

Prevalence and Treatment of Children's Asthma in Rural Areas Compared with Urban Areas in Beijing

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Abstract

Background: The prevalence of childhood asthma has been increasing in China. This study aimed to compare the prevalence, diagnosis, and treatment of asthmatic children from urban and rural areas in Beijing, China.

Methods: Schools, communities, and kindergartens were randomly selected by cluster random sampling from urban and rural areas in Beijing. Parents were surveyed by the same screening questionnaires. On-the-spot inquiries, physical examinations, medical records, and previous test results were used to diagnose asthmatic children. Information on previous diagnoses, treatments, and control of symptoms was obtained.

Results: From 7209 children in rural areas and 13,513 children in urban areas who completed screening questionnaires, 587 children were diagnosed as asthma. The prevalence of asthma in rural areas was lower than in urban areas (1.25% vs. 3.68%, $\chi^2 = 100.80$, $P < 0.001$). The diagnosis of asthma in rural areas was lower than in urban areas (48.9% vs. 73.9%, $\chi^2 = 34.6$, $P < 0.001$). Compared with urban asthmatic children (56.5%), only 35.6% of rural asthmatic children received inhaled corticosteroids ($P < 0.05$). The use of bronchodilators was also lower in rural areas than in urban areas (56.5% vs. 66.4%, $\chi^2 = 14.2$, $P < 0.01$).

Conclusion: The prevalence of asthma in children was lower in rural areas compared with children in the urban area of Beijing. A considerable number of children were not diagnosed and inadequately treated in rural areas.

Key words: Asthma; Children; Diagnosis; Treatment; Rural; Urban

INTRODUCTION

Asthma is one of the most common chronic respiratory diseases in childhood. The total asthma prevalence in children of 14 years and young increased with 64.8% in urban areas of major cities in China from 1990 to 2001.^[1] The increasing prevalence of asthma and related atopic disorders has been documented in many studies using the similar questionnaire from the International Study of Asthma and Allergies in Childhood.^[2,3] With the development of economics and fast urbanization in China, a wide difference of environment people live has occurred between urban and rural areas,^[4] which may relate to differences in asthma prevalence between urban and rural areas. However, there are only a few studies on the prevalence of childhood asthma in rural areas compared with an increasing number of surveys of childhood asthma in urban areas of China.^[5]

In China, achieving adequate asthma diagnosis and treatment in pediatric patients has become a key point in control of symptoms. Treatment with regular inhaled corticosteroids (ICS) was associated with improved asthma control and reduced asthma medication use.^[6,7] Despite clinical guidelines, such as the Global Initiative for Asthma (GINA), asthma control is suboptimal in many children in the Asia-Pacific region.^[8,9]

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Received: 09-02-2015 **Edited by:** Li-Min Chen

How to cite this article: Zhu WJ, Ma HX, Cui HY, Lu X, Shao MJ, Li S, Luo YQ, Wang Q, Xu CY, Xu DQ, Liu CH, Chen YZ. Prevalence and Treatment of Children's Asthma in Rural Areas Compared with Urban Areas in Beijing. Chin Med J 2015;128:2273-7.

Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.163381

Beijing was one of the cities involved in the third nationwide survey of childhood asthma in China. Children younger than 14 years of age in urban and rural areas were recruited for the survey. The purpose of this study was to compare the prevalence, diagnosis, and treatment of asthma in children between urban and rural areas.

METHODS

Study population

Children aged 14 years and younger were recruited in this study. These children were born between July 1995 and June 2010, but baby from the neonatal period was not included in. Children enrolled were requested either born in Beijing or lived in Beijing for more than 6 months. The rural areas in the study were the Fangshan District located in the Southwest of Beijing and the Tongzhou District located in the Southeast of Beijing. The urban areas were the Xicheng District located in the center of Beijing. The children were randomly selected by cluster random sampling in schools, kindergartens, and communities.

Cross-sectional study design

Based on the data from a previous epidemiological survey and an analysis of children's asthma in Beijing in 2000, the prevalence of childhood asthma in urban areas was 2.69%.^[10] With a level of confidence of 95%, power of 80%, and tolerance error of 0.538%, we estimated that 3,617 children would be a sufficient number in urban areas to estimate population statistics. Because the prevalence of childhood asthma in a rural area was not available, we expected that the prevalence of childhood asthma in rural areas was 1.89%, according to a survey of adult asthma.^[11] With a level of confidence of 95%, power of 80%, and tolerance error of 0.378%, we estimated that 5281 children would be sufficient in rural areas.

According to screening questionnaires which were filled by parents, the children with suspected asthma were selected and given on-the-spot inquiries and examined by two experts to diagnose whether they had asthma. If the diagnosis by the two experts differed, the child was reassessed. The previous diagnosis, medicine treatment, and control of symptoms of asthmatic children were further investigated through face-to-face questionnaire surveys written by the investigators. To reduce recall bias, the children's outpatient service records were retrieved by investigators. We called the parents to complete questionnaires if questionnaires were not completed.

Questionnaire

The same screening questionnaires for the National Epidemiological Survey of Childhood Asthma were distributed to parents of children in schools, kindergartens, and communities between October 2010 and March 2011. The questionnaires were written in Chinese and included questions on demographics, eight questions about respiratory diseases and another eight about allergy history. The demographics included gender, age, birthplace, and

residential address. The questions on respiratory problems were: (1) Did the child have any symptoms of wheezing? (2) Did the child have any symptoms of wheezing in the past 12 months? (3) Did the child's wheezing sound like whistling? (4) Was the child diagnosed with respiratory diseases such as asthma, asthmatic bronchitis, bronchiolitis, or asthmatic pneumonia by a physician? (5) Has the child had coughing every day in the past 1-month? (6) Has the child had repeated "respiratory infections" in the past 12 months? Suspected asthma was defined as getting a "yes" on any of questions 1–4 or answering "yes" to both questions 5 and 6.

Asthma diagnosis was made following the guidelines in Global Strategy for Asthma Management and Prevention.^[12] Classification of asthma met *the criteria for childhood asthma in the Chinese guideline*.^[13] Typical asthma meant more than one symptom (wheeze, shortness of breath, cough, chest tightness). These symptoms were often worse at night or in the early morning and varied over time and in intensity, and symptoms were controlled by asthma treatment. Features of cough variant asthma (CVA) suggest that chronic cough (>4 weeks) is the principal symptom. CVA can be controlled by asthma management rather than antibiotics. Past or family allergic disease is another feature suggesting a diagnosis of CVA.

Analysis of data

Investigators distributed 21,805 screening questionnaires to parents of children and acquired 20,823 questionnaires. In this survey, 101 screening questionnaires were not completed for lack of a phone number. Eighteen (0.25%) questionnaires in rural and 83 (0.61%) in urban areas were not completed. The final study population comprised of 20,722 (94.8%) with complete data.

All data were entered by Epi Info version 3.5.1 (Centers for Disease Control and Prevention, USA) using double entry by two independent persons. Data were categorized and analyzed using the Statistical Package for Social Sciences software (SPSS, version 19.0, Armonk, NY:IBM Corp, USA). The Chi-square test was used to compare prevalence rates of disease and treatment between groups. The Mann-Whitney *U* was used to compare the control of symptoms between groups for abnormal distribution. Results are presented as 95% confidence intervals where appropriate. A $P < 0.05$ was considered significant.

RESULTS

Questionnaires were completed for 13,513 children in urban areas (boys, 7190) and 7209 children in rural areas (boys, 3732). The sex distribution of children was not statistically different ($\chi^2 = 3.8$, $P = 0.05$). The age of children involved in the investigation was 7.7 ± 4.0 years in rural areas and 7.1 ± 4.1 years in urban areas.

Prevalence of asthma in urban and rural areas

The total asthma prevalence was 2.83% (587/20,722) based on screening questionnaires, on-the-spot inquiries, and

physical examinations. The asthma prevalence in rural areas was lower than in urban areas (1.25% vs. 3.68%, $P < 0.001$). Two-thirds of asthmatic children (60/90, 66.6%) in rural areas were diagnosed with typical asthma, which was also lower than in children in urban areas (451/497 = 90.7%, $\chi^2 = 39.2$, $P < 0.01$). CVA prevalence was not different between urban and rural areas ($P > 0.05$) [Table 1].

Investigators recruited 7338 younger children (≤ 5 years old) (4927 in urban and 2411 in rural areas) and 13,384 older children (> 5 years old) (8586 in urban and 4798 in rural areas). The prevalence of asthma was 3.11% (416/13,384) in older children, which was higher than that in younger children (2.33%, 171/7338, $\chi^2 = 10.4$, $P < 0.01$). In urban areas, the asthmatic rate in older children was also higher than that in younger children (4.17% vs. 2.83%, $\chi^2 = 16.1$, $P < 0.01$). However, in rural areas, age did not affect the prevalence of asthma (1.21% vs. 1.33%, $\chi^2 = 0.2$, $P = 0.669$). In both the younger and older groups, the prevalence of asthma was lower in rural than in urban areas ($P < 0.05$) [Table 1].

Gender played a significant role in the prevalence of asthma. The prevalence of asthma in males was 3.69% (4033/10,926), but it was only 1.88% (184/9796) in females ($\chi^2 = 61.5$, $P < 0.01$). In urban areas, the prevalence of asthma in males was double that of females (4.80% vs. 2.40%, $\chi^2 = 54.5$, $P < 0.01$). Just as in urban areas, the prevalence of asthma in rural areas was also higher in males than in females (1.45% vs. 0.92%, $\chi^2 = 5.80$, $P = 0.01$). Whether male or female, the prevalence of asthma in rural areas was lower than in urban areas ($P < 0.05$) [Table 1].

Previous diagnosis of asthma in urban and rural areas

We investigated previous diagnoses and use of medication and found that 26.1% (153/587) of asthmatic children had never been diagnosed with asthma. The percentage of previous asthmatic diagnoses in rural areas was much lower

than in urban areas (48.9% vs. 78.5%, $\chi^2 = 34.6$, $P < 0.001$). In asthmatic children from rural areas, 11.1% were incorrectly diagnosed with pneumonia, 28.9% with bronchitis, and 11.1% with other conditions. For asthmatic children in urban areas, 3.2% were misdiagnosed with pneumonia, 12.9% with bronchitis, and 5.4% with others [Figure 1].

Table 2 shows asthma symptoms, such as total number of wheezing, the times of wheezing in the past 1-year, the times of wheezing in the most severe year, and total months with wheezing in the most severe year. The median (interquartile range) was used to describe the control levels of asthma. Except for total months with wheezing in the most severe year, symptoms were not statistically different between the children with asthma in city and children with asthma in the countryside ($P > 0.05$).

Treatment of asthma in urban and rural areas

Among the rural asthmatic children, only 35.6% (32/90) reported that they used ICS as compared with 56.6% (281/497) of asthmatic children in urban areas ($\chi^2 = 13.5$, $P < 0.01$). Just as with ICS, the usage of bronchodilators was lower in rural areas than in urban areas (41/90 = 45.6% vs. 330/497 = 66.4%, $\chi^2 = 14.2$, $P < 0.01$). Although the usage of theophylline was higher in rural areas, the difference was

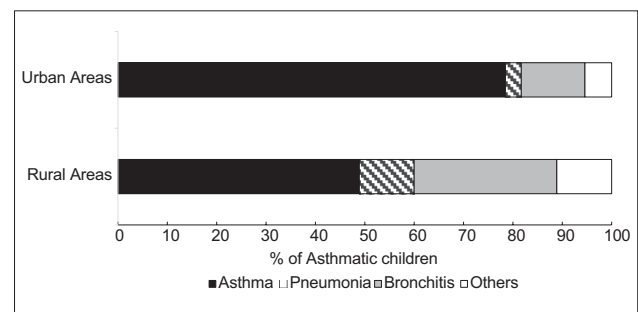


Figure 1: Percentage of previous diagnosis in asthmatic children.

Table 1: The prevalence of childhood asthma in Beijing rural areas and urban areas

Characteristics	Urban areas		Rural areas		χ^2	P
	<i>n</i> (%)	95% CI	<i>n</i> (%)	95% CI		
Asthma	497 (3.68)	3.36–4.00	90 (1.25)	0.99–1.51	100.8	<0.001
Typical asthma	451 (3.34)	3.03–3.62	60 (0.83)	0.62–1.04	122.7	<0.001
CVA	46 (0.34)	0.24–0.43	30 (0.42)	0.27–0.57	0.7	0.39
≤ 5 year	139 (2.83)	2.37–3.30	2 (1.33)	0.87–1.78	15.9	<0.001
> 5 year	358 (4.17)	3.75–4.59	58 (1.21)	0.90–1.52	89.6	<0.001
Males	345 (4.80)	4.30–5.29	58 (1.45)	1.16–1.95	72.9	<0.001
Females	152 (2.40)	2.03–2.78	32 (0.92)	0.60–1.23	26.7	<0.001

95% CI: The rate of 95% confidence intervals; CVA: Cough variant asthma.

Table 2: Frequency of asthma episodes in children from Beijing (Median (P_{25} – P_{75}))

Items	Urban areas	Rural areas	Mann–Whitney <i>U</i>	<i>Z</i>	P
Total number of wheezing	5 (3–10)	5 (2–10)	20,113	–0.750	0.450
Number of wheezing in last year	1 (0–2)	1 (0–2)	19,603	–1.027	0.304
Number of wheezing in the most severe year	2 (1–4)	2 (1–4)	19,910	–0.190	0.849
Total months with wheezing in the most severe year	1 (1–2)	2 (1–3)	16,220	–2.550	0.011

not statistically significant ($P > 0.05$). The usage of medicine, such as systemic corticosteroids, leukotriene receptor antagonists, antihistamines, specific immunotherapy, antibiotics, and Chinese medicine, were not significantly different ($P > 0.05$) [Figure 2].

DISCUSSION

This study is the first comparing the prevalence of asthma, diagnosis, and medical treatment between urban and rural areas using the screening questionnaires and on-the-spot inquiries in China. Results of this study demonstrated that there was a lower prevalence of asthma in rural children (1.25%) compared with urban children (3.68%). In both rural and urban areas, there was a higher prevalence of asthma in males. The result above was comparable to what Ma reported that prevalence of asthma in rural Chinese children was significantly lower than in urban children,^[5] and what Garcia-Marcos *et al.* found in his study that male gender was a risk factor for asthma.^[14] The rural asthmatic rate in our study was lower than the results from South India study,^[15] which was conducted in school children. The large age range in our study may account for the difference of asthma prevalence between the two studies. In our study, the lowest age of child found with asthma was 2 years and 9 months in rural areas, and the lowest age of children with asthma was 2 months and 28 days in urban areas. Compared with the only questionnaire-based study,^[15] it is uncertain how the result of asthma prevalence was affected by screening questionnaires, on-the-spot inquiries, and examination. Last of all, difference of ethnic and regional factor might also exert influence on asthma prevalence.

The reason for a lower prevalence of asthma in rural areas is unclear. In one study, exposure to agricultural farming and livestock farm conferred protection from asthma.^[5] Conversely, particulate air pollution, which adversely affects lung function in asthmatics, was higher in urban locations compared with rural locations.^[16,17] The low prevalence of asthma in children in rural areas of Beijing might be attributed to these two factors.

Another new finding may help to characterize children with asthma in rural and urban areas in our study. There was an interesting phenomenon that compared with younger

children, older children were more likely to have asthma in urban areas; however, this phenomenon was not found in rural areas. Although this has not been reported in other studies of asthma, research on allergic airway diseases such as allergic rhinitis has reported a similar phenomenon.^[18] Aeroallergen sensitization begins at a young age and reaches a peak in adolescence.^[19] Children who live in urban areas had more exposure to air pollution than children from rural areas and had more aeroallergen sensitization.^[16,17] This may explain why the prevalence of asthma in older children was high in urban areas than in rural areas.

In the Global Strategy for Asthma Management and Prevention, treatment with a regular daily low dose of ICS is highly effective in reducing asthma symptoms and reducing the risk of asthma exacerbation.^[12] However, we found that only 36% of asthmatic children in rural areas used ICS, which was lower than in urban areas. The factors accounting for low ICS use may be as follows: First, the rate of asthmatic diagnoses previously in rural areas was extremely low, which obviously resulted in low usage of ICS; the second reason for the low usage of ICS might be that patients with asthma diagnosed were not treated according to guidelines; and in the third, the availability of ICS was influence factor as well. Even in children with asthma diagnosed previously, only 54.6% of these children used ICS in our study. Despite many guidelines and drugs for control of asthma were available at present, the dissemination and implementation of the guideline in rural are still challenges in China.^[9]

The use of practical tools that assesses the GINA criteria for asthma control, such as the asthma control test (ACT) and childhood ACT, may assist with quick (within 4 weeks) identification of pediatric patients with suboptimal asthma control.^[20,21] In our survey, we analyzed asthma symptoms such as total number of wheezing, the total incidents of wheezing in the past 1-year, and total incidents of wheezing in the most severe year. These data were not different between urban asthmatic children and rural asthmatic children. A lack of regular use of ICS results in low control of symptoms in both urban and rural areas. Even though the regular use of ICS was not investigated in our study, Zhang *et al.* reported that only one-third of asthmatic children adhered to the use of ICS in Beijing urban areas.^[22] Daily ICS resulted in a significant increase in asthma-free days, improved asthma control, and reduced use of additional asthma medication.^[6] Irregular ICS may lead to high frequent use of bronchodilators although more ICS was used in asthmatic children in urban areas. Furthermore, poor control of concomitant allergic rhinitis may have also contributed to the poor control of asthma; this relationship has been well-documented in the literature.^[7,23]

Lung function test was not included in our survey due to the limitation of performance ability from different ages of children, even though this test is an important criterion for asthma diagnosis and control. And also for studies in schools, kindergartens, and communities, the equipment for

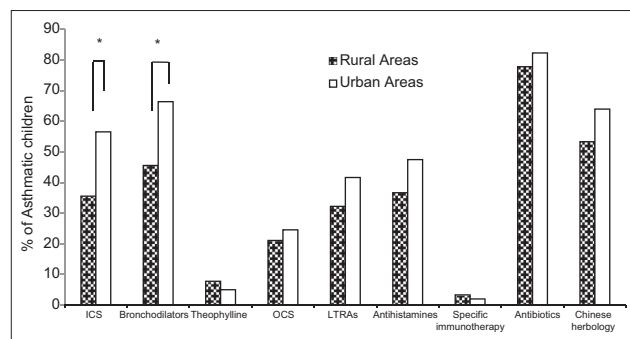


Figure 2: Medications used in asthmatic children. ICS: Inhaled corticosteroids; OCS: Oral corticosteroids; LTRAs: Leukotriene receptor antagonists. * $P < 0.01$.

lung function tests was not available. In our study, there was probably recall bias about previous diagnosis and treatment in some old children with long time of history with or without disease, but outpatient service books were included in our study to reduce the bias, even though it did happen in certain case that the parents forgot to take it to the field. Last of all, lead time bias is inevitable, and it is estimated that the prevalence of asthma might be higher than its true value.

However, findings from this study show that the prevalence and treatment of asthma in children in rural areas were lower compared with children with asthma in urban areas. The diagnosis and treatment of asthma in children need to be improved in rural areas.

Acknowledgments

The author acknowledges the critical review and writing assistance provided by Prof. Jiu-Yao Wang, Department of Pediatrics, National Cheng Kung University, Taiwan, China.

Financial support and sponsorship

This study was supported by a grant from Capital Medical Development Research Fund (No. 2009-1048).

Conflicts of interest

There are no conflicts of interest.

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