Preplanned Studies

The Spectrum and Age-Sex Patterns Among Outpatients with Allergic Diseases — Yichang City, Hubei Province, China, 2018–2021

Jinyi Wang[1,&]; Mingwei Sun[2,&]; Guoxing Li[3]; Dapeng Yin[4]; Chi Hu[5]; Jinfang Sun[2,#]

Summary

What is already known about this topic?

Allergic diseases have affected an estimated 40% of the population in China. However, our understanding of the full spectrum of these diseases remains insufficient.

What is added by this report?

Between 2018 and 2021, Yichang City documented 625,929 outpatient visits mainly related to skin and mucous membrane allergies (77.90%) and allergic respiratory conditions (19.64%). In 2021, the occurrence of outpatient visits for conditions such as allergic rhinitis, acute atopic conjunctivitis, and atopic dermatitis increased. The demographic analysis revealed that male patients comprised the majority of the under 18 age bracket (56.05%), while female patients were predominantly represented in the 18 to 65 age bracket (61.79%).

What are the implications for public health practice?

This constitutes the first analysis of the spectrum of allergic diseases, utilizing regional outpatient data, which has substantial implications for understanding the disease burden.

Approximately 40% of the Chinese population is affected by allergic diseases, which pose potential threats to the respiratory system, skin, and digestive tract and may even be life-threatening (*1*). These common diseases include allergic rhinitis (AR), asthma, urticaria, atopic dermatitis (AD), and allergic contact dermatitis (ACD). Currently, most research within the country on allergic diseases concentrates specifically on major diseases and distinct age groups, leading to the unclear picture of the disease spectrum. Particularly, the majority of prior studies have employed cross-sectional designs and are lacking in longitudinal data on dynamic changes in these diseases (*2*–*3*). However, the era of big data in healthcare presents new possibilities. The utilization of regional healthcare big data can facilitate easier access to and analysis of medical data. This study applied the Yichang Healthcare Big Data Platform to elucidate the spectrum and distribution characteristics of allergy-related outpatients during the years 2018–2021 in Yichang City, Hubei Province. The findings demonstrated that the augmentation of allergic respiratory disease (ARD) visits in 2021 was primarily due to an uptick in AR, along with acute atopic conjunctivitis (AAC) and AD. For patients under 18, allergy outpatient visits were predominantly male, whereas those aged 18–65 were primarily female. Due attention should be directed toward AR, AAC, and AD, and future disease control and preventive measures should be optimized according to the age-sex specific pattern of allergic diseases.

This research study utilized allergy-related outpatient data derived from the Yichang Healthcare Big Data Platform, which accumulates data from all health institutions within its urban locales. Yichang City has accomplished active automated scrutiny, risk analysis, and consistent tracking of diverse diseases and health risk factors using this medical data. In relation to innovation and application in scientific research, approximately 20 research projects have been undertaken utilizing this medical data, encompassing epidemic features, environmental risk factors, medical expenditure, and genetic characteristics of diseases, among others. The information assembled includes demographic attributes, disease names, International Statistical Classification of Diseases' 10th revision (ICD-10) codes, and diagnosis timelines. This study incorporated all healthcare institutions in Yichang's urban regions (comprising 9 tertiary hospitals, 2 secondary hospitals, and 18 community health service institutions). The frequency data (excluding personal information) of primary diagnoses of allergic diseases in outpatient services were extracted employing the ICD-10. Supplementary Table S1 (available in https://weekly.chinacdc.cn) contains the specific ICD-10 codes for each disease studied. Quantitative

normal distribution data was defined by the mean and standard deviations, while non-normal distributions were reported through the median and interquartile range (IQR). Frequencies and percentages were highlighted for categorical variables, and the Mann-Kendall test was utilized for trend analysis. Differences in gender and age distributions were assessed using the chi-squared (χ^2) test. Data analysis was conducted using the R software (version 4.1.0, R Foundation for Statistical Computing, Vienna, Austria).

Between 2018 and 2021, the Yichang City recorded a total of 625,929 outpatient visits attributable to allergic diseases. The male-to-female patient ratio was 0.84∶1, and the average frequency of visits for each individual was 2.01. The median age was 31 years for males (IQR: 7–55) and 34 years for females (IQR: 18–51), with an overall median of 33 years (IQR: 10–52).

The highest proportion of outpatient visits was attributed to allergic diseases of the skin and mucous membranes (77.90%). This was followed by ARD at 19.64%, severe anaphylaxis at 1.32%, ocular allergies (OA) at 0.86%, allergic diseases of the digestive tract at 0.02%, and other allergies at 0.25%.

A slight decrease in visits concerning skin-related and mucous membrane-related allergic diseases was noted over the four-year period, dropping from 78.81% to 76.28% (Mann-Kendall test, Z=−1.019, P=0.308). Conversely, visits involving ARD increased from 18.56% to 21.13% (Z=1.698, P=0.089) (Figure 1).

The predominant characterizations of allergic diseases affecting the skin and mucous membranes were other types of dermatitis (65.59%) and urticaria (13.81%). Similarly, ARDs primarily comprised of AR (59.30%) and asthma (40.42%). Among severe anaphylaxis cases, allergic purpura was significantly prevalent, accounting for 91.27%. In 2021, there was a substantial rise in outpatient visits for AD, AR, and AAC compared to preceding years (Table 1).

Age and gender distribution significantly affected the proportion of allergic diseases (χ^2=19,636.111, P<0.001). Amongst outpatients diagnosed with allergies, those under the age of 18 constituted 30.57% with males (56.05%) making up the majority. A significantly larger proportion (57.73%) fell within the age bracket of 18–65 years, with a predominance of females (61.79%), while 11.70% were individuals over 65 years of age, primarily males (56.10%). Allergic diseases that impacted the skin and mucous membranes were predominantly found among adults between 18 and 65 years (60.18%), with females forming the majority (62.19%). ARDs were most prevalent among adults of the same age group (50.02%) with a higher proportion of afflicted individuals being women (59.45%), while 41.76% were children under 18 years old, primarily male (64.70%). An overwhelming majority of severe anaphylaxis cases (61.74%), OA cases (51.44%), and allergic diseases affecting the digestive tract (60.54%) were found in children below 18 years old (Figure 2A).

The twelve leading disease subcategories were identified, ranked by the frequency of outpatient visits. We observed greater proportions of male patients under 18 years old for each category of allergic disease, while for the 18–65 age group, the proportions were

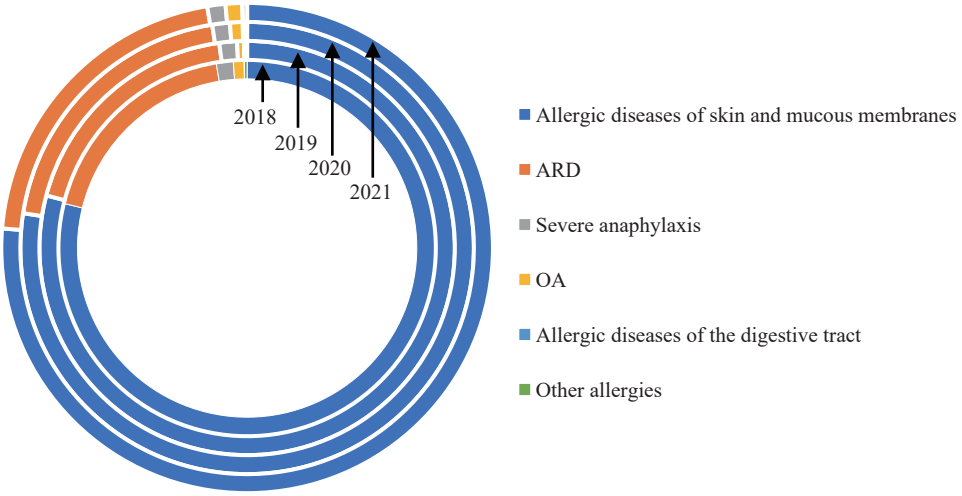

FIGURE 1. Composition of outpatient visits for various allergic diseases in Yichang City, Hubei Province, 2018–2021.
Abbreviation: ARD=allergic respiratory diseases; OA=ocular allergy.

TABLE 1. Number of outpatient visits for allergic disease in Yichang City, Hubei Province, 2018–2021.

Categories	2018	2019	2020	2021	Total
Allergic diseases of the skin and mucous membranes (*n*=487,615)					
Other dermatitis	76,322	89,964	65,284	88,275	319,845
Urticaria	16,748	19,425	13,461	17,688	67,322
Lichen simplex chronicus and prurigo	9,571	10,188	6,429	9,219	35,407
Allergic contact dermatitis	6,988	9,437	6,214	9,858	32,497
Unspecified contact dermatitis	2,514	2,734	1,790	2,504	9,542
AD	1,741	1,968	1,437	3,393	8,539
ARD (*n*=122,951)					
AR	15,635	17,659	15,492	24,127	72,913
Asthma	11,912	14,926	9,721	13,138	49,700
Upper respiratory tract hypersensitivity reaction, site unspecified	53	44	19	16	132
Allergic bronchopulmonary aspergillosis	21	24	32	53	130
Hypersensitivity pneumonitis due to organic dust	21	29	8	11	69
Allergic bronchopulmonary disorders	2	2	0	3	7
Severe anaphylaxis (*n*=8,252)					
Allergic purpura	1,997	2,178	1,412	1,945	7,532
Drug hypersensitivity reactions	122	162	82	85	451
Anaphylactic shock, unspecified	30	43	54	23	150
Food-related allergic reactions	15	9	26	42	92
Anaphylactic shock due to adverse effect of correct drug or medicament properly administered	2	5	5	7	19
Anaphylactic shock due to adverse food reaction	1	3	2	1	7
OA (*n*=5,371)					
AAC	1,376	921	1,133	1,941	5,371
Allergic diseases of the digestive tract (*n*=147)					
Allergic gastroenteritis and colitis	32	36	39	40	147
Other allergies (*n*=1,593)	344	391	354	504	1593
Total	148,962	174,252	125,951	176,764	625,929

Abbreviation: AD=atopic dermatitis; ARD=allergic respiratory diseases; AR=allergic rhinitis; OA=ocular allergy; AAC=acute atopic conjunctivitis.

higher for females. AR (50.92%), AD (55.09%), allergic purpura (65.60%), and AAC (51.44%) were prevalently noted in patients under 18 years of age. Interestingly, 65% of the children diagnosed with AR and AAC were male.

In contrast to other conditions, dermatitis (59.90%), urticaria (59.90%), asthma (56.86%), lichen simplex chronicus and prurigo (56.60%), allergic contact dermatitis (69.91%), unspecified contact dermatitis (59.89%), irritant contact dermatitis (76.18%) and dermatitis due to substances taken internally (72.77%) were primarily seen in adults aged 18–65 years. Furthermore, more than 66% of adults diagnosed with urticaria and allergic contact dermatitis were female (Figure 2B).

DISCUSSION

The total population of Yichang City as of 2021 stood at 3.91 million, with 1.60 million accounting for its urban populace. This investigation unveiled that the highest number of allergy-involved outpatient appointments in the Yichang City from 2018 to 2021 were due to skin and mucous membrane allergies (77.90%), with ARD forming the next largest category (19.64%). Main subsets of allergic diseases included other forms of dermatitis, AR, asthma, and urticaria. Further differences in age and gender regarding outpatient visits for specific allergic diseases were highlighted. A distinct retrospective cross-sectional investigation conducted on children's outpatient cases

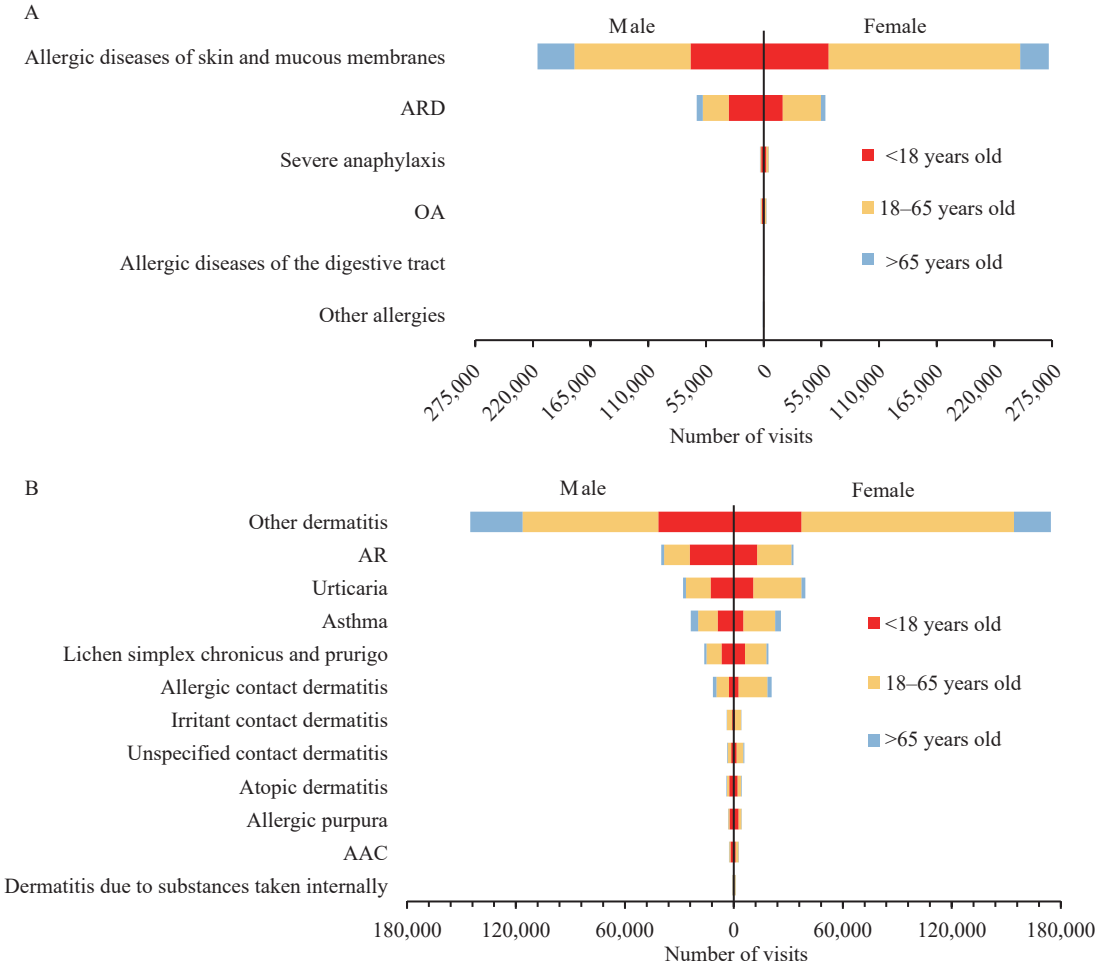

FIGURE 2. Age-sex patterns of outpatient visits for various allergic diseases in Yichang City, Hubei Province, 2018–2021. (A) Age-sex patterns for different disease categories; (B) Age-sex patterns for primary disease subcategories. Abbreviation: AR=allergic rhinitis; AAC=acute atopic conjunctivitis; ARD=allergic respiratory diseases; OA=ocular allergy

with allergic diseases in a tertiary hospital in Botswana revealed asthma to be the most common disease, representing 61.2%, followed by AR, AD, AC, and food allergies (*2*). These findings differ from those of the Yichang study, which could be attributed to varying genetic and environmental prompts of allergic diseases across different populations, or potential disparities in age structure and sample size. Epidemiological research focusing on the spectrum of allergic diseases remains scarce globally (*2*–*3*). The acquisition of such insights is crucial for understanding which allergic diseases pose a significant risk to population health and for establishing healthcare service priorities.

The observed increase in outpatient visits for ARD from 2018 to 2021 can primarily be attributed to the surge in visits for AR in 2021, along with AAC and AD. This can be reasoned by the direct exposure of nasal mucosa, conjunctiva, and skin to the exterior environment — such exposure potentially makes these regions more prone to irritation and sensitization from ambient allergens, resulting in a heightened number of outpatient visits for AR, AAC, and AD. AD, a chronic, relapsing inflammatory skin condition akin to eczema, is frequently diagnosed. Current research indicates that direct skin contact with airborne allergens can prompt skin reactions in those with AD (*4*).

Owing to its subtropical location, the city of Yichang retains high humidity throughout the year, which engenders a favorable condition for dust mite proliferation. Dust mites, the main airborne allergens, rise concurrently with the increase in humidity levels (*5*). Prior research illuminates the frequent co-occurrence of AR and AC, owing to exposure to perennial airborne allergens such as dust mites, molds, and animal dander, or seasonal allergens like pollen. Over half of AR patients also experience symptoms of AC or conjunctivitis. This is presumably due to the

shared properties of the conjunctiva and nasal mucosa — they have the same type of epithelial cells, they show similar allergen reactivity, and both play a role in Immunoglobulin E (IgE)-mediated allergic inflammation, indicating shared pathological mechanisms. Plus, the presence of an anatomical link between the eyes and nasal mucosa through the nasolacrimal duct enables allergic reactions to spread from the conjunctiva to the nose (*6*).

In addition, the number of outpatient visits for asthma in Yichang City did not reveal a significant surge. The intricate interrelationship among asthma, allergies, and bronchial hyperreactivity is rapidly becoming clear, with multiple factors apart from allergens contributing to the development of asthma. The mechanisms implicated in asthma potentially exhibit more complexity when compared with AR, AC, and AD. Research conducted in Hong Kong Special Administrative Region (SAR), China, unveiled a substantial escalation in the prevalence of allergic rhinoconjunctivitis and atopic eczema among school-aged children between 1995 and 2001, positively correlating with frequent upper respiratory tract infections. However, the prevalence of asthma largely remained consistent (*7*). Future research is warranted to explore the correlation between the rise in the number of allergy-related visits and potential contributing factors like environmental allergens and upper respiratory tract infections.

Furthermore, in the population of allergic outpatients under 18 years, males superseded the females. Conversely, among those aged 18–65 years, females were more prominent. Studies have demonstrated that testosterone can suppress immune memory responses, inhibiting reactivity to the same antigen. Both epidemiological and experimental studies suggest that female hormones, often amplify the immune memory response, potentially intensifying allergic diseases. Estrogen, specifically, has been shown to bolster humoral immunity, antibody synthesis, and the activation and sensitization of mast cells. Such findings might underscore the predisposition of male children and female adults to allergies. Existing research indicates a shift in the prevalence of AR in Asia — from being predominantly male during childhood to becoming predominantly female in adulthood. A similar trend has been documented concerning asthma. Males exhibit higher total serum IgE levels and rates of allergic sensitization than females during the first year of life. These rates persistently rise in males through adolescence but decrease in adulthood, whereas rates in females remain steady (*8*). Besides hormonal influences, differential lifestyle factors, microbial diversity, dietary habits, and occupational preferences between males and females could drive this disparity and warrant further research (*8*).

Our study primarily found AD and allergic purpura in outpatient children under the age of 18. This observation mirrors findings from previous studies where AD predominantly surfaces in early life, affecting approximately 20%–30% of children compared to only 3% of adults. Longitudinal studies suggest that allergic conditions tend to manifest in a specific sequence, typically transitioning from AD in infancy to allergic asthma and AR later in life (*9*). Allergic purpura, a systemic vasculitis largely mediated by immunoglobulin IgA, is found in almost 90% of child cases. Moreover, the prevalence amongst children is 2–33 times higher than in adults (*10*).

The present study was subjected to certain limitations. First, there was a noticeable decline in the number of outpatient visits for allergic diseases during the coronavirus disease 2019 pandemic in 2020. This decrease may be attributed to fears of contracting the virus or stricter control measures implemented during this period. As a result, the total number of outpatient visits could potentially be an underestimation. Regardless, this research employed relative composition ratios for comparative reasons. Second, this study utilized the widely recognized ICD-10 codes. However, it is noteworthy that the ICD-10 falls short in providing an intricate classification system for diseases related to food allergies, possibly leading to some conditions being misclassified. Lastly, to maintain the integrity of the dataset, this study only incorporated data from urban-based medical institutions in Yichang City, primarily comprising urban residents.

In conclusion, considering the substantial rise in outpatient visits for AR, AAC, and AD during 2021, it is imperative that future efforts concentrate on the prevention and treatment of these three significant allergic diseases, along with investigating their root causes in Yichang. Further, attention ought to be directed towards examining the gender propensity of allergic diseases across diverse age groups.

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[#] Corresponding author: Jinfang Sun, sunjf@chinacdc.cn.

[1] Jiangsu Taizhou People's Hospital, Taizhou City, Jiangsu Province, China; [2] Office of Epidemiology, Chinese Center for Disease Control and Prevention, Beijing, China; [3] Department of Occupational and Environmental Health Sciences, Peking University School of Public Health, Beijing, China; [4] Hainan Center for Disease Control and Prevention, Haikou City, Hainan Province, China; [5] Yichang Center for Disease Control and Prevention, Yichang City, Hubei Province, China.
[&] Joint first authors.

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SUPPLEMENTARY MATERIALS

SUPPLEMENTARY TABLE S1. Detailed listing of ICD-10 codes for allergic diseases.

Categories	Subcategories of diseases and corresponding ICD-10 codes
Allergic diseases of skin and mucous membranes	Other dermatitis (L30), urticaria (L50), lichen simplex chronicus and prurigo (L28), allergic contact dermatitis (L23), unspecified contact dermatitis (L25), atopic dermatitis (L20), irritant contact dermatitis (L24), dermatitis due to substances taken internally (L27), unspecified erythema multiforme (L51.9), angioneurotic oedema (T78.3), diaper dermatitis (L22), toxic epidermal necrolysis [Lyell] (L51.2), eczematous external otitis (H60.501), allergic rash (R21.X01), radiodermatitis (L58), eyelid dermatitis (H01.101), exfoliative dermatitis (L26), photocontact dermatitis [berloque dermatitis] (L56.2), solar urticaria (L56.3), erosive erythema multiforme (L51.800), lichenoid drug reaction (L43.2), acute skin change due to ultraviolet radiation (L56.9), nonbullous erythema multiforme (L51.0), serum-reactive urticaria (T80.603), allergic dermatitis of the eyelid (H01.154), and drug photoallergic response (L56.1)
Allergic respiratory diseases	Allergic rhinitis (J30.1, J30.2, J30.3, J30.4), asthma (J45, J46), upper respiratory tract hypersensitivity reactions at unspecified sites (J39.3), allergic bronchopulmonary aspergillosis (B44.101), hypersensitivity pneumonitis due to organic dust exposure (J67), and other allergic bronchopulmonary disorders (J98.413)
Severe anaphylaxis	Allergic purpura (D69.0), drug hypersensitivity reactions (T88.701), unspecified anaphylactic shock (T78.2), food-related allergic reactions (T78.101), anaphylactic shock due to the adverse effect of a correctly administered drug or medicament (T88.6), anaphylactic shock resulting from adverse food reactions (T78.0), and anaphylactic shock due to serum (T80.5)
Ocular allergy	Acute atopic conjunctivitis (H10.1)
Allergic diseases of the digestive tract	Allergic gastroenteritis and colitis (K52.200, K52.201, K52.202, K52.203, K52.204)
Other allergies	Unspecified allergy (T78.4), allergic otitis media (H65.101, H65.102)