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Prevalence trends in the characteristics of patients with allergic asthma in Beijing, 1994 to 2014

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Abstract

This study aimed to determine the clinical profiles and prevalence trends during 1994 to 2014 among patients with allergic asthma (AA), which is a clinical phenotype of asthma.

We retrospectively analyzed the characteristics of 319 patients who were diagnosed with AA between March 1, 1994 and February 28, 2014 at 3 Beijing centers.

The patients included 155 males and 164 females, and the mean age was 50.86 ± 15.27 years (range 13–86 years). The proportions of asthma attacks in summer and autumn were 60.7% (1994–1999), 61.8% (1999–2004), 56.4% (2004–2009), and 33.1% (2009–2014). The most frequently used medication at home was theophylline (27.9%), which was followed by inhaled corticosteroids (20.38%), inhaled corticosteroids/long-acting beta-2-agonists (10.66%), and leukotriene receptor antagonists (9.4%). The elderly group had the highest rates of summer and autumn attacks, multiple hospitalizations, reduced pulmonary function, smoking history, and positive allergen tests. The middle-aged group had the lowest rates of summer and autumn attacks, and multiple hospitalizations. The youngest group had the lowest rates of reduced pulmonary function, smoking history, and positive allergen tests. The top 5 allergens were dust (9.1%), mites (8.8%), seafood (8.2%), pollen (6.3%), and animal fur (6%). Women were significantly more likely to have a positive allergen test (93 women vs 68 men).

The present study revealed the characteristics of Chinese patients with AA, and allergen-specific differences in sex and age during 1994 to 2014. The use of therapeutic drugs at home remains insufficient.

Abbreviations: AA = allergic asthma, ANOVA = analysis of variance, FEV1 = forced expiratory volume in 1 second, FEV1%PRED = FEV1%-predicted, GINA = Global Initiative for Asthma, ICS = inhaled corticosteroids, IgE = immunoglobulin E, LABA = long-actingβ2-agonist, LTRA = leukotriene receptor antagonist, PEF = peak expiratory flow, SD = standard deviation.

Keywords: allergic asthma, characteristics, clinical, hospitalization, trend

1. Introduction

1.1. Background

Asthma is characterized by chronic airway inflammation and diagnosed based on various respiratory symptoms, such as wheezing, shortness of breath, chest tightness, cough, and expiratory airflow limitation.[1] Asthma is the most common chronic pulmonary disease worldwide and has many phenotypes, such as allergic asthma (AA), nonallergic asthma, late-onset asthma, and asthma with fixed airflow limitations. AA is the most common phenotype of asthma, and is associated with allergic disease or a family history of allergies.[1]

China is the world's largest developing country and has recently undergone many obvious changes. In addition, the prevalence of AA has been affected by these changes, which involve the traditional lifestyle and living environment. The prevalence of AA increased from 7.3% to 8.4% during 2001 to 2010 in the United States,[2] and from 1.54% to 2.32% during 2000 to 2010 in China.[3,4] Furthermore, acute asthma exacerbation is associated with a substantial health burden, with approximately 2 million emergency visits and 373,000 hospitalizations in 2012.[5] These conditions create significant public health concerns and a heavy economic burden. Thus, a better understanding of the features of AA could help clinicians provide more effective care and reduce the socioeconomic burden.

1.2. Objective

To the best of our knowledge, few studies have focused on the characteristics of patients with AA. Therefore, the present study aimed to evaluate the clinical profiles, allergens, and sex and age-specific differences in the characteristics of 319 patients who were diagnosed with AA at 3 Beijing centers between 1994 and 2014.

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The authors report no conflicts of interest.

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2. Methods

2.1. Study design

This multicenter retrospective study evaluated patients from 3 tertiary hospitals in Beijing who were hospitalized between March 1, 1994 and February 28, 2014. The hospitals were the Peking Union Medical College Hospital, the Peking University Third Hospital, and the Chinese PLA General Hospital. We collected data regarding the patients' general characteristics (age, sex, smoking, and family history), clinical features, allergens, hospitalization history, and medications used at home. One doctor performed the data collection at each hospital. This study's retrospective design was approved by the Ethics Committee of Chinese PLA General Hospital.

2.2. Patients

All patients fulfilled the following criteria: age of ≥14 years; a history of at least 1 hospitalization at a participating center during the study period; and had a definitive diagnosis of asthma (history of variable respiratory symptoms and airflow variability), based on the official global guidelines.[1] Airflow variability was defined as having a >12% and 200-mL increase in forced expiratory volume during 1 second (FEV1) after the inhalation of salbutamol (400 μg) or a 20% reduction in FEV1 (<16 mg/mL) after the inhalation of methacholine. Patients were diagnosed with AA based on fulfilling at least 1 of the following conditions: a personal and/or family history of allergic disease (eg, allergic rhinitis, eczema, or food or drug allergy), at least 1 positive result from allergen testing, increased serum levels of immunoglobulin E (IgE), and pretreatment-induced sputum that revealed eosinophilic airway inflammation.[1] Cases with incomplete data were excluded from the study.

2.3. Statistical analysis

Continuous variables were reported as mean ± standard deviation, and categorical/binary variables were reported as number and percentage, frequency distribution, or constituent ratio. Differences between the groups were assessed using 1-way analysis of variance (ANOVA) or chi-square tests, as appropriate. Differences were considered statistically significant at a P value <.05. Statistical analyses were performed by using IBM SPSS software (version 20.0; IBM Corp., Armonk, NY).

3. Results

3.1. General information

The 319 eligible patients included 22 cases from the Peking Union Medical College Hospital, 164 cases from the Peking University Third Hospital, and 133 cases from the Chinese PLA General Hospital. The patients had a mean age of 50.86 ± 15.27 years (range 13–86 years) and included 155 males.

3.2. Clinical characteristics

The patients were divided according to their hospitalization period: group A (1994.3.1–1999.2.28), group B (1999.3.1–2004.2.29), group C (2004.3.1–2009.2.28), and group D (2009.3.1–2014.2.28). All 4 groups had similar basic characteristics (age, sex, smoking, and family history), and no significant differences were observed (Table 1).

All 4 groups exhibited general downward trends in the frequencies of summer and autumn attacks (P=.02) and multiple hospitalizations (≥2 hospitalizations, P=.01) (Fig. 1). All 4 groups also exhibited significant general upwards trends in the frequencies of allergic rhinitis (P=.02), positive allergen tests (P=.01), and positive IgE tests (P=.01) (Fig. 2).

Table 1

Patient demographics in the 4 groups.

	Group A (n=61)	Group B (n=55)	Group C (n=55)	Group D (n=148)	P
Age, y, mean/SD	45.70/16.77	50.25/14.48	53.82/12.62	52.10/15.43	.20
Sex (male) (n, %)	37 (60.7%)	32 (58.2%)	29 (52.7%)	57 (38.5%)	.13
Smoking (n)	18	14	19	33	.32
Family history (%)	9.80%	10.90%	18.20%	13.50%	.56
Allergens, n (%)					
Dust	2 (3.3%)	8 (14.5%)	7 (12.7%)	12 (8.1%)	.14
Mites	3 (4.9%)	6 (10.9%)	9 (16.4%)	10 (6.8%)	.10
Sea food	2 (3.3%)	2 (3.6%)	5 (9.1%)	17 (11.5%)	.13
Pollen	3 (4.9%)	8 (14.5%)	6 (10.9%)	3 (2.0%)	.01
Animal fur	1 (1.6%)	4 (7.3%)	3 (5.5%)	11 (7.4%)	.42
Weeds	2 (3.3%)	0	3 (5.5%)	11 (7.4%)	.16
Mold	2 (3.3%)	3 (5.5%)	2 (3.6%)	7 (4.7%)	.93
Cockroach	0	2 (3.6%)	5 (9.1%)	3 (2.0%)	.03
Milk	0	0	3 (5.5%)	7 (4.7%)	.11
Trees	1 (1.6%)	0	1 (1.8%)	6 (4.1%)	.37
Egg	0	0	3 (5.5%)	5 (3.4%)	.15
Nuts	0	0	3 (5.5%)	4 (2.7%)	.14
Cereals	0	1 (1.8%)	0	5 (3.4%)	.26
Meats	0	0	1 (1.8%)	4 (2.7%)	.38
Medications at home, %					
ICS	4.92%	16.36%	20.00%	34.55%	.02
ICS/LABA	0	3.64%	14.55	16.22%	.01
LTRA	0	3.64%	12.73%	14.19%	.01
Theophylline	47.10%	43.60%	36.40%	17.60%	.01

ICS = inhaled corticosteroids, LABA = long-acting β2-agonist, LTRA = leukotriene receptor antagonist, SD = standard deviation.

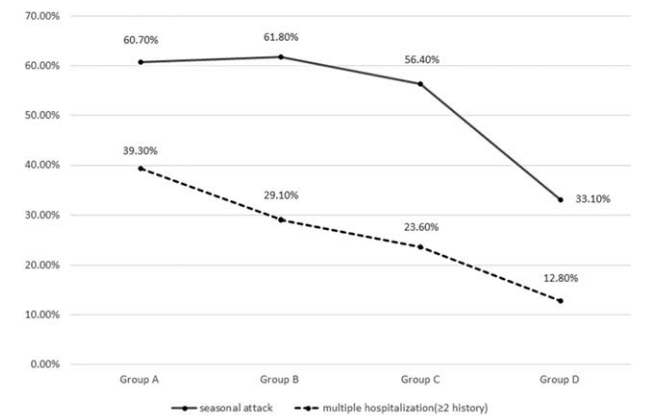

Figure 1. Trends in summer and autumn attacks and multiple hospitalizations.

3.3. Medications used at home for AA

Four kinds of drugs that were extensively used at home were analyzed and compared (Table 1). All 4 groups exhibited gradually increasing usage proportions for inhaled corticosteroids (ICS) ($P=.02$), ICS/long-acting beta-2-agonist (LABA) ($P=.01$), and leukotriene receptor antagonists (LTRAs) ($P=.01$). A decreasing trend was observed for theophylline ($P=.01$) (Table 1). Group D exhibited the highest percentages for ICS (34.55%), ICS/LABA (16.22%), and LTRA (14.19%), and the lowest percentage for theophylline (17.6%). Among the various drugs, the most frequently used medication at home was theophylline (27.9%), which was followed by ICS (20.38%), ICS/LABA (10.66%), and LTRA (9.4%).

3.4. Influence of allergic rhinitis on pulmonary function

Abnormal lung function was defined as <80% for the percentage of the predicted FEV1 value (FEV1%PRED) or a peak expiratory flow (PEF) value of <80%. Patients with AA and with or without allergic rhinitis did not exhibit any significant differences in FEV1%PRED or PEF (Table 2).

3.5. Allergens

Among the various allergens, the most frequently positive allergen was dust (9.1%), which was followed by mites (8.8%), seafood (8.2%), pollen (6.3%), and animal fur (6%) (Table 3). Significantly differences between groups A, B, C, and D were observed for pollen ($P=.01$) and cockroach ($P=.03$) allergens. No other significant differences were observed (Table 1).

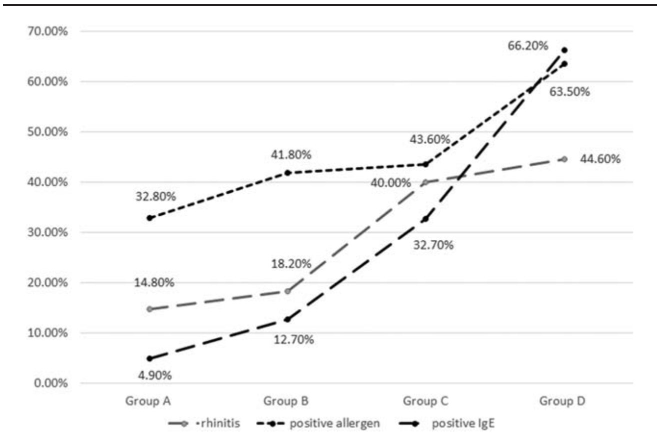

Figure 2. Trends in rhinitis, and positivity to allergens, and immunoglobulin E (IgE).

Table 2

The relationship between allergic rhinitis and pulmonary function.

	Allergic rhinitis		
	Negative (n, %)	Positive (n, %)	*P*
FEV1/FEV1%PRED <80%	144 (70.6%)	80 (69.6%)	.90
PEF% <80%	163 (79.9%)	82 (71.3%)	.10

FEV1 = forced expiratory volume in 1 second, FEV1%PRED = FEV1%-predicted, PEF = peak expiratory flow.

3.6. Sex-specific differences in allergens

Women had significantly more positive allergen tests, compared with men (93 women vs 68 men; $P<.05$). However, the sex-specific proportions of the 14 most common allergens were not significantly different.

3.7. Age-specific differences in allergens

The patients were divided into a young group (<45 years old), a middle-aged group (45–60 years old), and an elderly group (>60 years old). The elderly group had the highest proportions for meats and cereals, and the lowest proportions for dust, animal fur, trees, milk, egg, and seafood. The middle-aged group had the highest proportions for weeds and nuts, and the lowest proportions for mold, mites, cockroach, and pollen. The young group had the highest proportions for dust, animal fur, trees, milk, egg, seafood, mold, mites, cockroach, and pollen, but the lowest proportions for nuts and meats (Table 3).

3.8. Age-specific differences in clinical characteristics

The elderly group had the highest proportions of summer and autumn attacks (61.6%; $P=.02$), multiple hospitalizations (37.4%; $P=.01$), reduced pulmonary function (FEV1%PRED of <80% = 79.8%; $P=.04$; PEF of <80% = 89.9%; $P=.01$), smoking history (35.4%; $P=.02$), and positive allergen tests (54.5%; $P=.49$). The middle-aged group had the lowest proportions of summer and autumn attacks (39.3%) and multiple hospitalizations (17.1%). The young group had the lowest proportions of reduced pulmonary function (FEV1% PRED of <80% = 65.7%; PEF of <80% = 69.4%), smoking history (18.5%), and positive allergen tests (46.3%) (Tables 3 and 4).

4. Discussion

The present study assessed the specific features and prevalence trends of AA in Beijing, and the findings may be useful for developing interventions to prevent and manage AA. Our results indicate that the proportions of summer and autumn AA attacks, reduced pulmonary function, multiple hospitalizations, and rhinitis complications increased during the most recent 10 years (2004–2014), compared with the previous 10 years (1994–2004).

Allergic asthma is usually induced by specific environmental factors or foods during summer or autumn. With the rapid urbanization and industrialization of China, many serious air

Table 3

Analysis of allergic asthma allergens.

	Total (N=319) (N, %)	Sex: Male (n=155) (n, %)	Sex: Female (n=164) (n, %)	*P*	Age: Young group (n=108) (n, %)	Age: Middle-aged group (n=112) (n, %)	Age: Elderly group (n=99) (n, %)	*P*
Sum	206 (64.6%)	68 (43.9%)	93 (56.7%)	.02	50 (46.3%)	57 (50.9%)	54 (54.5%)	.49
Dust	29 (9.1%)	16 (10.3%)	13 (7.9%)	.46	13 (12.0%)	9 (8.0%)	7 (7.1%)	.41
Mites	28 (8.8%)	17 (11%)	11 (6.7%)	.18	14 (13.0%)	6 (5.4%)	8 (8.1%)	.13
Sea food	26 (8.2%)	11 (7.1%)	15 (9.1%)	.50	11 (10.2%)	10 (8.9%)	5 (5.1%)	.38
Pollen	20 (6.3%)	12 (7.7%)	8 (4.9%)	.29	9 (8.3%)	5 (4.5%)	6 (6.1%)	.49
Animal fur	19 (6%)	9 (5.8%)	10 (6.1%)	.91	7 (6.5%)	7 (6.3%)	5 (5.1%)	.90
Weeds	16 (5%)	6 (3.9%)	10 (6.1%)	.36	6 (5.6%)	8 (7.1%)	2 (2.0%)	.22
Mold	14 (4.4%)	6 (3.9%)	8 (4.9%)	.66	8 (7.4%)	3 (2.7%)	3 (3.0%)	.17
Cockroach	10 (3.1%)	4 (2.6%)	6 (3.7%)	.82	6 (5.6%)	2 (1.8%)	2 (2.0%)	.21
Milk	10 (3.1%)	3 (1.9%)	7 (4.3%)	.38	5 (4.6%)	4 (3.6%)	1 (1.0%)	.31
Trees	8 (2.5%)	3 (1.9%)	5 (3%)	.78	3 (2.8%)	3 (2.7%)	2 (2.0%)	.93
Egg	8 (2.5%)	2 (1.3%)	6 (3.7%)	.32	4 (3.7%)	3 (2.7%)	1 (1.0%)	.46
Nuts	7 (2.2%)	2 (1.3%)	5 (3%)	.49	2 (1.9%)	3 (2.7%)	2 (2.0%)	.91
Cereals	6 (1.9%)	3 (1.9%)	3 (1.8%)	.99	2 (1.9%)	2 (1.8%)	2 (2.0%)	.99
Meats	5 (1.6%)	3 (1.9%)	2 (1.2%)	.95	1 (0.9%)	2 (1.8%)	2 (2.0%)	.80

pollution problems have emerged,[6] and air pollutants have become new AA allergens, which has induced changes in the clinical features of AA. For example, seasonal differences in pollen production are linked to seasonal trends in asthma attacks, and all 4 study groups had significantly positive allergen tests. However, the present study also revealed a gradual decrease in the proportion of seasonal asthma attacks, which may be related to the increased suspension of airborne particles containing allergens, a prolonged pollen season as a consequence of global warming,[6] and modification of the allergen by air pollutants.[7] Moreover, we observed an increasing prevalence of allergic rhinitis, which agrees with the increasing prevalence of AA in a previous report.[8] Previous epidemiological studies of allergic rhinitis have confirmed that approximately 80% of asthma cases involve allergic rhinitis, and 10% to 40% of allergic rhinitis cases also involve asthma.[9–13] These studies concluded that allergic rhinitis may be a risk factor for the development of asthma,[9] and that uncontrolled allergic rhinitis may worsen asthma symptoms, increase bronchial hyperactivity, and reduce lung function.[13] Inverse relationships have also been observed for asthma affecting allergic rhinitis.[14] However, the present study did not detect a clear relationship between uncontrolled allergic rhinitis and reduced lung function, and we hope to perform further studies to examine this issue.

Specific allergens are vital triggers for AA exacerbation, and the most common positive allergens in the present study were dust, mites, seafood, pollen, and animal fur. However, in the United States, the 5 most common allergens are *Alternaria*, *Aspergillus*, *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, and cat dander.[15] Among men in the present study, the 5 most common allergens were mites, dust, pollen, seafood, and animal fur, whereas the most common allergens among women were seafood, dust, mites, animal fur, and weeds. These differences suggest that patients with AA exhibit differences according to their race, sex, and age. Thus, Chinese AA allergen data should likely be used to develop local interventions to prevent asthma exacerbation.

In addition to climate change, smoking is also a critical risk factor for the exacerbation and poor control of asthma, and also an impaired corticosteroid response.[16–18] In the present study, we found that elderly patients had the highest proportion of smoking history (35.4%; $P=.02$) and the poorest lung function (FEV1%PRED of <80%=79.8%; $P=.04$; PEF of <80%=89.9%; $P=.01$). In this context, impaired lung function may be related to smoking interfering with airway cleaning functions, increasing airway epithelial cell damage, accelerating airway inflammation, increasing the risk of asthma attacks, and reducing sensitivity to glucocorticoid therapy.[19–23] Thus, patients with asthma should stop smoking to improve their quality of life.

Interestingly, we observed that female patients were more likely to have positive allergen test results, compared with male patients. Thus, it appears that women may be more vulnerable to allergens and more susceptible to allergic diseases. Asthma-related morbidities also exhibit age and sex-specific differences. For example, a higher prevalence of AA is observed among boys before puberty (vs girls), although women exhibit a higher prevalence, compared with men.[24] In addition, women are more likely to be hospitalized, compared with men.[25–27] Previous studies have revealed a decreasing trend when middle-aged patients were compared with young patients, although a subsequent increase was observed among elderly patients.[28] In the present study, the elderly group had the highest proportions of multiple hospitalizations and summer and autumn attacks, but the poorest pulmonary function. However, we also observed a gradually increasing trend among middle-aged patients, which indicates that this condition should be monitored

Table 4

Comparison of the different age groups.

	Young (n=108) n/%	Middle-aged (n=112) n/%	Elderly (n=99) n/%	*P*
Seasonal attack	46/42.6%	44/39.3%	61/61.6%	.02
Multiple hospitalization (≥2 history)	22/20.4%	19/17.1%	37/37.4%	.01
FEV1%PRED <80%	71/65.7%	74/66.1%	79/79.8%	.04
PEF% <80%	75/69.4%	81/72.3%	89/89.9%	.01
Smoking	20/18.5%	29/25.9%	35/35.4%	.02

FEV1=forced expiratory volume in 1 second, FEV1%PRD=FEV1%-predicted, PEF=peak expiratory flow.

in middle-aged patients to reduce any later increase in severity among elderly patients. Furthermore, the sex and age-specific differences that we observed may be useful for developing both preventative and therapeutic interventions, which could be adjusted for the patient's age and sex.

Appropriate medication and education are 2 important factors that influence the successful prevention of asthma exacerbation.[29] ICS reduces asthma symptoms, increases lung function, improves quality of life, and reduces the risks of exacerbation, asthma-related hospitalizations, and death.[30–33] The present study revealed gradually increasing rates of using medications at home (eg, ICS, ICS/LABA, and LTRA), as recommended by the Global Initiative for Asthma guidelines[1] and other relevant bronchial asthma guidelines. However, these increases remain insufficient (ICS: 20.38%, ICS/LABA: 10.66%, and LTRA: 9.4%), and the usage rates are much lower than those in developed countries.[34] These changes are likely influenced by improved treatment adherence among patients with asthma, which is related to reformed education approaches, good doctor/patient partnerships, and an increased level of medical service in the Chinese population.[35,36] However, the medical insurance system may not evenly cover all patients, and socioeconomic status varies greatly between different Chinese cities.[29] Moreover, many patients express worry regarding adverse drug reactions, and ineffective treatment remains a vital cause of asthma exacerbation. Thus, the prevention of asthma attacks may be improved through more appropriate asthma therapy, further improving patient compliance, and providing more culturally and linguistically appropriate asthma education.

4.1. Limitations

The present study has several limitations that warrant consideration. First, we only evaluated records from inpatients, as the records for outpatients are often simpler and briefer. Second, we could not analyze the effects of lifestyle and diet on the patients' changing features, as these details are not included in their inpatient clinical records. Third, the limited sample size and retrospective design are associated with known risks of bias. Thus, large high-quality prospective studies with long follow-ups are needed to confirm and explain the relationship between air pollution and the prevalence of AA.

5. Conclusions

In conclusion, the present study revealed several changes in the characteristics of patients with AA during 1994 to 2014. We observed age and sex-specific differences, and also differences between smokers and nonsmokers in the different age groups. Furthermore, the use of therapeutic drugs at home remains insufficient.

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