7 (4.9)	84 (59.2)	0 (0)	33 (23.2)
χ^2 value		25.27	8.73	44.67	2.66	1.41
P value		<0.01	<0.05	<0.01	>0.05	>0.05

[a], P<0.05, compared with the suburban and rural areas.

rural areas, respectively, whereas asthma relief was achieved in 202 (36.7%), 41 (27.3%), and 37 (26.1%) patients. Obviously, the percentage of asthma attack/exacerbation gradually increased from the urban area to the rural area (P<0.05), while the percentage of asthma relief gradually declined (P<0.05). About 14-22% of the pediatric patients had not experienced asthma attacks for more than two years (*Table 8*).

Treatment

In all these three areas, over 80% of the pediatric asthmatic patients had used bronchodilators. Antibiotics were used in around 90% of the patients, and the antibiotic usage rate was significantly higher in the rural area than in the urban and suburban areas. The use of inhaled corticosteroids gradually decreased from the urban area to the suburban area, and then to the rural area; the use of leukotriene modifiers showed similar trend; and, the usage rates of systemic hormones were particularly high in the rural area (*Table 9*).

Health care costs for asthma

The overall health care costs since the disease onset was below RMB 10,000 in more than half of the pediatric

Table 8 Trends of asthma attacks in three areas [n (%)]

Group	n	Exacerbation	Unchanged	Relief	No attack within one year	No attack after two years	Attack after one or more years
Urban area	551	33 (6.0)[a]	90 (16.3)[b]	202 (36.7)[a]	83 (15.1)	118 (21.4)	25 (4.5)[a]
Suburban area	150	14 (9.3)	30 (20.0)	41 (27.3)	21 (14.0)	33 (22.0)	11 (7.3)
Rural area	142	17 (12.0)	40 (28.2)	37 (26.1)	14 (9.9)	20 (14.1)	14 (9.9)
χ^2 value		6.55	10.41	8.57	2.54	4.08	6.37
P value		<0.05	<0.01	<0.05	>0.05	>0.05	>0.05

[a], P<0.05 compared with the suburban area and rural area; [b], P<0.05 compared with the rural area.

Table 9 Treatment of asthma in three areas [n (%)]

Group	n	Bronchodilators	Systemic hormones	Inhaled steroids	Anti-leukotrienes	Antiallergics	Immune modulators	Desensitization therapy	Antibiotics	Traditional Chinese drugs
Urban areas	551	503 (91.3)	194 (35.2)[a]	383 (69.5)[a]	176 (31.9)[a]	350 (63.5)	76 (13.8)[a]	21 (3.8)	490 (88.9)[b]	335 (60.8)
Suburban area	150	134 (89.3)	48 (32.0)	57 (38.0)	19 (12.7)	94 (62.7)	3 (2.0)	3 (2.0)	134 (89.3)[b]	109 (72.7)
Rural area	142	114 (80.3)	85 (59.9)	32 (22.5)	8 (5.6)	115 (81.0)	2 (1.4)	1 (0.7)	139 (97.9)	128 (90.1)
χ^2 value		14.08	36.08	125.07	41.13	16.50	32.10	4.38	15.73	32.16
P value		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	>0.05	<0.01	<0.01

[a], P<0.05 compared with the suburban area and rural area; [b], P<0.05 compared with the rural area.

Table 10 Personal history of allergy in three areas [n (%)]

Group	n	History of eczema	History of allergic rhinitis	History of urticaria	History of drug allergy
Urban area	551	253 (45.9)[a]	286 (51.9)[b]	134 (24.3)[a]	97 (17.6)[a]
Suburban area	150	38 (25.3)	74 (49.3)	22 (14.7)	16 (10.7)
Rural area	142	21 (14.8)	52 (36.6)	11 (7.7)	14 (9.9)
χ^2 value		57.59	10.57	22.69	8.05
P value		<0.05	<0.05	<0.05	<0.05

[a], P<0.05, compared with the suburban and rural areas; [b], P<0.05, compared with the rural area.

asthma patients; however, due to the differences in family income, educational level, and parents' concerns about their children, the health care costs were below RMB 2,000 in 71.8% of rural pediatric patients and exceeded RMB 30,000 in 5.8% of urban pediatric patients.

Asthma-related factors

Personal history of allergy

The prevalence rates of various allergic diseases were significantly highest among children living in the urban area, followed by the suburban and rural areas (P<0.05) (*Table 10*).

Family history of allergy

The proportions of children with a family history of asthma in their first- or second-degree relatives were 27.2%, 28.0%, and 42.3% in the urban, suburban, and rural areas, and the family history of other allergies were reported in 37.6%, 16.0%, and 38.0% of these children (*Table 11*).

Discussion

When choosing the research subjects, the inclusion criteria were different from those adopted by two large-scale surveys on childhood asthma in China (1-2,4) and an epidemiological survey conducted in several major

Table 11 Family history of allergy in three areas [n (%)]

Group	n	History of asthma in the first and second-grade relatives	History of other allergies in the first and second-grade relatives
Urban area	551	150 (27.2)	207 (37.6)
Suburban area	150	42 (28.0)	24 (16.0)
Rural area	142	60 (42.3)	54 (38.0)
χ^2 value		12.48	25.87
P value		<0.01	<0.01

cities in recent years (5). In addition to the 0-14-year-old children in the downtown of Chengdu, children who were living in the suburban and rural areas that have the same geological location, season and climate change but with different population density, economic income, health care resources, and life habits were also enrolled in this study. The suburban area (Chengguan Town, Jintang County) was roughly 100 kilometers away from Chengdu, whereas the urban area is a hilly town. The results showed that the cumulative incidence rate of asthma was significantly higher in the urban area (4.56%) than in the suburban (2.64%) and rural areas (2.54%). This may be explained by the following factors: (I) along with the rapid industrialization and the increase of socioeconomic levels, the urban area has become more populous, and the number of families having cars, air conditioners, and carpets has rapidly increased; as a result, the environmental pollution is more severe in the urban area than in suburban and rural areas. More children who are prone to allergy are more likely to be affected by the environmental triggers (6). Furthermore, children who are living in the urban area are more likely to exposed to allergenic foods such as eggs and seafoods when they are at a young age; (II) the Jintang County, located in the outskirt of Chengdu, is a hilly area that are surrounded by hills and waters. Compared with the downtown of Chengdu, it is less populous; and, without environmental pollution from large plants, it has much fresher air; (III) according to the "Hygiene Hypothesis", children living in the urban areas are less possible to be exposed to the pathogenic microorganisms due to their good hygiene and sanitary conditions, and therefore they are less likely to suffer from communicable diseases and other infectious diseases; as a result, however, the Th1 response towards these microorganisms is weakened, together with relatively enhanced Th2 response. Thus, children in the urban areas are more susceptible to allergic diseases. As shown in our current study, the pediatric asthma children with a history of eczema, allergic rhinitis, and/or other allergic diseases were most common in the urban area, followed by the suburban and rural areas, which is consistent with the literature (7,8). In addition, a significantly higher proportion of male patients were found in all these three areas, which is also consistent with the literature (9,10). The possible explanations include the differences in hormone secretion and genetic susceptibility; the lower infection threshold in female carriers of pathogenic genes may also play a role.

Our study also showed that the correct rate of diagnosis of asthma was highest in the urban areas, followed by the suburban and rural areas. In China, the advocation, training, and implementation of the Global Initiative for Asthma (GINA) has greatly improved the early diagnosis of asthma; however, due to the diversities in health care resources, professional levels, socioeconomic development, family income, and parents' awareness and knowledge, the asthma diagnosis warrants further improvements in different areas.

The occurrence of asthma is closely linked to environmental factors, and childhood asthma is often age- and season-specific. In our current study, children whose first asthma attack occurred below 4-year-old accounted for over 75% in all the three areas. The most common trigger was respiratory tract infection, followed by climate change and irritative taste. The predilection seasons were autumn and winter as well as the transitions of seasons. This may be explained by the fact that the organs and systems are not well developed and the immune system is not sufficiently robust in infants and young children.

Our survey also found that the proportion of the pediatric patients who had not experienced asthma attack for one or two years was significantly lower in the rural area than in the suburban and urban areas; meanwhile, from the urban area to the suburban and rural areas, the percentage of asthma exacerbation gradually increased, whereas that of asthma relief declined. Although nearly 90% of the pediatric patients in all these three areas had used antibiotics, the usage rate of antibiotics was significantly higher in the rural area than in the suburban and urban areas; meanwhile, the

use of inhaled hormones inhaled steroids and leukotriene modifiers showed a declining trend from the urban area to the suburban and rural areas. Notably, in recent years efforts have been made by various professional and academic groups to advocate the GINA protocol among pediatricians, which has greatly improved the understanding and management of asthma in the majority of hospitals in the urban area. However, due to the unequal distribution of medical resources, the outdated facilities, poorly trained medical staff, and limited health care investments in the rural area has restricted the medical staff's access to new knowledge and new techniques. On the other hand, the residents in the rural areas often have low income and lack sufficient awareness and knowledge about their children's disease. Many children in the rural area only receive antibiotics or symptomatic treatment during the asthma attacks, and will not use any drug once the symptoms are controlled. As a result, a significant proportion of asthmatic children living in the rural areas are not properly managed.

In summary, our current study provided solid evidences for the health authorities and may guide future-decision making on disease control, prioritized investments in health care in rural area, and appropriate prevention and control of childhood asthma.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. Chen YZ, National Cooperation Group On Childhood Asthma. A nationwide survey in China on prevalence of asthma in urban children. Zhonghua Er Ke Za Zhi 2003;41:123-7.
2. National Cooperation Group on Pediatric Asthma. Survey on asthma prevalence among 900,000 0-14-year-old children in China. Chin J Tuberc Respir Dis 1993;16:64-83.
3. Subspecialty Group of Respiratory Diseases Society of Pediatrics; Chinese Medical Association; Chinese Journal of Pediatrics Editorial Board. Guideline for the diagnosis and optimal management of asthma in children. Zhonghua Er Ke Za Zhi 2008;46:745-53.
4. Li M, Wang CL, Liu XF, et al. Epidemiological Survey on Childhood Asthma in Chengdu. Journal of Preventive Medicine Information 2002;18:206-8.
5. Bo J, Zhao J, Shen KL, et al. Prevalence of Childhood Asthma in Beijing, Chongqing, and Guangzhou. Chinese Journal of Allergy & Clinical Immunology 2010;4:280-5.
6. McConnell R, Berhane K, Yao L, et al. Traffic, susceptibility, and childhood asthma. Environ Health Perspect 2006;114:766-72.
7. Riedler J, Braun-Fahrländer C, Eder W, et al. Exposure to farming in early life and development of asthma and allergy: a cross-sectional survey. Lancet 2001;358:1129-33.
8. Seiskari T, Kondrashova A, Viskari H, et al. Allergic sensitization and microbial load--a comparison between Finland and Russian Karelia. Clin Exp Immunol 2007;148:47-52.
9. Huang S, Wang JH, Huang SK, et al. Survey on the correlation factors of the pathogenesis of asthma in children in Guangzhou community. The Journal of Practical Medicine 2010;26:3240-3.
10. Li L, Liu JM, Chen Q, et al. Epidemiological survey on asthma among 0-14-year-old children in the downtown of Nanchang. Jiangxi Medical Journal 2011;46:1051-2.

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