

Prevalence of Self-Reported Allergic Rhinitis in Eleven Major Cities in China

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Key Words

Allergic rhinitis • Epidemiology • Intermittent allergic rhinitis • Persistent allergic rhinitis • Self-reported rhinitis • Underdiagnosis, rhinitis

Abstract

Background: Allergic rhinitis (AR) is a common disease and its prevalence is increasing worldwide. Data on the current prevalence of AR in China, one of the biggest countries in the world, with a population of around 1.3 billion citizens, are scarce. The aim of this study was to investigate the prevalence of self-reported AR in Chinese citizens. **Methods:** In a cross-sectional, population-based study, telephone interviews were conducted in 11 major cities in China after sampling target telephone numbers through the approach of random digital dialing. The questions for the telephone interviews were based on validated questionnaires. **Results:** A total of 38,203 telephone interviews were conducted from September 2004 to May 2005. The response rate was 63.7%. After adjustment for age and gender, the self-reported prevalence of AR was lowest in Beijing (8.7%) and highest in Urumqi (24.1%). Among the subjects with self-reported AR,

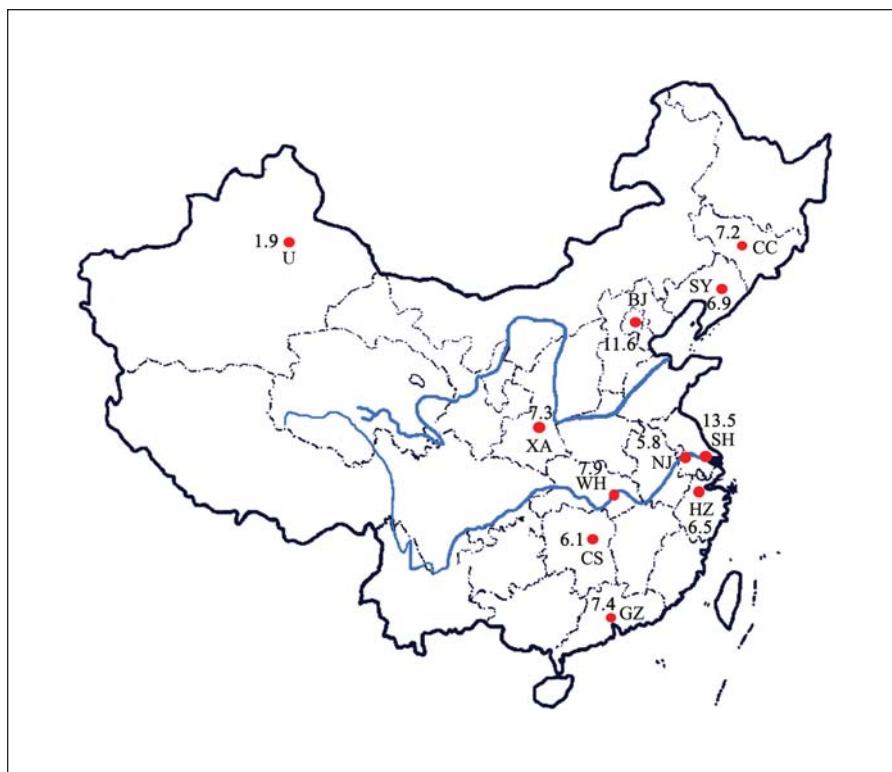
25.6% were diagnosed with persistent AR and 74.4% suffered from intermittent AR. Less than half of the subjects with self-reported AR had presented at a health clinic. In 37.3% AR had previously been diagnosed by physicians, and 33.1% of subjects with self-reported AR had been treated. Comorbidities reported were asthma (9.2%), rhinosinusitis (13.3%) and atopic dermatitis (16.4%). **Conclusions:** This study demonstrates that the self-reported prevalence of AR in 11 cities across Mainland China has wide variations, ranging from <10% to >20%; 26% of the self-reported AR subjects were classified as suffering from persistent AR.

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Introduction

Respiratory allergies, including allergic rhinitis (AR), have increased in prevalence in recent decades [1–7] and appear to have spread across a wider age range [4, 6]. There are insufficient epidemiological data for AR in China. In Hong Kong, the prevalence of AR has been reported to increase, demonstrating an increase in AR but not asthma among children from 1995 to 2001 [8]. In

Fig. 1. The locations of the 11 major cities in China chosen for the current study. The number given for each city represents its population in millions. BJ = Beijing; CC = Changchun; CS = Changsha; GZ = Guangzhou; HZ = Hangzhou; NJ = Nanjing; SH = Shanghai; SY = Shenyang; U = Urumqi; WH = Wuhan; XA = Xi'an.



1998, the International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee published data for the worldwide prevalence of allergic rhinoconjunctivitis symptoms and other allergy symptoms among children aged 13–14 years, including five major cities (Beijing, Chongqing, Guangzhou, Shanghai and Urumqi) in Mainland China and in Hong Kong. While the cities of Mainland China showed a prevalence of 5–10%, Hong Kong demonstrated a prevalence of about 24% [9]. However, there are few epidemiological studies of the adult population in China, a country with different climate zones and rapidly expanding industrialization.

The People's Republic of China is one of the largest countries in the world and has a population of around 1.3 billion citizens. It is divided into 34 administrative divisions including 23 provinces, 5 autonomous regions, 4 municipalities directly under the Central Government and 2 Special Administrative Regions (Hong Kong and Macao). Geographically, China is situated in the eastern part of Asia, on the west coast of the Pacific Ocean, and spans 49 degrees of latitudes (from 53°30' N to 4° N) and over 60 degrees of longitude (from 135°05' E to 73°40' E). It has an area of around 9.6 million square kilometers and is traditionally divided into 7 divisions including North,

Northeast, East, South, Northwest, Central and Southwest China.

Recently AR has been recognized as a disease affecting increasing numbers of patients in Mainland China and reclassified by the Allergic Rhinitis and Its Impact on Asthma (ARIA) Initiative. However, until now, no estimate of the nationwide prevalence of AR has been available using the new classification. The aim of this cross-sectional, population-based study was to investigate the prevalence of self-reported AR in 11 major cities of Mainland China and its association with factors such as location, socioeconomic status, meteorology and air pollution.

Patients and Methods

Eleven major cities in Mainland China were selected for the study. The population size and locations of the cities studied are given in figure 1. While the city with the smallest population was Urumqi (1.86 million inhabitants), the largest was Shanghai (13.52 million). These eleven largest cities of Mainland China include the main municipalities (Beijing and Shanghai), capital cities of major provinces throughout Mainland China, and one capital city of an autonomous region (Urumqi). Geographically, Chang-

chun (Jilin Province) and Shenyang (Liaoning Province) are located in Northeast China; Beijing in North China; Hangzhou (Zhejiang Province), Nanjing (Jiangsu Province) and Shanghai in East China; Changsha (Hunan Province) and Wuhan (Hubei Province) in Central China; Urumqi (Xinjiang Autonomous Region) and Xi'an (Shanxi Province) in Northwest China, and Guangzhou (Guangdong Province) is located in South China (fig. 1). A cross-sectional telephone interview was carried out in these 11 cities (fig. 2).

Selection of Subjects

The target population consisted of subjects having fixed telephones within 11 cities in China. The fixed telephone coverage rates in the cities selected were as follows: 63% (Beijing), 56% (Shanghai), 46% (Hangzhou), 41% (Nanjing), 39% (Shenyang), 37% (Guangzhou), 32% (Urumqi), 29% (Changchun), 23% (Xi'an), 20% (Wuhan) and 18% (Changsha). The study was designed to include a random sample of the target population in those cities. Approval was obtained from the Scientific Committee of the Beijing Institute of Otolaryngology.

Questionnaire Design

The questionnaire for the telephone interviews was derived from well-validated questionnaires used by the ISAAC [10] and the European Community Respiratory Health Survey studies [11]. Two Chinese independently translated the original questionnaire into Chinese. These two translations were harmonized, and then checked by independent back-translation by two native English speakers. The harmonized translation was pre-tested in a pilot study on 203 Chinese subjects. The final version of the questionnaire in Chinese was then applied to the respondents in our survey. There were 15 closed questions taken from the questionnaires, which considered nasal symptoms, length of past history, self-reported allergens, concomitant allergic diseases and the allergy status of the family (fig. 3).

The criteria used to diagnose AR were consistent with those of the ARIA document [12]: subjects would be screened positive if they had a problem with symptoms such as sneezing, or runny, blocked or itchy nose within the last 12 months unrelated to suffering from an upper respiratory infection. AR subjects were diagnosed with intermittent or persistent AR based on the self-reported duration of symptoms. Intermittent AR was defined as a report of nasal symptoms lasting ≤ 4 days/week or ≤ 4 weeks/year. Persistent AR was defined as a report of nasal symptoms lasting > 4 days/week and > 4 weeks within the last 12 months.

Telephone Number Sampling

After designing the questionnaire, the approach of random digital dialing (RDD) via computer was conducted for sampling target telephone numbers. The procedure was carried out according to list-assisted RDD [13] and the modified Mitofsky-Waksberg two-stage sampling method [14]. Firstly, a certain number of area code prefixes from the city telephone directory (2004 Yellow Pages) were randomly sampled. Secondly, about 500 four-digit suffixes appending to the same sampled area code prefix were randomly selected, which generated one block including all the telephone numbers with the same first 3 or 4 digits. Telephone numbers within the retained block would be dialed until a target interview number had been reached. When the call was answered, the telephone interview would start. If the line was busy or there

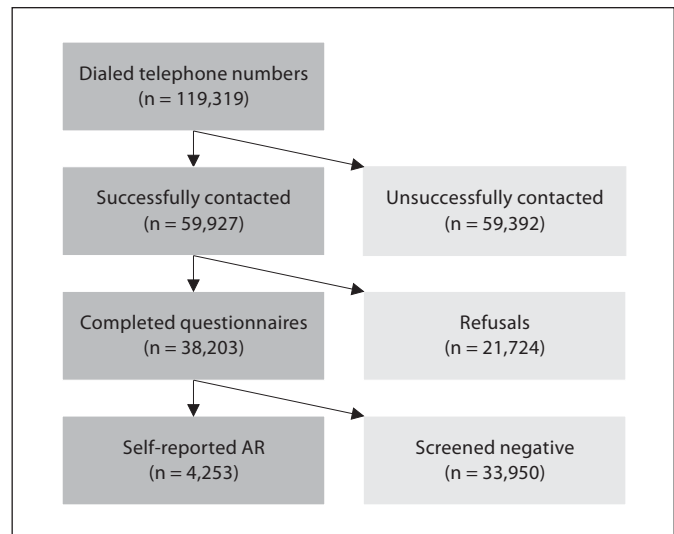


Fig. 2. Flow chart for the study.

was no response, a maximum of three repeat calls would be undertaken. The block would be discarded if all of the telephone numbers within it were business numbers, nonexistent or the interview was refused.

Sample Size

A sample size N of at least 1,000 per city was chosen for the target interviews, which was calculated according to formula 1:

$$N = Z^2 P (1 - P) / d^2 \quad (1)$$

where N is the sample size [15, 16]; Z is the statistic for a level of confidence, equal to 1.96 for the level of confidence of 95%, which is conventional; P is the estimated prevalence of AR and is equal to 0.15 based on the prevalence of previous epidemiological surveys of Chinese children [9], and d is precision, here chosen to be 0.03. As a result, the target sample size equaled 544, according to the formula. However, in order to compare the prevalence of AR in 11 cities, considering that some cities may have limited fixed telephones or smaller population, the sample size was set to be at least 1,000 in each of the target cities.

Telephone Interview

Ten interviewers received training in telephone interview-related methods and skills for 2 days in August 2004 and were finally qualified. The telephone interviews were conducted either during weekdays, from 17:30 to 21:00 h, or during the weekend, from 9:00 to 22:00 h. The whole procedure lasted 8 months (from September 2004 to April 2005). For each contacted telephone number, only the person who answered the telephone was interviewed. Subjects in any age class were enrolled in the screening telephone interview, though only subjects aged between 16 and 65 were considered as the eligible age class who could complete the core telephone questionnaire by themselves. Subjects who were not eligible regarding age but could reach an eligible family member to answer the telephone instead were enrolled in answering

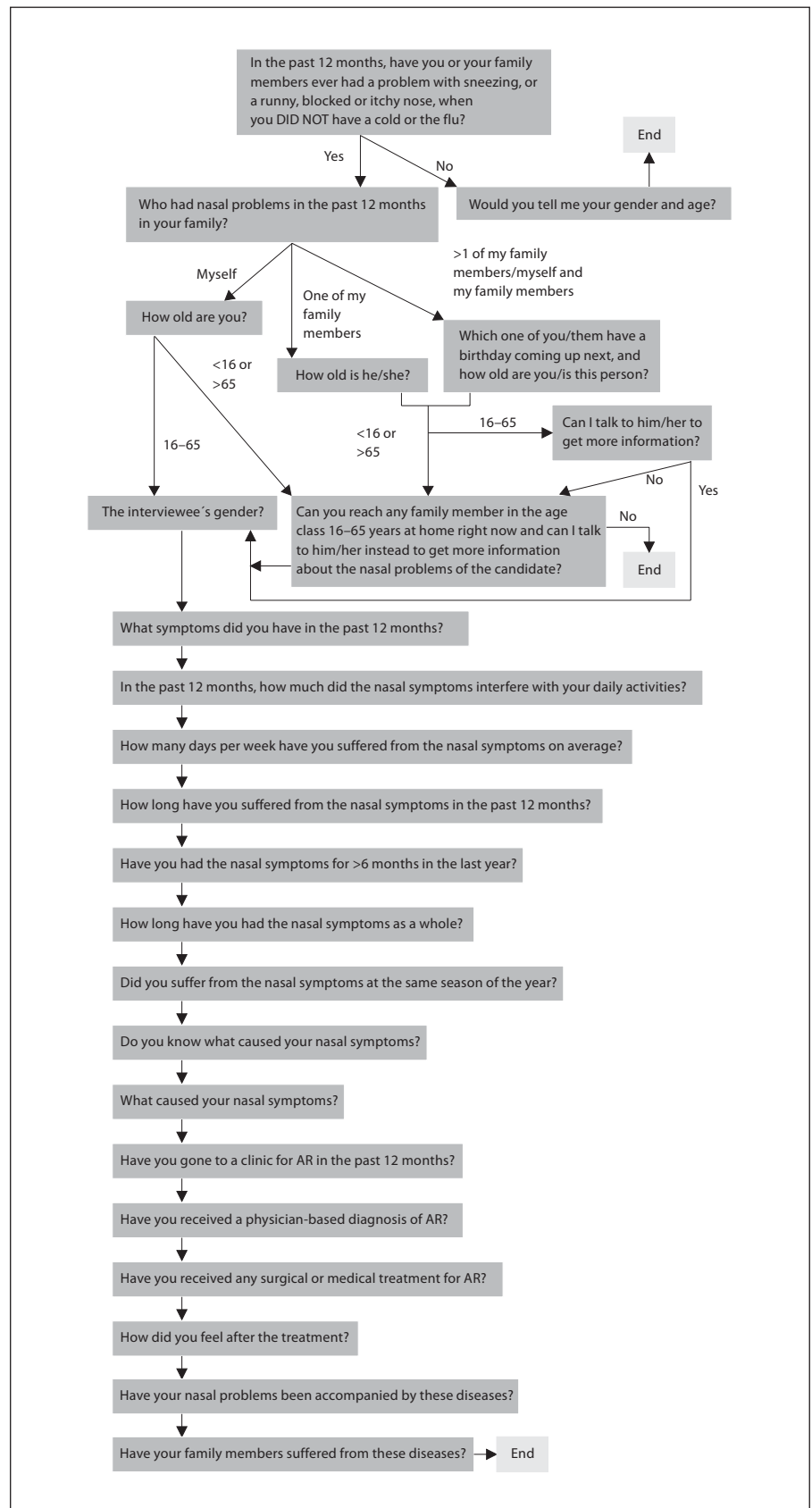


Fig. 3. Flow diagram for the questionnaire.

Table 1. Characteristics of subjects (n) with self-reported AR in the 11 cities in China

City	Completed screening questionnaire	Self-reported AR	Female (%)	Classification		Prevalence of AR	
				persistent (%)	intermittent (%)	before adjustment	age- and gender-adjusted
Beijing	9,688	940	433 (48.5)	346 (38.7)	547 (61.3)	9.7	8.7
Changchun	2,347	211	112 (54.6)	54 (26.3)	151 (73.7)	9.0	11.2
Changsha	2,632	315	165 (54.1)	52 (17.0)	253 (83.0)	12.0	16.1
Guangzhou	3,346	440	202 (49.3)	79 (19.3)	331 (80.7)	13.2	14.1
Hangzhou	3,403	346	141 (46.2)	47 (15.4)	258 (84.6)	10.2	8.9
Nanjing	2,797	322	166 (54.4)	56 (18.4)	249 (81.6)	11.5	13.3
Shanghai	4,051	441	204 (49.8)	87 (21.2)	323 (78.8)	10.9	13.6
Shenyang	2,252	317	140 (45.6)	89 (29.0)	218 (71.0)	14.1	15.7
Urumqi	1,021	218	114 (55.6)	74 (36.1)	131 (63.9)	21.4	24.1
Wuhan	2,064	335	158 (51.8)	52 (17.0)	253 (83.0)	16.2	19.3
Xi'an	4,602	368	138 (44.1)	77 (24.6)	236 (75.4)	8.0	9.1
Total	38,203	4,253	1,973 (49.8)	1,013 (25.6)	2,950 (74.4)	–	–

the core questionnaire; however, persons who were potentially eligible based on the screening telephone interview were subsequently excluded on completion of the core questionnaire if they were not eligible regarding age and could not reach an eligible family member to answer the telephone instead.

The telephone interview had a mean duration of 10 min. The supervisors randomly checked the recording process. In Beijing, telephone numbers where no response was obtained or the questionnaire was refused after three attempts were randomly sampled and dialed, to test for a bias resulting from those numbers.

Self-Reported Prevalence of AR

After harvesting the prevalence of AR in each city, we calculated age- and gender-adjusted prevalence, also known as the directly standardized prevalence (DSP), according to formula 2. The demographic structure data in each city were from the 2005 Statistical Yearbook.

$$\text{DSP} = \sum_i \text{AGP}p_i \cdot S_i / \sum_i S_i \quad (2)$$

where i is an index of age and gender groups (i.e. males aged under 16 years or females aged 26–40, for example). There are S individuals in the standard population with S_i individuals in each age and gender group i , and there are P individuals in the observed population with P_i individuals in each age and gender group i . $\text{AGP}p_i$ is the prevalence of age and gender group i in the observed population P . If $\text{O}p_i$ is the number of subjects with AR, then $\text{AGP}p_i$ is equal to $\text{O}p_i / P_i$.

Collecting Data for Socioeconomic Status, Meteorology and Air Pollution

In order to generally assess the association between the prevalence of AR and factors such as population, geographical location, socioeconomic status, meteorological factors and air pollution, we considered the following factors: (1) population of the city; (2) the longitude and latitude of the city; (3) indicators of socioeconomic status including gross domestic product (GDP), GDP per capita, gross output value of industry and the gross output value

of industry per capita; (4) indicators of weather conditions including annual average temperature, annual average relative humidity, annual hours of sunshine and annual precipitation, and (5) indicators of air pollution from 2003 to 2005, including annual mean of sulfur dioxide, annual mean of nitrogen dioxide and annual mean of particulate matter with an aerodynamic diameter $\leq 10 \mu\text{m}$ (PM_{10}), as received from the National Bureau of Statistics of China (<http://www.stats.gov.cn/tjsj/ndsj/2005/indexch.htm>).

Data Analysis

All data were entered into the computer twice by two independent investigators. The data were categorized and analyzed using SPSS 11.5 for Windows (Statistical Package for Social Sciences). The χ^2 test was used to assess the potential difference between the adjusted self-reported prevalence of AR in the 11 cities sampled. A multiple linear correlation was used in order to estimate the relationship between the age- and gender-adjusted prevalence of AR and factors such as population, geographical location, socioeconomic status, meteorological factors and air pollution. A value of $p < 0.05$ was considered to be significant.

Results

Telephone Number Sampling

In total, the procedure of list-assisted RDD had selected 684 blocks of telephone numbers from about 34,200 blocks in 11 cities, and the dialed telephone numbers accounted for 119,319 calls. A total of 59,927 telephone numbers were eligible, while 59,392 telephone numbers were not reachable after three attempts, representing a rate of 50.2% (59,927/119,319). Among the 59,927 telephone numbers that were eligible, 38,203 subjects completed the interview, giving a response rate of 63.7%

Table 2. Reported AR symptoms and allergens in the 11 cities in China

City	Reported symptoms, n (%)						
	blocked nose	runny nose	itchy nose	sneezing	olfactory disorder	ocular symptoms	throat symptoms
Beijing	614 (68.8)	685 (76.7)	629 (70.4)	798 (89.4)	200 (22.4)	529 (59.2)	426 (47.7)
Changchun	102 (49.8)	120 (58.5)	101 (49.3)	186 (90.7)	30 (14.6)	66 (32.2)	78 (38.0)
Changsha	167 (54.8)	180 (59.0)	194 (63.6)	284 (93.1)	25 (8.2)	101 (33.1)	130 (42.6)
Guangzhou	228 (55.6)	269 (65.6)	270 (65.9)	381 (92.9)	36 (8.8)	153 (37.3)	140 (34.1)
Hangzhou	139 (45.6)	137 (44.9)	175 (57.4)	273 (89.5)	28 (9.2)	97 (31.8)	109 (35.7)
Nanjing	142 (46.6)	168 (55.1)	193 (63.3)	279 (91.5)	22 (7.2)	99 (32.5)	124 (40.7)
Shanghai	238 (58.0)	251 (61.2)	271 (66.1)	383 (93.4)	38 (9.3)	158 (38.5)	164 (40.0)
Shenyang	176 (57.3)	215 (70.0)	178 (58.0)	277 (90.2)	50 (16.3)	115 (37.5)	127 (41.4)
Urumqi	107 (52.2)	121 (59.0)	128 (62.4)	187 (91.2)	16 (7.8)	104 (50.7)	87 (42.4)
Wuhan	181 (59.3)	186 (61.0)	224 (73.4)	288 (94.4)	25 (8.2)	121 (39.7)	135 (44.3)
Xi'an	191 (61.0)	223 (71.2)	185 (59.1)	275 (87.9)	73 (23.3)	167 (53.4)	166 (53.0)
Total	2,285 (57.7)	2,555 (64.5)	2,548 (64.3)	3,611 (91.1)	543 (13.7)	1,710 (43.1)	1,686 (42.5)

Table 3. Reported medical history, allergy status of the family and comorbidities in self-reported AR subjects in the 11 cities in China

City	Medical history, n (%)					Co-morbidities, n (%)		
	presented at a clinic	diagnosed AR	treated AR	effectively treated	not effectively treated	asthma	sinusitis	atopic dermatitis
Beijing	554 (62.0)	485 (54.3)	436 (48.8)	290 (66.5)	146 (33.5)	113 (12.7)	177 (19.8)	202 (22.6)
Changchun	74 (36.1)	56 (27.3)	51 (24.9)	35 (68.6)	16 (31.4)	17 (8.3)	16 (7.8)	21 (10.2)
Changsha	130 (42.6)	98 (32.1)	88 (28.9)	55 (62.5)	33 (37.5)	23 (7.5)	39 (12.8)	41 (13.4)
Guangzhou	188 (45.9)	153 (37.3)	131 (32.0)	87 (66.4)	44 (33.6)	22 (5.4)	51 (12.4)	51 (12.4)
Hangzhou	135 (44.3)	96 (31.5)	83 (27.2)	56 (67.5)	27 (32.5)	40 (13.1)	31 (10.2)	30 (9.8)
Nanjing	131 (43.0)	104 (34.1)	84 (27.5)	52 (61.9)	32 (38.1)	28 (9.2)	25 (8.2)	52 (17.0)
Shanghai	171 (41.7)	136 (33.2)	120 (29.3)	70 (58.3)	50 (41.7)	38 (9.3)	40 (9.8)	64 (15.6)
Shenyang	120 (39.1)	101 (32.9)	88 (28.7)	56 (63.6)	32 (36.4)	27 (8.8)	36 (11.7)	69 (22.5)
Urumqi	103 (50.2)	77 (37.6)	69 (33.7)	46 (66.7)	23 (33.3)	13 (6.3)	21 (10.2)	17 (8.3)
Wuhan	120 (39.3)	86 (28.2)	83 (27.2)	59 (71.1)	24 (28.9)	13 (4.3)	41 (13.4)	46 (15.1)
Xi'an	128 (40.9)	87 (27.8)	80 (25.6)	50 (62.5)	30 (37.5)	30 (9.6)	51 (16.3)	58 (18.5)
Total	1,854 (46.8)	1,479 (37.3)	1,313 (33.1)	856 (65.2)	457 (34.8)	364 (9.2)	528 (13.3)	651 (16.4)

(38,203/59,927; fig. 2). The highest and lowest response rates were 75.3 (Xi'an) and 50.5% (Guangzhou), respectively (table 1).

Self-Reported Prevalence of AR

Among the 38,203 respondents, 4,253 subjects reported AR (11.1%); 33,950 subjects were screened negative in the telephone interviews. Variation in the prevalence of self-reported AR among the cities was large; the highest and lowest prevalence rates of self-reported AR were 21.4

(Urumqi) and 8.0% (Xi'an), respectively. The demographic structure of the sampled population was compared with the actual demographic structure in each city, and only small deviations were found, according to the 2005 Statistical Yearbook and the 2000 Bulletin of Population Census. After being adjusted to the age and gender structure of the population in each city, the prevalence of self-reported AR ranged from 8.7 (Beijing) to 24.1% (Urumqi; table 1).

Reported allergens, n (%)				
pollens	fungi	dust mites	animal dander	others
168 (47.7)	44 (12.5)	104 (29.5)	102 (29.0)	8 (2.3)
19 (21.2)	5 (8.2)	9 (14.8)	15 (24.6)	1 (1.6)
37 (36.6)	8 (7.9)	20 (19.8)	29 (28.7)	4 (4.0)
51 (39.5)	14 (10.9)	24 (18.6)	51 (39.5)	0 (0.0)
36 (28.6)	3 (2.4)	15 (11.9)	20 (15.9)	3 (2.4)
102 (72.4)	7 (5.0)	23 (16.3)	32 (22.7)	6 (4.3)
62 (46.9)	14 (10.6)	31 (23.5)	37 (28.0)	2 (1.5)
38 (49.4)	4 (5.2)	17 (22.1)	17 (22.1)	0 (0.0)
42 (53.9)	2 (2.6)	9 (11.5)	18 (23.1)	2 (2.6)
83 (60.2)	17 (12.3)	22 (15.9)	34 (24.6)	4 (2.9)
41 (48.8)	3 (3.6)	8 (9.5)	17 (20.2)	3 (3.6)
679 (47.8)	121 (8.5)	281 (19.8)	372 (26.2)	32 (2.3)

Allergies in the family members, n (%)			
AR	asthma	sinusitis	atopic dermatitis
179 (20.0)	68 (7.6)	65 (7.3)	73 (8.2)
15 (7.3)	4 (2.0)	7 (3.4)	2 (1.0)
36 (11.8)	9 (3.0)	14 (4.6)	12 (3.9)
72 (17.6)	10 (2.4)	13 (3.2)	23 (5.6)
26 (8.5)	10 (3.3)	5 (1.6)	18 (5.9)
46 (15.1)	22 (7.2)	13 (4.3)	20 (6.6)
87 (21.2)	22 (5.4)	13 (3.2)	22 (5.4)
44 (14.3)	11 (3.6)	14 (4.6)	29 (9.4)
47 (22.9)	8 (3.9)	6 (2.9)	9 (4.4)
55 (18.0)	9 (3.0)	12 (3.9)	13 (4.3)
42 (13.4)	13 (4.2)	22 (7.0)	28 (8.9)
649 (16.4)	186 (4.7)	184 (4.6)	249 (6.3)

Among the 4,253 subjects with self-reported AR, 290 subjects who were not in the eligible age class (between 16 and 65 years) and could not reach an eligible family member to answer the telephone instead did not complete the core questionnaire, leaving a total number of 3,963 (93.2%) subjects with completed questionnaires screened positive. Table 1 summarizes the characteristics of the subjects with AR. The age distribution of the 3,963 self-reported AR subjects was as follows: 7.4% aged <16; 21.2% aged between 16 and 25; 31.8% aged between 26

and 40; 33.9% aged between 41 and 65, and 5.8% aged >65. 50.2% of allergic subjects were male, 49.8% were female. The prevalence in the different age groups was as follows: 29.4% in subjects aged <16; 12.6% in subjects aged between 16 and 25; 12.7% in subjects aged between 26 and 40; 11.6% in subjects aged between 41 and 65, and 11.4% in subjects aged >65 years. While 2,950 out of 3,963 (74.4%) were diagnosed as having intermittent AR, 1,013 out of 3,963 (25.6%) were persistent AR sufferers. The rates of persistent self-aware AR ranged from 15.4% (47 out of 305) in Hangzhou to 38.7% (346 out of 893) in Beijing.

The self-awareness of nasal symptoms and allergens is summarized in table 2. Sneezing was commonly reported by most subjects (91.1%), followed by running (64.5%), itchy (64.3%) and blocked nose (57.7%). Ocular symptoms (43.1%), throat symptoms (42.5%) and olfactory disorders (13.7%) were less common. Pollen was the most commonly reported allergen (47.8%), followed by animal dander (26.2%) and dust mites (19.8%).

Table 3 summarizes the medical history of the AR subjects in the 11 cities. In total, nearly half (46.8%) of the subjects (1,854 out of 3,963) had presented at a health clinic for their complaints within the last 12 months. Among them, 1,479 (37.3%) were previously diagnosed as having AR by physicians within the last 12 months and 1,313 (33.0%) received surgical and/or medical treatment. More than half (856 out of 1,307, 65.5%) of the subjects receiving treatment affirmed the effect of therapy, and the others reported no change or a worsening of symptoms. Apart from AR, atopic dermatitis (16.4%) was the most frequently reported accompanying disease, followed by sinusitis (13.3%) and asthma (9.2%). AR was also the most frequently mentioned disease (16.4%) affecting other family members, followed by atopic dermatitis (6.3%), asthma (4.7%) and sinusitis (4.6%; table 3).

The Influences of Population Size, Location, Socioeconomic Status, Meteorology and Air Pollution

The adjusted self-reported prevalence of AR was not correlated with the size of the population of the cities ($p > 0.05$). The longitudes of the cities were from the most easterly at 125°13'E (Changchun) to the most westerly at 87°37' E (Urumqi). The adjusted prevalence of AR was negatively correlated with the longitudes of the cities ($r^2 = -0.635$, $p = 0.036 < 0.05$). The latitudes of the cities were from the most northerly at 43°54' N (Changchun) to the most southerly at 23°08' N (Guangzhou), which had no correlation with AR prevalence ($p > 0.05$).

Table 4. Economic data from the 11 cities in China (2004)

City	GDP million CNY	GDP per capita CNY/person	Gross output value of industry million CNY	Gross output value of industry per capita CNY/person
Beijing	428,331.00	36,833.3	573,336.11	49,302.7
Changchun	153,500.51	21,201.7	171,267.89	23,655.8
Changsha	113,388.28	18,576.7	70,605.78	11,567.5
Guangzhou	411,580.07	55,794.6	504,333.23	68,368.4
Hangzhou	251,500.00	38,592.6	414,910.39	63,667.8
Nanjing	191,000.00	32,727.9	328,502.12	56,288.9
Shanghai	745,027.00	55,089.7	1,287,586.55	95,208.2
Shenyang	190,068.86	27,392.6	149,340.04	21,522.8
Urumqi	48,425.99	26,041.1	41,821.70	22,489.6
Wuhan	195,600.00	24,888.7	167,834.19	21,355.7
Xi'an	109,587.00	15,115.2	78,921.70	10,885.6

CNY = Chinese Yuan Renminbi.

Table 5. Meteorological data from the 11 cities in China (2004)

City	Average temperature °C	Average relative humidity, %	Annual sunshine h	Annual precipitation mm
Beijing	13.5	49	2,515.4	483.5
Changchun	7.1	58	2,602.6	476.2
Changsha	18.3	72	1,626.2	1,346.5
Guangzhou	22.8	68	1,767.4	1,636.5
Hangzhou	17.8	70	1,874.9	1,046.5
Nanjing	16.9	70	2,141.3	975.1
Shanghai	17.5	72	1,965.0	1,061.0
Shenyang	9.6	57	2,291.7	705.2
Urumqi	8.0	56	2,495.6	333.6
Wuhan	18.3	70	1,918.0	1,572.2
Xi'an	15.4	59	1,913.1	512.7

Since the survey was carried out in 2004, we used the socioeconomic, meteorological and air pollution data for 2004 (tables 4, 5) to assess the association between those indicators and prevalence of AR. There was no correlation between the adjusted self-reported prevalence of AR and socioeconomic factors such as GDP, GDP per capita, gross output value of industry and gross output value of industry per capita ($p > 0.05$, respectively). While the prevalence of AR was positively correlated with the concentration of SO_2 ($r^2 = 0.614$, $p = 0.044 < 0.05$), no correlation was found between the prevalence of AR and meteorological factors (all $p > 0.05$) or other air pollution factors (all $p > 0.05$).

Discussion

The prevalence of AR has increased in industrialized countries over recent decades [2, 4, 5]. In contrast, little epidemiological data have been published for AR in Mainland China, a country that has undergone rapid industrialization over the last 10 years. In this cross-sectional, population-based study, telephone interviews were conducted in 11 major cities in China after sampling target telephone numbers through the approach of RDD. The questions for the telephone interviews were based on validated questionnaires. A total of 38,203 telephone interviews were conducted. After adjustment for age and gender, the self-reported prevalence of AR was lowest in Beijing (8.7%) and highest in Urumqi (24.1%). Using the new ARIA classification, we found that about a quarter of the subjects with self-reported AR were classified as suffering from persistent AR. Using the modified ISAAC protocol, a study carried out about 10 years ago showed that the self-reported prevalence of AR was 30.0% in 2,978 children in Beijing and 31.1% in 2,840 children (6 and 7 years old) in Urumqi, respectively [17]. Another study conducted about 5 years ago showed that 15.7% of 1,062 students (~14 years old) in Hong Kong and 2.1% of 737 students (~16 years old) in San Bu reported hay fever [18]. Hong Kong and San Bu are situated 174 km southeast and 140 km southwest of Guangzhou, respectively. In a study in Anqing, a rural province (Anhui) of Mainland China, low percentages of rhinitis were also reported for 10,009 relatives of 2,544 families of asthmatics (3.5%) and the asthmatics themselves (6.2%) [19]. To our knowl-

edge, the current study is the first nationwide survey of the prevalence of self-reported AR in adolescents and adults in Mainland China, although our study recruited only citizens of 11 major Chinese cities, i.e. these figures only represented urban areas and did not include rural areas of China.

In general, commonly used methods for epidemiological research include postal questionnaire surveys, face-to-face interviews and telephone interviews, which may be supplemented with physical examinations. Postal questionnaires offer a cheap alternative and preserve confidentiality; however, response rates are often low [11]. Written questionnaires are less intrusive than telephone or face-to-face surveys, and could reduce interviewer bias. However, written questionnaires are more costly in time and money than telephone interviews [10]. Telephone interviews can provide researchers with an efficient method to collect data with acceptable response rates and low interviewer bias [20–22]. In a study carried out in 2004, a total of 9,646 telephone interviews were conducted to measure the prevalence of AR among European adults, and 19% of the subjects had self-reported AR [21]. Telephone surveys generally require less time and money than face-to-face interviews. However, the absence of a telephone at home among a proportion of potential respondents poses a challenge to telephone surveys [14]. Since the telephone coverage rates of rural areas were low, we chose urban areas for this survey [the fixed telephone coverage rate (set/100 persons) in the 11 cities ranged from 23.1 to 57.5 during our survey]. In the future, we intend to target rural areas for interviews using other methods.

To elucidate the influence of the different survey methods, we had reinterviewed 1,499 adults in Beijing face-to-face 12 months after interviewing them by telephone, the comparability of telephone and face-to-face interview was examined through contrasting the age- and gender-adjusted prevalence of AR associated with the two assessment procedures (prevalence obtained from face-to-face interview: 10.5%; prevalence obtained from telephone interview: 8.7%). Given the result that the telephone interview had a similar rate and acceptable agreement with the original 'gold standard' face-to-face interview, the data obtained from telephone interviews were considered feasible. Our survey used telephone interviews in 11 cities across Mainland China and the response rate was 63.7%, which was close to the rate in the Israeli population (58.5%) [23] obtained using a similar methodology of a telephone questionnaire [20, 21]. In the ISAAC survey conducted in Singapore in 1994 and 2001, which used

written questionnaires to collect data, the response rates were 90% in 1994 and 91% in 2001 [24], whereas rates were as low as 47–57% in New Zealand, depending on the mode of data collection [25]. Thus, the response rate observed in the current study was within the expected range, although inevitably there could be some selection bias.

Most epidemiological surveys so far have made use of the classical terminology of seasonal and perennial self-reported AR [3]. The new classification of AR proposed by the ARIA Initiative is relatively recent and prevalence data are rare. In France, 49% of patients consulting for AR were classified as having persistent AR [26]. However, in population-based studies carried out in six European countries, approximately one third of the subjects with AR had persistent AR [21]. Similarly, in our survey, 25.6% of the subjects were diagnosed as having persistent AR, while the other 74.4% had intermittent AR. Furthermore, the proportion of persistent AR in our survey was highest (24.6–38.7%) in northern cities (e.g. Changchun, Shenyang and Urumqi) and lowest (15.4–21.2%) in southern cities (e.g. Wuhan, Changsha and Guangzhou). This is also consistent with data from Europe, with the proportion of persistent AR cases being higher (24.8–53.8%) in northern countries (e.g. UK, Belgium and Germany) and lower (21.0–32.4%) in southern countries (e.g. France, Italy and Spain) [21]. In general, most of the main cities included in the study had lower AR prevalence rates than European countries (19%). Within the 11 cities across Mainland China, the self-reported prevalence of AR has wide variations, ranging from <10% to >20%. Meanwhile, the gross output value of industry per capita of the most developed city, Shanghai, is eight times higher than that of the least developed city, Xi'an. Those results may hint at the influence of industrialization. However, we did not find a correlation between the prevalence of AR and major socioeconomic indicators.

There is accumulating evidence that both genetic and environmental factors play important roles in the etiology of AR. However, large increases in the prevalence of AR within a short period of time are unlikely to be explained by variations in the genetic background. Therefore, attempts to study the effect of environmental factors on AR prevalence are useful. While urban air pollution consists of a complex mixture of compounds, here we focused on SO₂, NO₂ and particles with an aerodynamic diameter of ≤10 μm (PM₁₀). SO₂ is a traditional pollutant of industrial origin relating to the combustion of coal and other fossil fuels; NO₂ is known to be the best indicator of modern pollutants from motor vehicle traffic emis-

sions [27], and PM₁₀ are produced mainly by the incomplete combustion of fuels and lubricants, which is also an important indicator of air pollution. PM₁₀ and NO₂ have been demonstrated to be acute respiratory irritants in animal and controlled human exposure studies. SO₂ could increase the permeability of the mucous membrane in airways, which may favor the penetration of allergens and the development of allergic reactions [28]. In the 1960s and 1970s, acute epidemics of respiratory diseases in Europe and the USA were associated with episodes of atmospheric winter pollution, especially high concentrations of SO₂ and particulate matter in the air of cities. Recently, a nationwide study was conducted on the relationship between air pollution and AR in 32,143 Taiwanese school children, which demonstrated that the prevalence of AR was significantly associated with SO₂, carbon monoxide and nitric oxides [28]. Consistent with the previous literature, our survey demonstrated that the adjusted self-reported prevalence of AR was positively correlated with the concentration of SO₂, but failed to show an association with concentrations of PM₁₀ and NO₂. Concentrations of SO₂ in the years 2003–2005 showed peak levels and increasing trends in Urumqi, while in Beijing and Xi'An relatively low levels and decreasing trends were observed, consistent with our AR prevalence data.

In the current study, less than half (46.8%) of the subjects presented at a health clinic within the previous year. Among them, 37.3% were previously diagnosed as having AR by physicians and 33.1% of the subjects received surgical or medical treatment. More than half (65.5%) of the subjects receiving medical treatment affirmed the effect of therapy. Conversely, the proportions of undiagnosed subjects or untreated subjects were relatively high, although being consistent with previous studies. A recent study in Poland among a random sample of 1,522 inhabitants found that half of the subjects with seasonal AR and 61% of the subjects with persistent AR had not been diagnosed by a practitioner [29]. Sibbald et al. [30] examined 7,702 adults in London; in approximately half of the subjects, perennial AR had not been diagnosed, whereas in more than one quarter of the subjects hay fever was not diagnosed. In 2002, in an epidemiological survey conducted in a total of 6,031 people aged 20–44 in Italy, only 17.2% of respondents reporting AR had used oral antihistamines in the last 12 months, and 1.8% of them had received vaccine injections to treat allergy in the previous year [31]. The proportion of subjects with self-reported AR with a previous diagnosis of or treatment for AR was relatively low in our study, the absence of diagnosis and treatment probably being related to the lack of recog-

nition of AR and of test methods established in the clinics in China.

In conclusion, the self-reported prevalence of AR in 11 cities across Mainland China seems to vary widely, affecting about 1–2 persons out of 10, with the highest prevalence in the age group of adolescents. However, frequently subjects with self-reported AR were not properly diagnosed previously, and no clinical confirmation of AR has been conducted in the current study, consequently the prevalence rates could be an over- or underestimation. Studies including an adequate group of patients with a clinically confirmed AR diagnosis and characterization of the responsible allergens are required. According to the new classification, subjects with self-reported AR were mostly diagnosed as having intermittent AR, and the proportion of persistent AR was higher in northern than in southern cities. Environmental and socioeconomic factors have been proposed as factors potentially affecting AR, and we have demonstrated that the self-reported prevalence of AR was positively correlated with the yearly concentrations of SO₂. This study should motivate future research on the prevalence of AR and AR-associated factors in China.

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