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Prevalence of allergic rhinitis comorbidity with asthma and asthma with allergic rhinitis in China: A meta-analysis

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Abstract

Background: Allergic rhinitis (AR) and asthma are the most common inflammatory diseases of the airways. The relationship between asthma and AR is widely and clinically recognised. The concept "one airway, one disease" has been gradually accepted. However, in China, we could not find any systematic review and meta-analysis on the prevalence of AR with asthma and asthma with AR.

Objective: The aim of this research was to carry out a meta-analysis on the results of all conducted studies to present valid information about the co-occurrence rate of AR with asthma and asthma with AR in China.

Methods: Pubmed/Medline, Science, Springer, Elsevier, Embase, Wanfang data, VIP, CBM, and CNKI were searched systemically and data were extracted from eligible studies by two independent reviewers. Meta-analysis, study quality assessment, and publication bias assessments were all done using Stata 12.1 software.

Results: The results of this meta-analysis showed that pooled prevalence estimates of AR with asthma ranged from 6.69% to 14.35%, asthma with AR from 26.67% to 54%. Furthermore, an overall prevalence of 10.17% (95% CI 9.08–11.27%) was ascertained for AR with asthma, and 38.97% (95% CI 34.42–43.53%) for asthma with AR.

Conclusions: The present meta-analysis comprehensively provided the first quantitative summary of the prevalence of AR with asthma and asthma with AR in China. Our study demonstrated that, in China, asthma and AR are often comorbid diseases and co-exist in the same patients. There is a close correlation between AR and asthma from an epidemiological standpoint.

Key words: allergic rhinitis, asthma, comorbidity, prevalence, China

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Introduction

Allergic rhinitis (AR) and asthma are the most common inflammatory diseases of the airways. The prevalence of AR is 10-40% worldwide.[1] Our previous epidemiological investigations showed that in Western China, the prevalence of self-reported AR was 32.3% (Chongqing), 34.3% (Chengdu), 37.9% (Urumqi), and 30.3% (Nanning).[2] Globally, the prevalence of asthma has more than doubled over the past 20 years.[3] The prevalence of asthma has been reported to vary in different countries: 10% in the United Kingdom, 4.8% in France, 4.8% in Germany, 4.7% in Italy, and 4.8% in Spain.[4,5]

The relationship between asthma and AR is widely and clinically recognised. Grossman first described the concept "one airway, one disease" in 1997, mainly from the pathophysiological roles of leukotriene inflammation in the upper and lower airways.[6] Research showed that many patients with asthma, particularly those with allergic asthma, also have AR. The mucosa of the upper and lower airways is continuous, and the types of inflammation in AR and asthma are very similar, involving T helper type 2 cells, mast cells, and eosinophils. Both diseases have characteristic symptoms and are strongly

influenced by environmental factors. Previous studies demonstrated that among patients with asthma and concomitant AR, those who received treatment for AR had a significantly lower risk of subsequent asthma-related events (emergency care visits /hospitalisations) than those who did not receive treatment.[7] Ohta et al. found that in Japan, AR is a common comorbidity (67.3%) in asthma and that it impairs asthma control.[8]

The data about the prevalence of allergic rhinitis, asthma among the Chinese population may affect the decision of policy makers, insurance organisations, and health authorities. Although, there are a few studies about the prevalence of AR and asthma in China, we could not find any systematic review and meta-analysis on the prevalence of asthma and AR among the Chinese population, especially the prevalence of AR with asthma and asthma with AR. Thus, the aim of this research was to carry out a meta-analysis on the results of all conducted studies to present valid information about the prevalence of AR with asthma. In addition, we aimed to investigate the co -occurrence rate of AR with asthma and asthma with AR in China.

Materials and Methods

Preferred reporting items for systematic reviews and meta -analyses (PRISMA) guidelines were followed while performing this meta-analysis and associated systematic review.[9]

Literature search

Sensitive, systematic searches were separately conducted by two trained researchers to find studies on allergic rhinitis and asthma. Several electronic databases including Pubmed/ Medline, Science, Springer, Elsevier, Embase, Wanfang data, VIP, CBM, and CNKI were searched for relevant articles. The major medical subject headings (MeSH) and keywords used in different logical combinations and phrases included "allergic rhinitis", "asthma", "epidemiology/prevalence/morbidity/incidence/attack rate", and "comorbidity". The search encompassed original research papers published from 2006 to 2016.

Inclusion and exclusion criteria

We included population-based studies that reported the prevalence of allergic rhinitis and asthma among Chinese populations. The inclusion criteria were: (1) studies reporting the prevalence of allergic rhinitis, asthma, allergic rhinitis with asthma, and/or asthma with allergic rhinitis; (2) studies reporting the exact diagnostic criteria; (3) cross-sectional studies; and (4) study reports with data in forms that were able to be utilised in the meta-analysis. The exclusion criteria were: (1) repeated publications; (2) reviews; (3) studies providing insufficient data; and (4) a methodological quality score less than 5.

Data extraction

Initially, two researchers independently reviewed all the titles and abstracts that were selected using the keywords. In the second phase, full texts of the articles, which were selected in the first phase, were reviewed; finally, the researchers selected the articles whose contents were suitable for data extraction. Disagreements between the two reviewers about selecting articles were resolved by a third reviewer via discussion and consensus. Extracted information included name of the first author, year of publication, type of study (local study or survey), total sample size, number of patients, point prevalence, and 95% confidence interval (CI) of point prevalence.

Study quality assessment

The global burden of disease quality assessment checklist was used to assess the quality of the studies. Total study quality score was achieved by summing the sampling method (1–4 score), the sample size (0–3), and the response rate (0–6).[10]

Statistical analysis

The AR with asthma and asthma with AR prevalences were calculated using the random effects model with 95% CI. To evaluate heterogeneity, we estimated the proportion of between-study inconsistency using the I^2 statistic, with values of 25%, 50%, and 75% considered low, moderate, and high, respectively. If the heterogeneity was significant and $I^2 > 50\%$, the random-effect model was adopted; otherwise, the fixed -effect model was used. All statistical tests were performed using Stata software version 12.1 (Stata Corporation, College Station, TX, USA).

Results

Literature search

Following the development of our search strategy, a total of 783 relevant articles were selected from primary research in electronic databases. After deleting duplicate articles and reviews, 325 potential articles were obtained. Then, 278 articles were excluded due to irrelevance to the study subject after evaluation of titles and abstracts, so 47 articles were included into the study for reviewing full-text. Finally, 26 articles were excluded after reviewing full-texts due to inappropriate study design and/or outcome. Thus, 21 studies that met inclusion criteria were included in the meta-analysis and summarised in **Figure 1** and **Table. 1**.

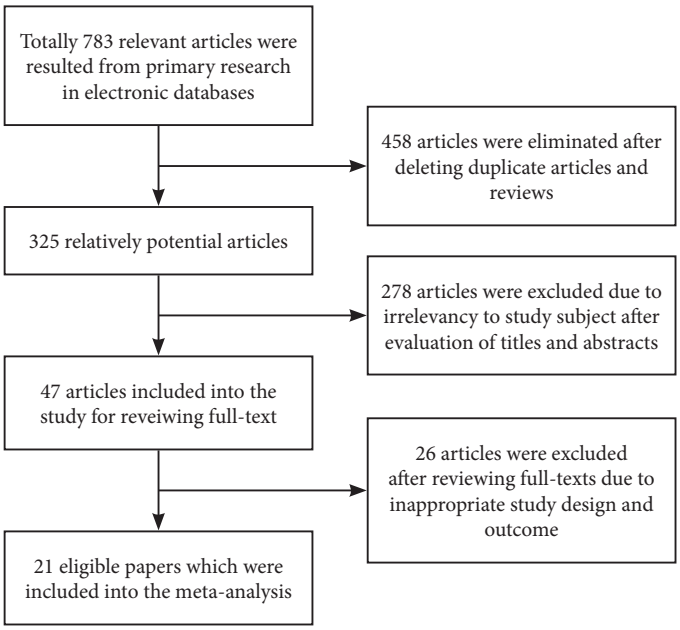

Figure 1. Flowchart for identification of studies selected.

Table 1. Characteristics of the included studies on prevalence of AR with asthma.

AR with asthma								
Year	**Author**	**Study**	**Age (y)**	**Diagnosis**	**AR**	**Asthma**	**Sample**	**Rate**
2015	Gao Rongli	Cross-sectional study	5-70	ARIA	248	20	2052	8.06%
2015	Zhang Liangran	Cross-sectional study	5-80	ISAAC	690	76	2778	11.01%
2015	Yang Li	Cross-sectional study	2-81	ARIA	324	22	8716	6.79%
2015	Chen Xing	Cross-sectional study	18-70	ARIA	425	61	2580	14.35%
2014	Liu Xiaoling	Cross-sectional study	5-66	ARIA	266	19	266	7.14%
2014	Wang Wenya	Cross-sectional study	≥ 14	ARIA	3859	355	3859	9.20%
2012	Fu Jingming	Cross-sectional study	7-75	ARIA	164	20	916	12.20%
2011	Zhu Xiuqing	Cross-sectional study	7-75	ARIA	672	78	2516	11.61%
2010	Yin Rong	Cross-sectional study	2-81	ARIA	2267	238	2267	10.50%
2009	Dou Xiuli	Cross-sectional study	> 15	ISAAC	901	101	6026	11.21%
2008	Yin Haihong	Cross-sectional study	18-24	ISAAC	226	26	1954	11.50%
Asthma with AR								
Year	**Author**	**Study**	**Age (y)**	**Diagnosis**	**Asthma**	**AR**	**Sample**	**Rate**
2015	Li Jipeng	Cross-sectional study	≥ 4	ARIA	174	79	14412	45.40%
2015	Feng Qiuyue	Cross-sectional study	0-99	ARIA	45	12	20000	26.67%
2014	Pan Huiming	Cross-sectional study	16-82	ARIA	212	78	212	36.79
2014	Li Jiaowu	Cross-sectional study	7-92	ARIA	72	21	6909	29.17%
2013	Wang Wenya	Cross-sectional study	> 14	ARIA	687	226	57647	32.90%
2013	Li Seng	Cross-sectional study	12-78	ARIA	300	162	300	54.00%
2011	Qian Juanjuan	Cross-sectional study	≥ 4	ARIA	95	43	4956	45.26%
2010	Ma Li	Cross-sectional study	0-85	ISAAC	731	296	731	40.49%
2009	Zhou Lin	Cross-sectional study	> 15	ARIA	73	23	5216	31.51%
2007	Yu Qihong	Cross-sectional study	14-82	ARIA	793	316	793	37.85%

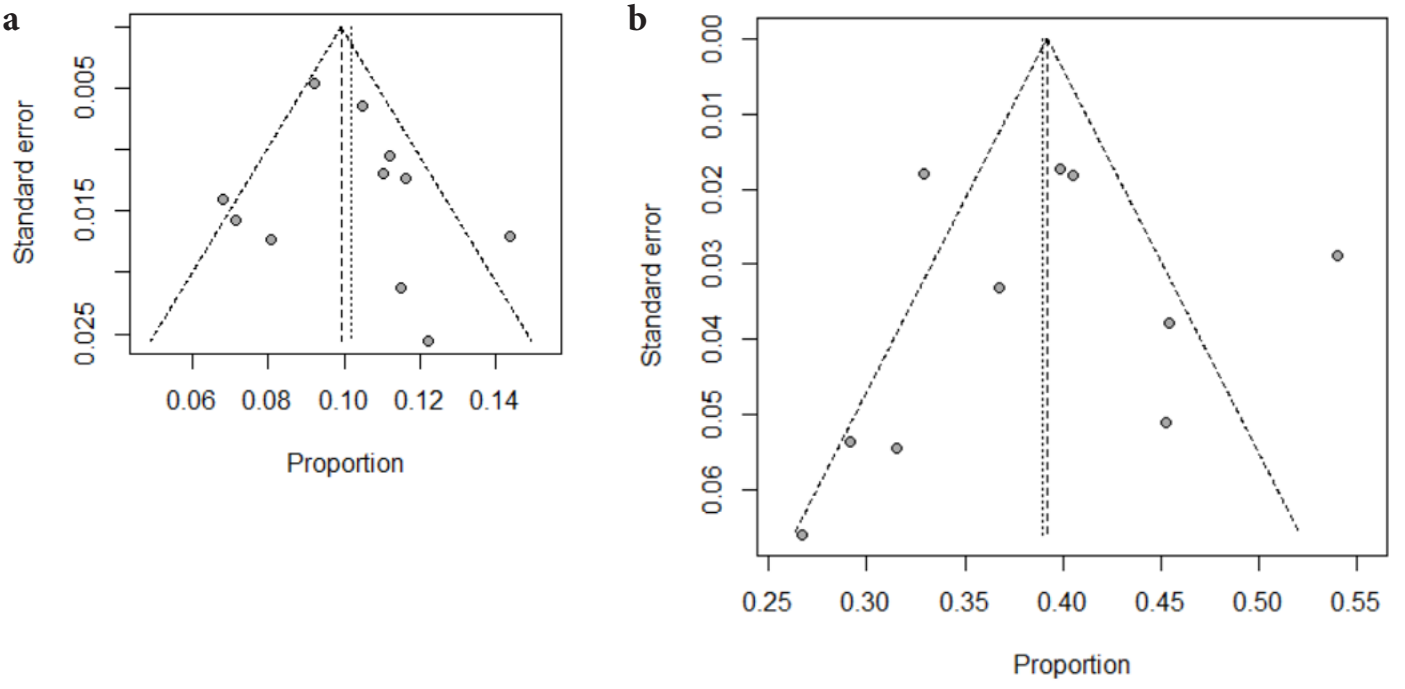

Figure 2. A funnel plot of the overall meta-analysis of metabolic and endocrine comorbidities reflecting publication bias. (a. AR with asthma; b. asthma with AR)

Study characteristics

The selected studies were published from 2006 to 2016 and all the included articles were carried out as cross-sectional surveys, including 133813 participants and 10042 AR patients and 3182 asthma patients in the articles that comprised this meta-analysis. Publication bias assessment was made by visual examination of the funnel plot symmetry. (**Figure 2**)

Estimated prevalence of AR comorbid with asthma

Eleven studies[11-21] about AR with asthma in China were selected in this research. Based on the results of random effect method, the overall prevalence of AR cmorbid with asthma in China was 10.17% (95% CI 9.08–11.27%). In total, 10042 AR patients with an average of 913 AR patients per study were evaluated. The highest prevalence was reported by Chen Xing et al. in 2015 (14.35%) and the lowest by Yang Li et al. in 2015 (6.79%). (**Figure 3**, **Table 1**)

Estimated prevalence of asthma comorbid with AR

Ten studies[22-31] about asthma with AR in China were selected. The overall prevalence of asthma comorbid with AR in China was 38.97% (95% CI 34.42–43.53%). In total, 3182 asthma patients with an average of 32 asthma patients per study were evaluated. The highest prevalence was reported by Li Seng et al. in 2013 (54%) and the lowest by Feng Qiuyue et al. in 2015 (26.67%). (**Figure 4**, **Table 1**)

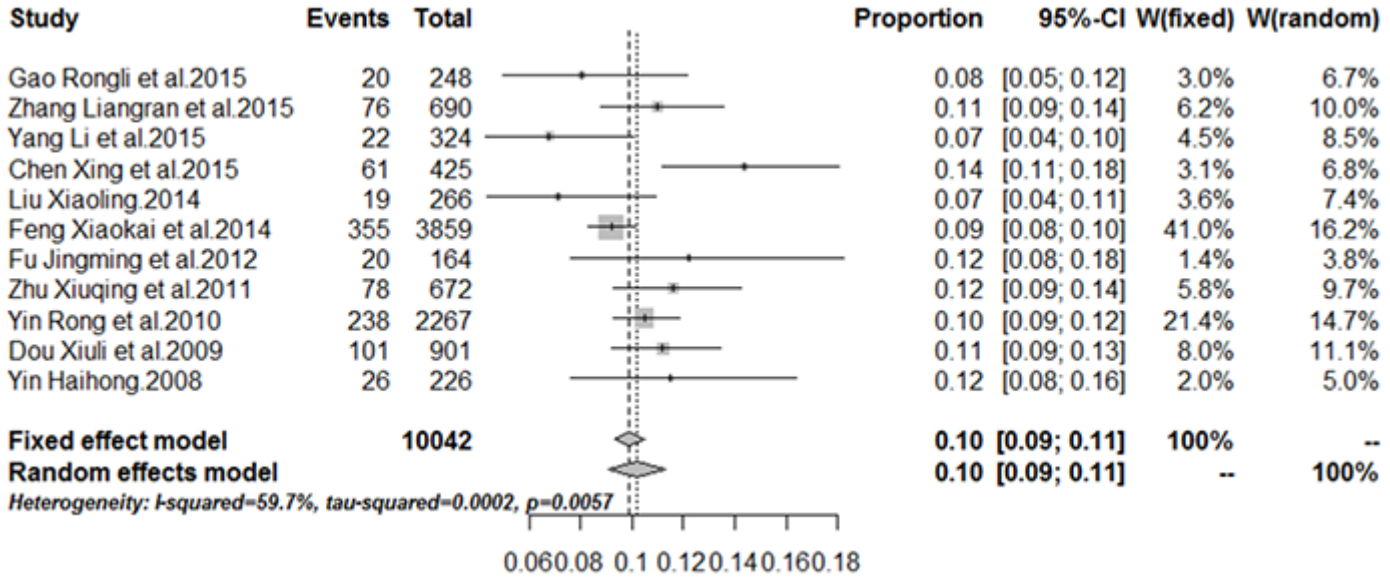

Figure 3. Forest plot of the rate of AR patients with asthma.

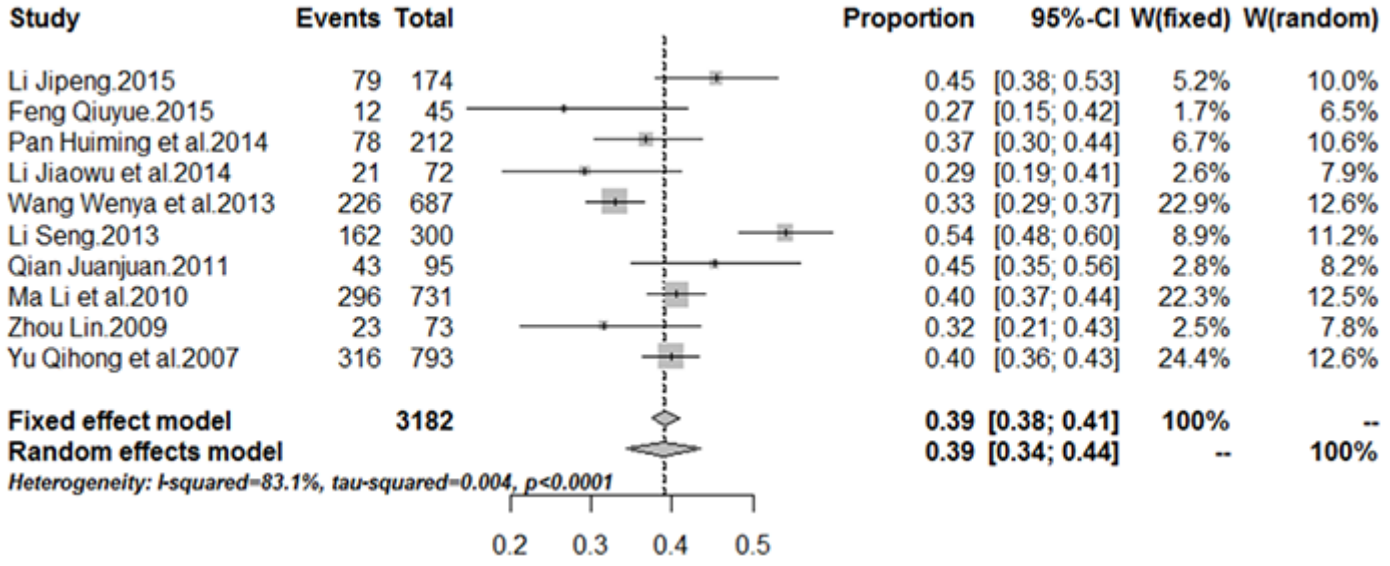

Figure 4. Forest plot of the rate of asthma patients with AR.

Discussion

Allergic rhinitis and asthma are both caused by an inappropriate immunological response to antigens compared to the response elicited in most individuals. Our study presented a comprehensive report about the prevalence of AR with asthma and asthma with AR. The results of this meta-analysis showed that pooled prevalence estimates of AR with asthma ranged from 6.69% to 14.35% and asthma with AR from 26.67% to 54%. Furthermore, an overall prevalence of 10.17% (95% CI 9.08–11.27%) was determined for AR with asthma, and 38.97% (95% CI 34.42–43.53%) for asthma with AR. This study presented a comprehensive report that is the first quantitative summary of the prevalence of AR with asthma and asthma with AR in China. The results of this meta-analysis demonstrated a close correlation between AR and asthma from an epidemiological perspective.

AR and asthma, rather than being considered two distinct diseases, can be unified by the concept of a "united airway," where allergic symptoms of the upper and lower airways can be thought of as manifestations of a common atopic entity.[6,32] Both diseases, which are IgE mediated, can be triggered by similar allergens, including mold, animal dander, and house-dust mites. Epidemiological studies have shown that the majority of patients with asthma have concomitant rhinitis and the presence of rhinitis is an increased risk factor for the development of asthma.[33,34] The prevalence of asthma is < 2% in subjects without rhinitis while it varies from 10% to 40% in patients with rhinitis.[35] Meanwhile, AR occurs in > 75% of patients with asthma, whereas asthma affects up to 40% of patients with AR.[36] In a 10-year longitudinal study of children with AR, asthma was eventually found in 19% of the cases, and in 25% of the sample size asthma and AR developed simultaneously.[37] In a 23-year follow-up study of almost 2000 college students, patients with AR, when compared with controls without AR, were about three times more likely to develop asthma.[38] Pefura-Yone et al. reported that the prevalence of rhinitis was 27.3% among subjects with current wheezing and 25.4% of participants with asthma had rhinitis in Cameroon.[39] Furthermore, in Japan, a nationwide survey of asthmatic patients revealed that 67.3% of asthmatic patients had AR.[8] In addition to the epidemiological evidence, several clinical reports point to a common pathophysiological relationship between AR and asthma.[40] Our meta-analysis demonstrated the prevalence of AR with asthma and asthma with AR in China. The results supported that asthma and AR are often comorbid diseases and co-exist in the same patients. Meanwhile, our data showed the prevalence of asthmatic patients with AR in China to be lower than in Japan. On the one hand, we think the difference may partly be ascribed to regional disparity. On the other hand, environmental factors and different allergens may aos play roles.[41]

Based on the results of previous research and our meta -analysis, we know that there is a close correlation between AR and asthma; AR is highly comorbid with asthma and is a risk factor for asthma. These studies indicate that establishing the overall concept of upper and lower airway is particularly important for AR and asthma treatment. Thus, on the one hand, we should pay attention to the evaluation of the lower airway of AR patients, using pulmonary function tests, bronchial provocation experiment, chest radiograph, and so on. On the other hand, in the process of asthma treatment, we should note to control the symptoms of AR.

Nevertheless, there are some several limitations to the present meta-analysis. First, the number of studies included was comparatively small. Second, the lack of detailed descriptions of AR and asthma features (such as atopic status, age of onset, and disease severity) constrained further subgroup analyses. Third, our study only included the studies from the last 10 years. As we all know, the environment has changed greatly during this time span. Thus, the changes in environmental risk factors for AR may have partially biased the results of this meta-analysis. Meanwhile, in this research, only published studies were reviewed; as a result, unpublished studies and gray literature were not included in our analyses because they were not accessible. Such sets of data could have greatly impacted our results.

In conclusion, the present meta-analysis comprehensively provided the first quantitative summary of the prevalence of AR with asthma and asthma with AR in China. The results of this study showed that the overall prevalence of AR with asthma and asthma with AR was 10.17 % and 38.97 %, respectively. Our study demonstrated that asthma and AR are often comorbid diseases and co-exist in the same patients. There is a close correlation between AR and asthma from an epidemiological perspective. These results can fill the knowledge gaps about the prevalence of respiratory diseases in China, and it can help policy makers, specialists, insurance companies, and all stockholders to make plans and evaluate the medical services required to reduce the prevalence of respiratory diseases.

Disclosure statement

The authors declare no financial or other conflicts of interest regarding the content of this article.

Acknowledgments

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