

Prevalence of Allergic Rhinitis and Associated Risk Factors in 6 to 12 Years Schoolchildren From Wuhan in Central China: A Cross-sectional Study

American Journal of Rhinology & Allergy

2020, Vol. 34(5) 632–641

© The Author(s) 2020

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/1945892420920499

journals.sagepub.com/home/ajr



Huan Tong, MD^{1,*} , Ling Gao, MMS^{1,*}, Yuqin Deng, MD^{1,2},
Yonggang Kong, MMS^{1,2}, Rong Xiang, MD¹, Lu Tan, MD¹,
Zezhang Tao, MD^{1,2}, and Yu Xu, MD^{1,2}

Abstract

Background: Over the past decade, the prevalence of allergic rhinitis (AR) in China increased and showed a trend of younger age. The clinical features of AR in primary schoolchildren are still not clear enough.

Objective: To investigate the prevalence and epidemiological characteristics of AR among 6- to 12-year-old children in the central region of China.

Methods: Children from 6 primary schools were randomly selected from urban area of Wuhan, which lies in the central region of China. The questionnaires were distributed by mobile APP and filled out by the children and their parents online together. AR was diagnosed by Score for Allergic Rhinitis. Logistic regression analysis was performed to assess the risk factors for AR.

Results: A total of 5550 valid questionnaires were returned for evaluation. The prevalence of AR among 6- to 12-year-old children in urban area of Wuhan was 28.6%. Multivariate analysis revealed that male (odds ratio [OR] = 1.521, 95% confidence interval [CI] = [1.335, 1.732]), family history of atopy (OR = 3.220, 95% CI = [2.818, 3.681]), previous food allergy (OR = 1.590, 95% CI = [1.302, 1.942]), air purifier (OR = 1.420, 95% CI = [1.240, 1.625]), exposure to dust (OR = 1.764, 95% CI = [1.410, 2.207]), maternal exposure to smoke during pregnancy (OR = 1.242, 95% CI = [1.047, 1.473]), living in towns (OR = 1.468, 95% CI = [1.043, 2.006]) or metropolis (OR = 1.629, 95% CI = [1.205, 2.201]) before 2 years old, frequent application of antibiotics are risk factors for AR, while daily outdoor time for more than 1 hour (OR = 0.770, 95% CI = [0.673, 0.881]) and breastfeeding for more than 6 months (OR = 0.799, 95% CI = [0.701, 0.910]) reduced the risk significantly.

Conclusions: We found an unexpectedly high prevalence of AR among primary schoolchildren aged 6 to 12 years in the central region of China. Both genetic and environmental factors were associated with the development of AR.

Keywords

allergic rhinitis, prevalence, children, epidemiology, allergic disease, allergy, questionnaire, score, environment, China

Introduction

Allergic rhinitis (AR) is an allergic inflammation of nasal mucosa mediated by immunoglobulin E (IgE) in susceptible individuals when exposure to allergens and characterized by itching nose, paroxysmal sneezing, runny nose, and nasal blockage. Severe allergic nasal symptoms could affect patients' daily activities. Researches indicated that allergic patients usually suffered subtle slowed speed of cognitive processing and some patients also had difficulties in working memory.¹

¹Department of Otolaryngology—Head and Neck Surgery, Renmin Hospital of Wuhan University, Wuhan, China

²Research Institute of Otolaryngology—Head and Neck Surgery, Renmin Hospital of Wuhan University, Wuhan, China

*The first two authors contributed equally to the study.

Corresponding Author:

Yu Xu, Department of Otolaryngology—Head and Neck Surgery, Renmin Hospital of Wuhan University, 238 Jiefang Road, Wuhan 430060, Hubei Province, China.

Email: xuy@whu.edu.cn

In the recent decades, with the acceleration of urbanization and increasing westernized lifestyle, the prevalence of AR in China increased and showed a trend of younger age, especially in densely populated urban areas. According to a survey during a 6-year period spanning from 2005 to 2011, the prevalence of self-reported AR in Chinese adults has increased from 11.1% to 17.6%.^{2,3} The prevalence of allergic diseases varied with age and district. A multicenter study in central China showed that the prevalence of AR in children increased with age and peaked in children aged 10 to 14 years, which was higher than in adults.⁴ Another cross-sectional survey evaluated the prevalence in children under 14 years, and the highest prevalence of AR was found in children aged 6 to 11 years.⁵ It could be speculated that the unmaturing immune function in primary school students led to a higher susceptibility and prevalence to allergic diseases. In addition, the pathogenesis and risk factors of AR are related to many factors including genetics and early lifestyle, which are still not fully understood. However, previous epidemiological surveys of AR in this age-group were scarce and relatively rough. Therefore, more attention should be paid to the occurrence of allergic diseases in this age-group, and detailed research is urged to be carried out.

Standardized diagnosis of AR is of crucial importance in epidemiology studies. Traditional epidemiological investigation methods of AR included self-report and combination of questionnaires with allergen tests. There is an overestimation of AR using self-report only, while the latter is difficult to implement in large populations. Consequently, the Score For Allergic Rhinitis (SFAR)⁶ was adopted to define AR in our study. By utilizing the score, we designed an online questionnaire to investigate the prevalence of AR in 6- to 12-year-old children in Wuhan, China. Another objective of this study was to preliminarily shed light on the clinical characteristics and risk factors of AR in this age bracket.

Methods

Study Design

This is a cross-sectional survey to children aged 6 to 12 years living in urban area of Wuhan, China. From June 2018 to September 2018, 6 primary schools, all public and evenly distributed in different districts, were randomly selected from the cluster sampling of all primary schools in the urban district of Wuhan. All children aged 6 to 12 years in these schools were included in the survey.

The questionnaire was designed by the authors with the reference to the International Study of Asthma and Allergies in Childhood (ISAAC),⁷ the European Community Respiratory Diseases Survey (ECRHS),⁸ and SFAR and codetermined by the experts of rhinology

and epidemiology, including questions about basic information, nasal symptoms of AR as well as related factors. The straightaway questionnaire of AR was distributed in the form of 2-dimensional code and filled out by participants and their parents jointly through the online system, WeChat. The target minimum sample size required in this study was evaluated to be 2957.⁹

Questionnaires were collected and verified by the team members of the project and then imported into the form for further analysis. To ensure the authenticity of information, we explained the questions to students and parents before they filled out the questionnaire. Telephone interviews were conducted by 2 members of the investigation team to verify its reliability after the questionnaire sheets were returned. This study was approved by the Ethics Committee of Renmin Hospital of Wuhan University (2017K-C047), and informed consents were obtained from all subjects and their parents.

Diagnosis

AR was diagnosed according to SFAR score (Table 1). The final SFAR score ranged from 0 to 16. Diagnosis validation of SFAR was performed in 109 participants, and the results of serum-specific IgE were used to assess the SFAR cut-off value identifying individuals with AR from those without. Sensitivity and specificity at different cut-off value were calculated (Figure 1). On the basis of receiver operator characteristics curve and the Youden's index (Figures 2 and 3), the best cut-off value of SFAR was set at ≥ 7 . This value allowed the SFAR to be adequately sensitive (98.4%) and specific (80.4%). Moreover, < 7 meant negative for AR and ≥ 7 meant positive, which was classified as the AR patients. Self-report was used to diagnose the allergic comorbidity and infective diseases.

Statistical Analysis

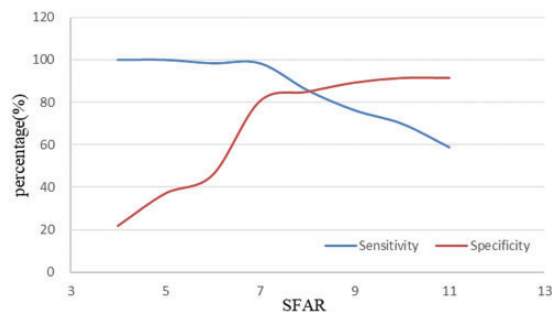
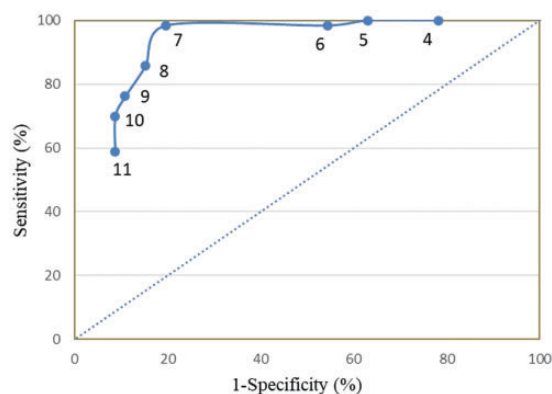
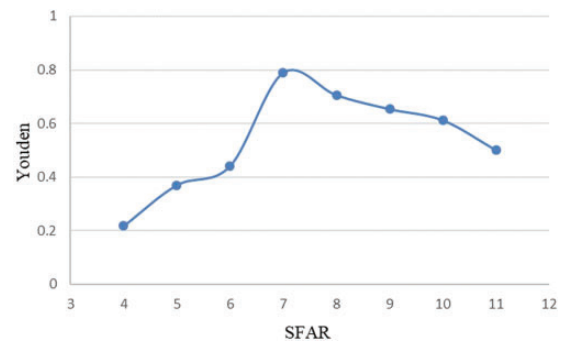
SPSS statistical software (version 23.0) was used for analysis. Continuous and categorical data were described as mean $\pm$ SD and percentages, respectively. Pearson chi-square tests or Fisher's exact tests were used to analyze the differences between subgroups. Missing and inconsistent responses were included in the denominator for the prevalence calculations, but excluded from subsequent bivariate analysis. Forward stepwise binary logistic regression was used to evaluate the correlation between AR and risk factors. $P < .05$ was considered statistically significant.

Results

In this survey, a total of 5550 valid questionnaires were returned. Among these children aged 6 to 12 years from

Table 1. Self-Completed Questionnaire, Attributed Score, and Repartition of the Items for the Score for Allergic Rhinitis.

Items Discriminators	Score (Points)	Cumulative Score
Nasal symptoms (blocked, runny nose, and/or sneezing) in the past year ^a	1 for each symptom	3
Months of the year	1 for perennial 1 for pollen season	5
Nasal symptoms plus itchy eyes (rhinoconjunctivitis) Triggers ^b	2	7
Pollens, house dust mites, dust	2	
Epithelia (cat, dog)	1	9
Perceived allergic status	2	11
Previous positive allergic tests	2	13
Previous medical diagnosis of allergy	1	14
Familial history of allergy	2	16
Total points		16

^aAt least 1 symptom.^bAt least 1 trigger.**Figure 1.** Graph of sensitivity and specificity of SFAR (n = 109). SFAR, Score For Allergic Rhinitis.**Figure 2.** Receiver operator characteristics curve of SFAR (n = 109).**Figure 3.** Youden's index according to different values of SFAR (n = 109). SFAR, Score For Allergic Rhinitis.**Table 2.** Prevalence of AR According to Age and Gender.

Age (years)	Male (n = 2993) (%)	Female (n = 2557) (%)	Total (n = 5550) (%)
6	76 (38.8)	54 (29.5)	130 (34.3)
7	198 (34.3)	117 (23.9)	315 (29.5)
8	180 (33.1)	133 (30.6)	313 (32.0)
9	151 (32.9)	87 (20.7)	238 (27.0)
10	184 (27.8)	135 (23.3)	319 (25.7)
11	72 (33.0)	50 (25.1)	122 (29.3)
12	99 (29.5)	49 (19.6)	148 (25.3)
Total	960 (32.1)	625 (24.4)	1585 (28.6)

The average age of children was 8.93 (± 1.741) years old. The prevalence of AR in males (32.1%) was significantly higher than in females (24.4%; $P < .001$).

6 primary schools, 2993 (53.9%) were males and 2557 (46.1%) were females, with an average age of 8.93 (± 1.741) years. The overall prevalence of AR was 28.6% (1585 of 5550). There was significant difference in the prevalence of AR between males and females (32.1% vs 24.4%, $P < .001$), as well as in the different

age groups ($P = .002$), with the highest in 6-year-old group (34.3%) and the lowest in 12-year-old group (25.3%; Table 2).

Of the 1585 children who were diagnosed with AR, 1323 (83.5%) complained about sneezing, 1256 (85.6%) were troubled by nasal itching, and 1183 (74.6%) had

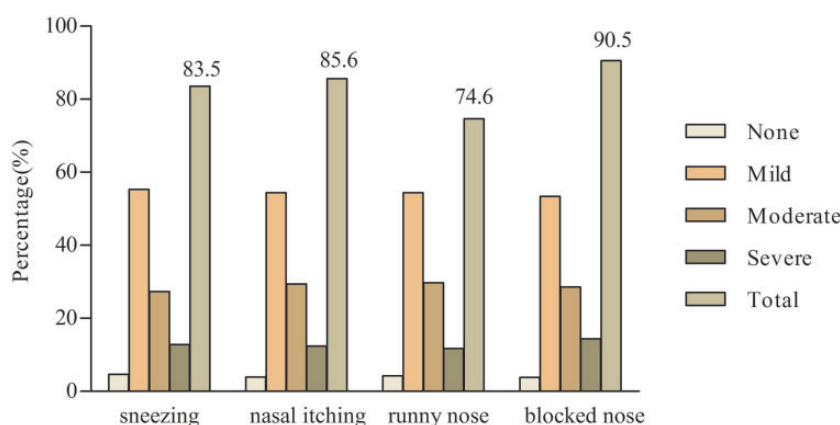


Figure 4. Influences degree of nasal symptoms on daily activities in AR patients.

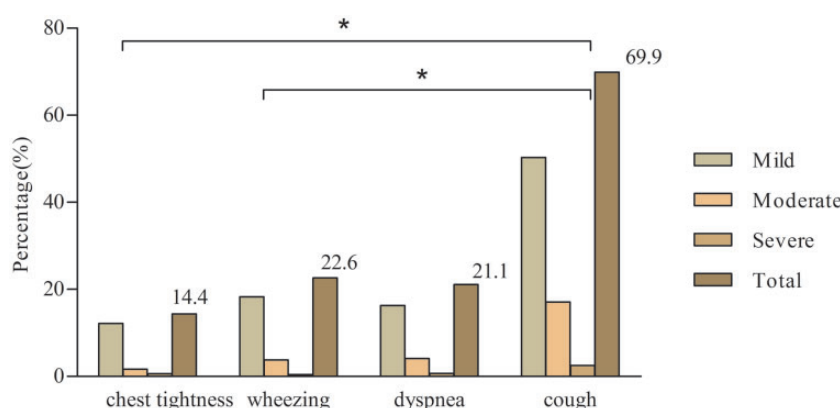


Figure 5. Occurrence and severity of bronchial symptoms in AR patients.

runny nose. Nasal blockage was the most common, with an incidence of 90.5% (1435 of 1585). Each symptom had similar degree of effects on daily activities ($P > .05$), most of which was mild and only few had no influence at all (Figure 4). The number of AR patients who showed itching eye and bronchial symptoms was 887 (56.0%) and 1108 (69.9%), respectively. The occurrence and severity of bronchial symptoms were shown in Figure 5. Cough was the most common (69.9%) one and more serious than chest tightness and wheezing, but not dyspnea. The triggers of nasal symptoms were summarized in Table 3. Dust mites or dust was the most common factor triggering nasal symptoms. Moreover, 58.4% patients showed seasonal onset. Seasonal incidence had 2 peaks: 1 in spring (March and April) and 1 in autumn (October; Figure 6).

Other allergic diseases combined with AR included asthma, eczema, atopic dermatitis, allergic conjunctivitis, and urticaria. Eczema (12.4%) was the most common one. The incidence of all combined allergic diseases was higher in the AR-positive group than in the

Table 3. Triggers of Nasal Symptoms in AR Patients.

Triggers	Patients (%)
Dust mites or dust	1444 (91.1)
Temperature change	1116 (70.4)
Cold air	1011 (63.8)
Pollen	747 (47.1)
Pet	402 (25.4)
Soot	217 (13.7)
Others	122 (7.7)

AR-negative group, showing a statistical meaning ($P < .05$; Figure 7). The previous infective diseases of all participants were represented in Figure 8, covering pneumonia, bronchitis, tonsillitis, sinusitis, and varicella. The incidence of all infective diseases in the AR-positive group was higher than that in AR-negative group, except varicella.

Univariate analysis was conducted to reveal the potential risk factors associated with AR (Table 4).

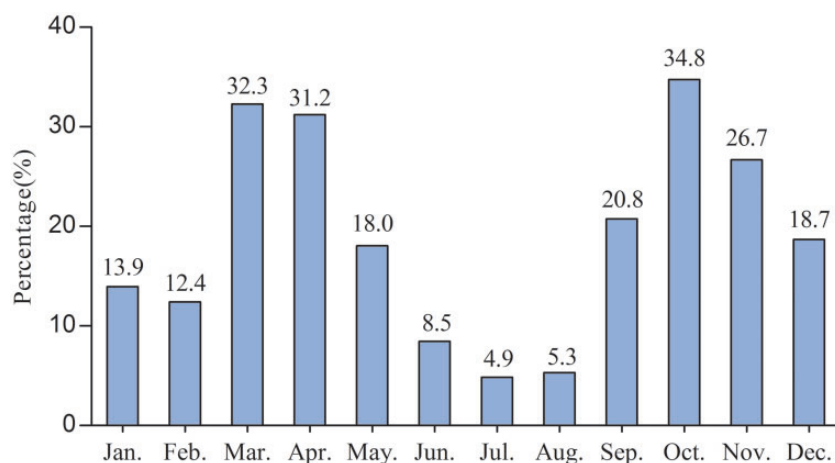


Figure 6. Seasonal variation of allergic rhinitis.

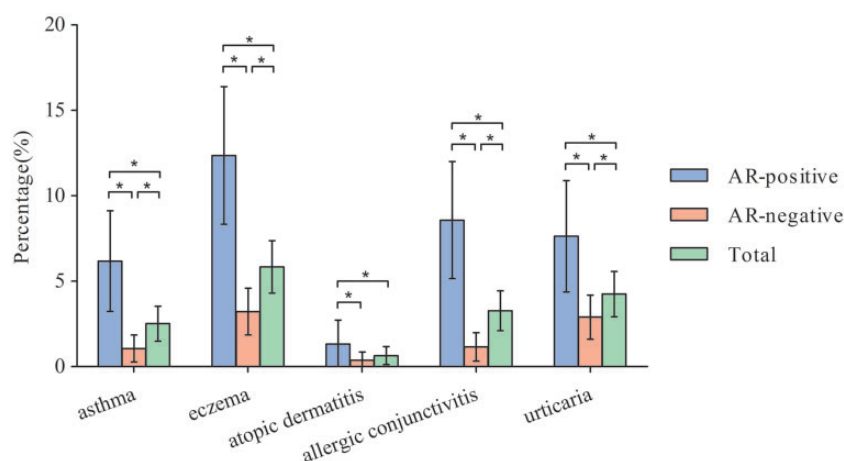


Figure 7. Comorbidity of allergic disease. Asterisk (*) means $P < .05$. AR, allergic rhinitis.

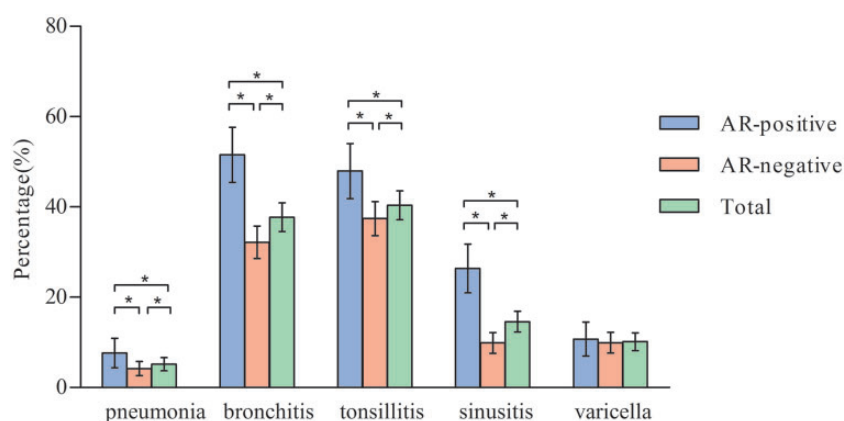


Figure 8. Previous infective diseases. Asterisk (*) means $P < .05$. AR, allergic rhinitis.

Gender, age, family history of allergy, air purifier, etc., were associated with AR ($P < .05$). With multivariate analysis of abovementioned factors, we found that male, family history of allergy, previous food allergy,

air purifier, exposure to dusty environment, maternal exposure to smoke during pregnancy, living in towns or metropolis before 2 years old, frequent application of antibiotics increased the risk of AR, while daily

Table 4. Potential Risk Factors Associated With Allergic Rhinitis.

	AR-Positive Children (n=1585) (%)	AR-Negative Children (n=3965) (%)	χ^2	P
Gender, male	960 (60.57)	2033 (51.27)	39.369	<.001
Age	8.79 ± 1.743	8.98 ± 1.737	21.448	.002
Family history	825 (52.05)	795 (20.05)	560.995	<.001
Food allergy	254 (16.03)	292 (7.36)	95.757	<.001
Drug allergy	177 (11.17)	275 (6.94)	27.103	<.001
Living environment				
Air purifier	648 (40.88)	1128 (28.45)	80.458	<.001
Exposure to smoking	666 (42.02)	1602 (40.40)	1.223	.269
Exposure to dust	184 (11.61)	293 (7.39)	25.659	<.001
House decoration	636 (40.95)	1627 (42.02)	0.519	.471
Carpet	37 (2.33)	94 (2.37)	0.006	.936
Exposure to moisture or mildew				
Never	1386 (87.44)	3610 (91.05)	17.081	.001
Occasionally	189 (11.92)	329 (8.30)		
Often	7 (0.44)	16 (0.40)		
Always	3 (0.19)	10 (0.25)		
Residence before 2 years old				
Rural area	65 (4.10)	391 (9.86)	70.412	<.001
Town	162 (10.22)	551 (13.90)		
Urban area	1358 (85.68)	3023 (76.24)		
Current residence				
Rural area	2 (0.13)	11 (0.28)	22.139	<.001
Town	66 (4.16)	294 (7.41)		
Urban area	1517 (95.71)	3660 (92.31)		
Daily outdoor time (>1 h)	938 (59.18)	2791 (70.39)	64.560	<.001
Physical exercise				
Never	69 (4.35)	163 (4.11)	6.562	.161
1–4 times per month	639 (40.32)	1493 (37.65)		
5–8 times per month	372 (23.47)	927 (23.38)		
9–12 times per month	195 (12.30)	493 (12.43)		
>12 times per month	310 (19.56)	889 (22.42)		
Daily sleeping time				
<8 h	117 (7.38)	238 (6.00)	10.839	.013
8–9 h	621 (39.18)	1451 (36.60)		
9–10 h	704 (44.42)	1837 (46.33)		
>10 h	143 (9.02)	439 (11.07)		
Keeping pets	420 (26.50)	1062 (26.78)	0.047	.828
Intestinal parasites	47 (3.54)	116 (3.37)	0.084	.773
Maternal age				
≤25	252 (15.90)	978 (24.67)	54.838	<.001
26–35	1267 (79.94)	2791 (70.39)		
≥36	66 (4.16)	196 (4.94)		
Delivery mode, eutocia	398 (25.11)	1209 (30.49)	15.941	<.001
Maternal medication during pregnancy	127 (8.01)	206 (5.20)	16.239	<.001
Maternal exposure to smoking during pregnancy	24 (1.51)	44 (1.11)	1.531	.216
Breastfeeding (for >6 months)	321 (20.25)	556 (14.02)	33.029	<.001
Antibiotics given in the first year of life	831 (53.03)	2418 (62.19)	39.908	<.001
Usage of antibiotics during the past 5 years (times/year)				
<1	264 (16.66)	1497 (37.76)	295.127	<.001
1–2	903 (56.97)	1950 (49.18)		
3–4	293 (18.49)	384 (9.68)		
5–6	84 (5.30)	99 (2.50)		
>7	41 (2.59)	35 (0.88)		

(continued)

Table 4. Continued

	AR-Positive Children (n=1585) (%)	AR-Negative Children (n=3965) (%)	χ^2	P
Annual family income (100 000 RMB)				
<1	309 (19.50)	1023 (25.80)	65.085	<.001
1–2	553 (34.89)	1562 (39.39)		
2–3	345 (21.77)	723 (18.23)		
3–4	157 (9.91)	265 (6.68)		
4–5	79 (4.98)	152 (3.83)		
>5	142 (8.96)	240 (6.05)		

Abbreviation: AR, allergic rhinitis.

Table 5. The ORs and 95% CI of Risk Factors Associated With Allergic Rhinitis.

	OR	95% CI		P
		Lower	Upper	
Gender, male	1.521	1.335	1.732	<.001
Family history	3.220	2.818	3.681	<.001
Food allergy	1.590	1.302	1.942	<.001
Drug allergy	1.299	1.042	1.620	.020
Air purifier	1.420	1.240	1.625	<.001
Exposure to dust	1.287	1.032	1.606	.025
Residence before 2 years old				
Rural area	1			.006
Town	1.468	1.043	2.066	.028
Urban area	1.629	1.205	2.201	.002
Daily outdoor time (>1 h)	0.770	0.673	0.881	<.001
Maternal age				
≤25	1			.031
26–35 ^a	1.190	1.000	1.417	.050
≥36	0.874	0.618	1.236	.447
Maternal exposure to smoke during pregnancy	1.242	1.047	1.473	.013
Breastfeeding (for >6 months)	0.799	0.701	0.910	.001
Usage of antibiotics during the past 5 years (times/year)				
<1	1			<.001
1–2	1.803	1.518	2.142	<.001
3–4	2.506	2.006	3.131	<.001
5–6	3.166	2.240	4.475	<.001
>7	3.986	2.376	6.687	<.001

Abbreviations: AR, allergic rhinitis; CI, confidence interval; OR, odds ratio. Adjustments were made for all factors simultaneously.

There was no association between AR and age, current residence, exposure to moisture or mildew, daily sleep time, delivery mode, maternal medication during pregnancy, antibiotics in the first week of life, intestinal parasites, annual family income.

^aOR = 1.190, 95% CI = (1.0003, 1.417).

outdoor time for more than 1 hour and breastfeeding for more than 6 months reduced the risk significantly (Table 5).

Discussion

Wuhan is a large and densely populated city, having an area of 8494 square kilometers and a population of more than 10 million. As the represented first-tier city in

China, Wuhan showed a rapid development and modernization process in the past decade. Located in the central region of China, it has a subtropical monsoon climate with 4 distinctive seasons. A 5-year follow-up study in Wuhan found the self-reported prevalence of AR among 3- to 6-year-old children had increased from 27.1% to 29.4%.¹⁰ Children aged 6 to 12 years were at the phase of primary school, which is not only the stage to obtain knowledge more systematically but

also the critical period of growth and immune development. Several time-trend studies in other countries showed that the incidence of AR among primary school-children has a trend of increase.^{11–13} To our knowledge, there was few detailed reports about the prevalence of children aged 6 to 12 years in China, especially in Wuhan. A previous study surveyed the prevalence of AR in children aged 6 to 13 years in 8 metropolitan capital cities of provinces in 2005, which demonstrated that the mean prevalence of childhood AR was 9.8% in China.¹⁴ But that cross-sectional survey was conducted long time ago, and the diagnostic method used in this survey was simple self-report. By combining questionnaire with SFAR, our survey showed that the prevalence of children aged 6 to 12 years in urban area of Wuhan was 28.6%, suggesting an obvious increase of the prevalence of AR.

Consistent with the surveys in several Chinese cities and in Almeria, Spain,^{15,16} we found that there was a distinct seasonal variation in the incidence of nasal symptoms, which showed 2 peaks in spring and mid-autumn. The triggers of seasonal rhinitis were mainly pollen, cold air, and temperature changes. The peaks period of airborne pollen in Wuhan occurred in spring (from March to April) and autumn (September to October),¹⁷ which was highly consistent with the peaks of incidence in our survey. On the other hand, frequent and drastic temperature changes usually happened in early spring and mid-autumn, which has been reported to be the most common factors triggering nasal symptoms.⁴ Besides, sudden temperature changes could result in obvious inflammatory nasal response with the recruitment and activation of eosinophils.¹⁸

In accordance with previous researches,^{19,20} our study showed that male gender increased the risk of AR, indicating an important role of gender in the morbidity of allergic diseases. It has been established that the sensitization rates, total IgE levels of boys, were higher than that of girls at 1 year old, as well as the peripheral eosinophil counts at 3 years old.²¹ The differential expression of atopic diseases between different genders may be contributed by the hormonal changes, which led to different immune response profile and differences in susceptibility to allergic diseases.

Our data demonstrated an increasing risk of AR in children with positive family atopic disease which was 3.2 times higher than in children without family history, suggesting that heredity played a significant part in AR. Similarly, Mehanna et al. combined paternal and maternal allergy history into 1 parental category and found that family history of allergies increased the risk of all allergic diseases which made the risk of AR in children with family history 2.8 times higher than that without family history.²²

Environment influence is important to the occurrence of AR. In our study, living in towns or metropolis before 2 years old increased the risk of AR compared with living in rural areas, which could be attributed to vehicle exhaust in urban areas and different lifestyle in early life. Previous findings suggested that air pollutants such as SO₂ and PM_{2.5} were the risk factors for asthma and AR in children.^{23–25} Another research found that living on a farm at preschool age reduced the risk and conjectured that it was due to endotoxin exposure.¹⁹ What's more, in Mongolia, the incidence of allergic diseases presented a gradual upward trend with increasing urbanization,²⁶ suggesting an environmental influence. Our investigation showed that dust exposure was significantly associated with AR. It has been established that living near to an air-polluted factory or mine were significant risk factors of AR.²⁰ Unequivocally, air pollution could increase the prevalence of AR.

Air purifier could purify the air and reduce the pollutants in the house, so it is easily to deduce that using air purifier in living room should be a protective factor for AR. However, in our current study, we were surprised to find that using air purifiers was risk factor for AR. The reasons we speculated may be as follows: in some type of air purifiers such as physical adsorption, the filter might be obstructed and lead to secondary emissions of adsorbed pollutants, with long-term use without cleaning. Other type of purifiers such as high-voltage electrostatic type may emit ozone which could cause chemical pollution aggravating rhinitis symptoms. In addition, families with AR are more likely to use air purifiers aiming to reduce indoor triggers, which may be another reason for the higher usage rate of air purifiers in AR families.

Antibiotic use during infancy was assumed to decrease the protective effect of the gut microbiota and increase the risk of atopic diseases. Plenty of research indicated that antibiotics given in the first year of life was associated with AR.^{13,19,20} Similar results were obtained in the univariate analysis of our study, though the multivariate analysis showed no statistic difference. We also found a correlation between the frequency of antibiotic given during the last 5 years and AR. Children taking antibiotics more than once a year were 1.80 to 3.99 times more likely to develop AR than children taking antibiotics less than once a year. It is important to avoid the misuse of antibiotics in aspect of its potential risk of AR especially during early life of children.

Previous studies had verified the association between exposure to cigarette smoking and asthma and demonstrated that ever-smokers had twice the risk of developing asthma than nonsmokers.^{27,28} Other literature confirmed that AR was associated with passive exposure to tobacco smoking.²⁹ Nevertheless, contrary to

expectations, our study did not find the association between passive smoking and AR.

In contrast with previous survey which reported that being outdoors more than 2 times a week increased the risk of AR,³⁰ we found daily outdoor time for more than 1 hour reduced the risk of AR. It could be speculated that moderate outdoor activities may be appropriate to prevent the allergic diseases. In our study, breastfeeding for more than 6 months reduced the risk of AR, which is in consistent with most of the previous research.³⁰ So the exclusive breastfeeding in the first 3 months should be suggested regardless of the family history of atopic.³¹

This study adopted the online questionnaire to investigate the prevalence of AR. This form facilitated the collection and arrangement, reduced the waste of paper, and avoided the omission in answering questions. As a simple and feasible diagnostic method in AR, SFAR was used to define AR in our study. The sensitivity and specificity of SFAR were evaluated to be 98.4% and 80.4%, respectively. Furthermore, when correlated with nasal smear eosinophil count, a high Spearman's correlation (0.88) was obtained for SFAR,³² making it applicable to the prevalence survey of AR in large sample capacity and areas far away from the laboratory. This study was limited by the absence of clinically confirmatory examinations. Besides, the subjects did not include children in the suburbs, which may increase the sampling bias. Therefore, in the future, it is necessary to carry out clinically confirmatory trials and expand the sample range to get more accurate results.

In conclusion, for the first time, this study investigated the schoolchildren aged 6 to 12 years in urban area of Wuhan whose prevalence of the AR was as high as 28.6%. Male, family history, air purifier, exposed to dust, etc., were associated risk factors, meanwhile the breastfeeding for more than 6 months and moderate outdoor activities were protective factors of AR, which mean both genetic and environmental factors playing vital parts in the etiology of AR. This study filled in the gap of epidemiological investigation of AR in children aged between 6 and 12 years in urban area of Wuhan of China and preliminary looked into the characteristics of AR in this population. In the future, we need to carry out allergen examinations to verify the exact prevalence of AR, and long-term follow-up should be executed to observe the change of AR incidence in this age-group.

Acknowledgments

The authors thank the children, their parents, and the teachers of these schools for their enthusiastic cooperation during the data collection phase.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by grant from the National Natural Science Foundation of China (no. 81770986).

ORCID iD

Huan Tong  <https://orcid.org/0000-0001-5713-2694>

References

1. Marshall PS, O'Hara C, Steinberg P. Effects of seasonal allergic rhinitis on selected cognitive abilities. *Ann Allergy Asthma Immunol.* 2000;84:403–410.
2. Wang XD, Zheng M, Lou HF, et al. An increased prevalence of self-reported allergic rhinitis in major Chinese cities from 2005 to 2011. *Allergy.* 2016;71:1170–1180.
3. Zhang L, Han D, Huang D, et al. Prevalence of self-reported allergic rhinitis in eleven major cities in china. *Int Arch Allergy Immunol.* 2009;149:47–57.
4. Chen J, Zhao Y, Li B, et al. A multicenter study of the clinical features of allergic rhinitis in central China. *Am J Rhinol Allergy.* 2014;28:392–396.
5. Zhao J, Bai J, Shen K, et al. Self-reported prevalence of childhood allergic diseases in three cities of China: a multicenter study. *BMC Public Health.* 2010;10:551.
6. Annesi-Maesano I, Didier A, Klossek M, et al. The Score For Allergic Rhinitis (SFAR): a simple and valid assessment method in population studies. *Allergy.* 2002;57:107–114.
7. Ellwood P, Asher MI, Beasley R, et al. The international study of asthma and allergies in childhood (ISAAC): phase three rationale and methods. *Int J Tuberc Lung Dis.* 2005;9:10–16.
8. Burney PG, Luczynska C, Chinn S, Jarvis D. The European Community Respiratory Health Survey. *Eur Respir J.* 1994;7:954–960.
9. Jones SR, Carley S, Harrison M. An introduction to power and sample size estimation. *Emerg Med J.* 2003;20:453–458.
10. Kong W, Chen J, Wang Y, et al. A population-based 5-year follow-up of allergic rhinitis in Chinese children. *Am J Rhinol Allergy.* 2012;26:315–320.
11. Duksal F, Akcay A, Becerir T, et al. Rising trend of allergic rhinitis prevalence among Turkish schoolchildren. *Int J Pediatr Otorhinolaryngol.* 2013;77:1434–1439.
12. Banac S, Rozmanic V, Manestar K, et al. Rising trends in the prevalence of asthma and allergic diseases among school children in the north-west coastal part of Croatia. *J Asthma.* 2013;50:810–814.
13. Sultesz M, Balogh I, Katona G, et al. Trends in prevalence and risk factors of allergic rhinitis symptoms in primary

- schoolchildren six years apart in Budapest. *Allergol Immunopathol (Madr)*. 2017;45:487–495.
14. Li F, Zhou Y, Li S, et al. Prevalence and risk factors of childhood allergic diseases in eight metropolitan cities in China: a multicenter study. *BMC Public Health*. 2011;11:437.
 15. Shen J, Ke X, Hong S, et al. Epidemiological features of allergic rhinitis in four major cities in Western China. *J Huazhong Univ Sci Technolog Med Sci*. 2011;31:433.
 16. Batlles-Garrido J, Torres-Borrego J, Rubi-Ruiz T, et al. Prevalence and factors linked to allergic rhinitis in 10 and 11-year-old children in Almeria. Isaac Phase II, Spain. *Allergol Immunopathol (Madr)*. 2010;38:135–141.
 17. Zhu RF. *One-Year Aerobiological Study in Wuhan City: Pollen and Fungi, Airbiological Data, and Clinical Correlations* [doctoral dissertation]. Wuhan, China: Huazhong University of Science and Technology; 2011:98.
 18. Graudenz GS, Landgraf RG, Jancar S, et al. The role of allergic rhinitis in nasal responses to sudden temperature changes. *J Allergy Clin Immunol*. 2006;118:1126–1132.
 19. Alm B, Goksor E, Pettersson R, et al. Antibiotics in the first week of life is a risk factor for allergic rhinitis at school age. *Pediatr Allergy Immunol*. 2014;25:468–472.
 20. Sultesz M, Katona G, Hirschberg A, Galffy G. Prevalence and risk factors for allergic rhinitis in primary schoolchildren in Budapest. *Int J Pediatr Otorhinolaryngol*. 2010;74:503–509.
 21. Uekert SJ, Akan G, Evans MD, et al. Sex-related differences in immune development and the expression of atopy in early childhood. *J Allergy Clin Immunol*. 2006;118:1375–1381.
 22. Mehanna N, Mohamed N, Wordofa M, et al. Allergy-related disorders (ARDs) among Ethiopian primary school-aged children: prevalence and associated risk factors. *PLoS One*. 2018;13:e04521.
 23. Arnedo-Pena A, Garcia-Marcos L, Carvajal UI, et al. Air pollution and recent symptoms of asthma, allergic rhinitis, and atopic eczema in schoolchildren aged between 6 and 7 years. *Arch Bronconeumol*. 2009;45:224–229.
 24. Gehring U, Wijga AH, Brauer M, et al. Traffic-related air pollution and the development of asthma and allergies during the first 8 years of life. *Am J Respir Crit Care Med*. 2010;181:596–603.
 25. Chen F, Lin Z, Chen R, et al. The effects of PM2.5 on asthmatic and allergic diseases or symptoms in preschool children of six Chinese cities, based on China, Children, Homes and Health (CCHH) project. *Environ Pollut*. 2018;232:329–337.
 26. Viinainen A, Munhbayarlah S, Zevgee T, et al. Prevalence of asthma, allergic rhinoconjunctivitis and allergic sensitization in Mongolia. *Allergy*. 2005;60:1370–1377.
 27. Okada Y, Kumagai H, Morikawa Y, Akasawa A. Epidemiology of pediatric allergic diseases in the Ogasawara Islands. *Allergol Int*. 2016;65:37–43.
 28. Huang K, Yang T, Xu J, et al. Prevalence, risk factors, and management of asthma in China: a national cross-sectional study. *Lancet*. 2019;394:407–418.
 29. Saulyte J, Regueira C, Montes-Martinez A, et al. Active or passive exposure to tobacco smoking and allergic rhinitis, allergic dermatitis, and food allergy in adults and children: a systematic review and meta-analysis. *PLoS Med*. 2014;11:e1001611.
 30. Zhang YM, Zhang J, Liu SL, et al. Prevalence and associated risk factors of allergic rhinitis in preschool children in Beijing. *Laryngoscope*. 2013;123:28–35.
 31. Brozek JL, Bousquet J, Baena-Cagnani CE, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines: 2010 revision. *J Allergy Clin Immunol*. 2010;126:466–476.
 32. Ologe FE, Adebola SO, Dunmade AD, et al. Symptom score for allergic rhinitis. *Otolaryngol Head Neck Surg*. 2013;148:557–563.