

# Prevalence of allergen sensitization among 1,091 patients with urticaria

JIE-DAN PING<sup>1\*</sup>, JUN-WEI ZHAO<sup>1\*</sup>, XIAO-XU SUN<sup>1</sup>, FAN WU<sup>1</sup>, ZHI-YUN JIANG<sup>1</sup>, ZHE CHENG<sup>2</sup>, LEI ZHENG<sup>1</sup>, HAI-KUO XUE<sup>1</sup>, JING-JING YANG<sup>1</sup> and LIANG MING<sup>1</sup>

<sup>1</sup>Clinical Laboratory, Key Clinical Laboratory of Henan Province, The First Affiliated Hospital of Zhengzhou University;

<sup>2</sup>Department of Respiratory and Critical Care Medicine, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan 450052, P.R. China

Received April 29, 2019; Accepted December 05, 2019

DOI: 10.3892/etm.2019.8367

**Abstract.** The etiology of urticaria is heterogeneous and allergic responses may be involved in it. The aim of the present study was to investigate the prevalence and distribution of sensitivity to inhaled and food allergens among patients with urticaria in Henan province (China). The levels of specific immunoglobulin E (sIgE) were detected using the AllergyScreen test and a total of 524/1,091 cases (48.0%) tested positive for sIgE to at least one of the 19 allergens. The most common inhaled allergens the urticaria patients were sensitive to were *D. pteronyssinus* (34.5%), cockroach (12.5%) and tree pollen mix (11.1%), while the food allergens with the highest rate of allergic reactions were cashew nut (8.1%), shrimp (6.8%) and crab (6.4%). The positive rates for *D. pteronyssinus*, dog hair, cockroach, mold mix, tree pollen mix and shrimp in the chronic urticaria group were higher than those in the acute urticaria group ( $P < 0.05$ ). Furthermore, positive rates for the majority of allergens were higher in males than in females and were significantly different between age groups ( $P < 0.05$ ). The results of the present study provided information on the characteristics of allergen sensitization of patients with urticaria and may facilitate the prevention, diagnosis and management of urticaria in Henan province.

## Introduction

Urticaria is a common skin disease characterized by wheals, itch and/or angioedema. The life-time prevalence for any subtype of urticaria is ~20% (1). Based on frequency and duration, it is classified into acute urticaria (AU) and chronic urticaria (lasting >6 weeks; CU). Recurrence of disease causes a serious decline in quality of life.

Urticaria is a heterogeneous disease in which allergy may be involved. Consequently, the determination of major allergens triggering these pathological processes is crucial for the prevention, diagnosis and management of patients with urticaria (2). Specific immunoglobulin E (sIgE) is a collective term for antibodies produced by the immune system with specificity for an individual allergen (3). Apart from the skin prick test, the serum-sIgE test may be an attractive alternative method to identify specific allergens, which is rapid and easy to perform in clinical practice (4). In the present study, the prevalence and distribution characteristics of sensitization to various allergens among patients with urticaria were investigated.

## Patients and methods

**Patients.** Chinese Han patients (n=1,091) with urticaria who were treated at the First Affiliated Hospital of Zhengzhou University (Zhengzhou, China) between October 2013 and February 2018 were enrolled in the present study. All patients resided in Henan Province (China). The cohort included 474 males (43.4%) and 617 females (56.6%) and the mean age was 29.59±15.93 years (range, 0-95 years). Patients with symptoms lasting ≤6 weeks were diagnosed with AU and if the duration was >6 weeks, patients were assigned to the CU group. All of these patients were clinically evaluated by their attending physicians and only patients with single disease (urticaria) were included. Patients were excluded if they were diagnosed with any other allergic diseases or malignancy, or were pregnant or lactating. Furthermore, patients who ever took immunosuppressants or other drugs within two weeks previously were also excluded. Each patient with urticaria was carefully checked according to the above criteria by JP and JY, who are laboratory physicians at our department. The present

---

*Correspondence to:* Professor Liang Ming, Clinical Laboratory, Key Clinical Laboratory of Henan Province, The First Affiliated Hospital of Zhengzhou University, 1E Jianshe Road, Zhengzhou, Henan 450052, P.R. China  
E-mail: mingliang3072@163.com

\*Contributed equally

**Abbreviations:** AU, acute urticaria; CU, chronic urticaria; sIgE, specific immunoglobulin E

**Key words:** allergen, immunoglobulin E, prevalence, urticaria, sensitization

study was a retrospective study. Written informed consent was obtained from the patients or their legal guardians and the present study was approved by the Medical Ethics Committee of the First Affiliated Hospital of Zhengzhou University (Zhengzhou, China).

**AllergyScreen test.** Serum allergen-sIgE of patients was detected by using an AllergyScreen test (cat. no. A182; Mediwiss Analytic GmbH). An immunoblot assay was used to semi-quantitatively detect circulating sIgE according to the manufacturer's protocol.

The results were semi-quantified and categorized into seven levels according to the manufacturer's protocol and a previous study by our group (5): Class 0 (<0.35 IU/ml, undetectable), class 1 (0.35-0.70 IU/ml, low), class 2 (0.70-3.50 IU/ml, intermediate), class 3 (3.5-17.5 IU/ml, high), class 4 (17.5-50 IU/ml, very high), class 5 (50-100 IU/ml, quite high) and class 6 (>100 IU/ml, extremely high). The cut-off value was set as 0.35 IU/ml and sIgE  $\geq$ 0.35 IU/ml was considered positive.

A total of 10 inhaled allergens and 9 food allergens were tested in all of the 1,091 patients. Inhaled allergens included *D. pteronyssinus*, house dust, mulberry, dog hair, cat dander, cockroach, amaranth, mold mix, grass mix and tree pollen mix. Food allergens included egg, cow's milk, shrimp, beef, cowry, crab, mango, cashew nut and pineapple.

**Statistical analysis.** Data were classified and analyzed by using SPSS version 19.0 (IBM Corp.). Demographic features (age, sex) and urticaria status were considered as categorical variables. Differences among variables were evaluated by the  $\chi^2$  test or Fisher's exact probability method. Odds ratios were determined to analyze the difference in positive rates between different disease types and genders.  $P < 0.05$  was considered to indicate statistical significance.

## Results

**Overall sensitization to inhaled and food allergens.** Of all of the 1,091 patients, 524 (48.0%) tested positive for sIgE to at least one of 19 allergens. *D. pteronyssinus* (n=376, 34.5%), cockroach (n=136, 12.5%) and tree pollen mix (n=122, 11.1%) were the top three inhaled allergens, while cashew nut (n=88, 8.1%), shrimp (n=74, 6.8%) and crab (n=70, 6.4%) were the food allergens for which the patients most frequently tested positive (Table I). Furthermore, the patients' sIgE-positive rate for a single allergen was 22.1%, while it was 25.9% regarding positivity for multiple allergens (Table SI).

**Comparison of allergen sensitization in different urticaria groups.** The total cohort of 1,091 cases comprised 818 patients with CU (75.0%; mean age, 32.41 $\pm$ 15.98 years; age range, 3-95 years) and 273 with AU (25.0%; mean age, 24.10 $\pm$ 15.16; age range, 0-83 years). Among the inhaled allergens, positivity for sIgE to *D. pteronyssinus*, dog hair, cockroach, mold mix and tree pollen mix was more common in patients with CU than in those with AU (37.4 vs. 25.7%,  $P < 0.001$ ; 3.6 vs. 0.0%,  $P < 0.001$ ; 15.3 vs. 4.1%,  $P < 0.001$ ; 7.7 vs. 2.7%,  $P = 0.002$ ; 12.6 vs. 6.8%,  $P = 0.005$ , respectively). Similarly, regarding the food allergens, positivity for sIgE to shrimp was more frequent

Table I. Overall allergen sensitization to inhaled and food allergens.

| A, Inhaled allergens    |              |                   |
|-------------------------|--------------|-------------------|
| Allergens               | Patients (N) | Positive rate (%) |
| <i>D. pteronyssinus</i> | 376          | 34.5              |
| House dust              | 74           | 6.8               |
| Mulberry                | 92           | 8.4               |
| Cat dander              | 15           | 1.4               |
| Dog hair                | 29           | 2.7               |
| Cockroach               | 136          | 12.5              |
| Amaranth                | 85           | 7.8               |
| Mold mix                | 70           | 6.4               |
| Grass mix               | 103          | 9.5               |
| Tree pollen mix         | 122          | 11.1              |
| B, Food allergens       |              |                   |
| Allergens               | Patients (N) | Positive rate (%) |
| Egg                     | 4            | 0.3               |
| Cow's milk              | 22           | 2.0               |
| Shrimp                  | 74           | 6.8               |
| Beef                    | 11           | 1.0               |
| Cowry                   | 0            | 0                 |
| Crab                    | 70           | 6.4               |
| Mango                   | 59           | 5.4               |
| Cashew nut              | 88           | 8.1               |
| Pineapple               | 26           | 2.4               |

among patients with CU than in those with AU (7.7 vs. 4.1%,  $P = 0.037$ ; Table II).

**Comparison of allergen sensitization among different gender groups.** Significant differences in allergen sensitization were observed between the male and female groups of the present cohort ( $\chi^2 = 9.597$ ,  $P < 0.01$ ). The overall sIgE-positive rate was higher in males than in females (53.4 vs. 43.9%,  $P < 0.01$ ; Table SII). The prevalence of sensitization to 10 allergens (*D. pteronyssinus*, mulberry, dog hair, cockroach, amaranth, tree pollen mix, cow's milk, cowry, crab and cashew nut) exhibited significant gender-specific differences and the positive rates were higher in males than in females (Fig. 1).

**Comparison of allergen sensitization in different age groups.** In the present study, individuals were divided into seven age groups: 0-3 years, 4-12 years, 13-18 years, 19-25 years, 26-40 years, 41-60 years and >60 years. There were no obvious age-specific differences in the sIgE-positive rates for the allergens of house dust, mulberry, tree mix, shrimp, beef, cowry and pineapple, but the positive rates for the other 12 allergens were significantly different (Table SIII). The positive rates of sIgE for *D. pteronyssinus*, cockroach and grass mix peaked in the 19-25 year-old group (41.0, 18.5 and 12.7%,

Table II. Comparison of allergen sensitization in different urticaria groups.

| Allergen                | CU (N=818) | AU (N=273) | P-value | OR (95%CI)          |
|-------------------------|------------|------------|---------|---------------------|
| <i>D. pteronyssinus</i> | 306 (37.4) | 70 (25.7)  | <0.001  | 1.733 (1.276-2.355) |
| House dust              | 55 (6.8)   | 18 (6.8)   | 1.000   | 1.021 (0.589-1.771) |
| Mulberry                | 74 (9.0)   | 18 (6.8)   | 0.257   | 1.409 (0.826-2.404) |
| Cat dander              | 7 (0.9)    | 7 (2.7)    | 0.055   | 0.328 (0.114-0.944) |
| Dog hair                | 29 (3.6)   | 0 (0)      | <0.001  | -                   |
| Cockroach               | 125 (15.3) | 11 (4.1)   | <0.001  | 4.296 (2.282-8.087) |
| Amaranth                | 70 (8.6)   | 15 (5.4)   | 0.118   | 1.610 (0.905-2.861) |
| Mold mix                | 63 (7.7)   | 7 (2.7)    | 0.002   | 3.171 (1.434-7.010) |
| Grass mix               | 74 (9.0)   | 30 (10.8)  | 0.343   | 0.806 (0.515-1.261) |
| Tree pollen mix         | 103 (12.6) | 18 (6.8)   | 0.005   | 2.041 (1.212-3.435) |
| Egg                     | 4 (0.5)    | 0 (0)      | 0.577   | -                   |
| Cow's milk              | 15 (1.8)   | 7 (2.7)    | 0.459   | 0.710 (0.286-1.760) |
| Shrimp                  | 63 (7.7)   | 11 (4.1)   | 0.037   | 1.987 (1.032-3.829) |
| Beef                    | 7 (0.9)    | 4 (1.4)    | 0.482   | 0.580 (0.169-1.998) |
| Cowry                   | 0 (0)      | 0 (0.0)    | -       | -                   |
| Crab                    | 59 (7.2)   | 11 (4.1)   | 0.065   | 1.851 (0.958-3.578) |
| Mango                   | 48 (5.9)   | 11 (4.1)   | 0.282   | 1.485 (0.760-2.902) |
| Cashew nut              | 66 (8.1)   | 22 (8.1)   | 1.000   | 1.001 (0.605-1.656) |
| Pineapple               | 22 (2.7)   | 4 (1.4)    | 0.359   | 1.859 (0.635-5.442) |

Values are expressed as n (%). AU, acute urticaria; CU, chronic urticaria; OR, odds ratio.

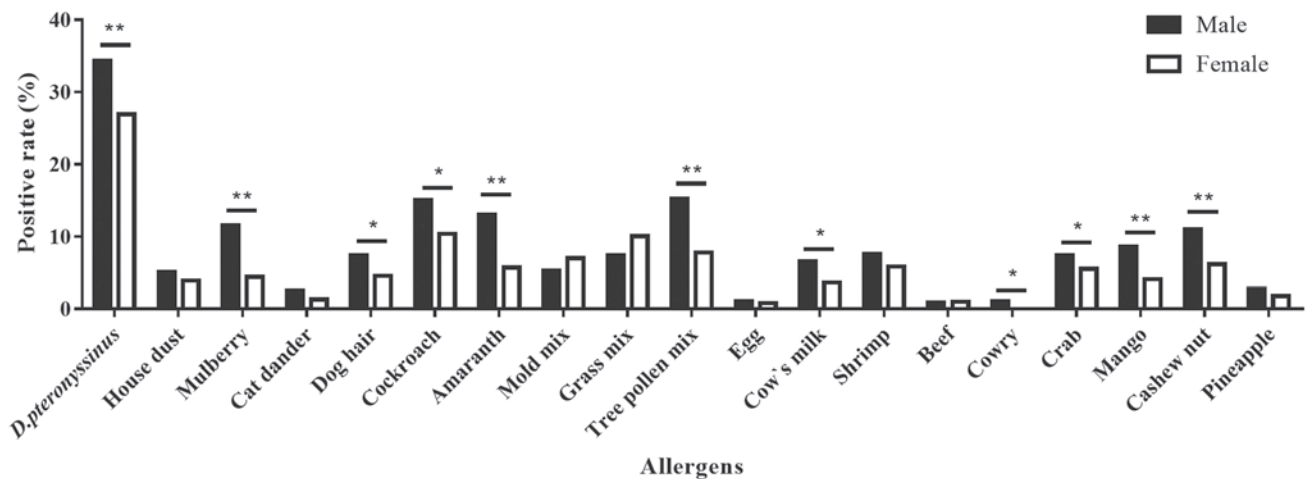


Figure 1. Allergen sensitization in different gender groups. \*P<0.05; \*\*P<0.01.

respectively), as well as the rate for mulberry peaked in the 26-40 year-old group. The positive rate of sIgE for amaranth increased with age and plateaued from 19-25 to 41-60 year-old group. sIgE-positive rates remained at a relatively high level with further increases in age. The sIgE-positive rates for cat dander and dog hair exhibited a steady decline with age and were higher in the 0-3 year-old group than in all of the other age groups (14.8 and 18.5%, respectively), while the rate for mold mix exhibited a constant increase and reached 20.0% in the >60 year-old group (Fig. 2).

With regard to food allergens, the sIgE-positive rates to egg and cow's milk were highest in the 0-3 year-old group

(7.4 and 31.5%, respectively). The rates of allergy to crab and cashew nut increased with age, but the difference was that the rate for crab peaked in the 19-25 year-old group (9.8%), while the rate for cashew nut reached a high level at 19-25 years and subsequently remained there (Table SIII).

*Comparison of degree of sIgE positivity for various allergens.* According to the grading, positivity for the 19 allergens was classified into 7 levels according to extent of positivity. The results indicated that the degree of sIgE positivity for most allergens was mainly at an 'Intermediate' or 'High' level, while that for certain food allergens (cow's milk and beef) was

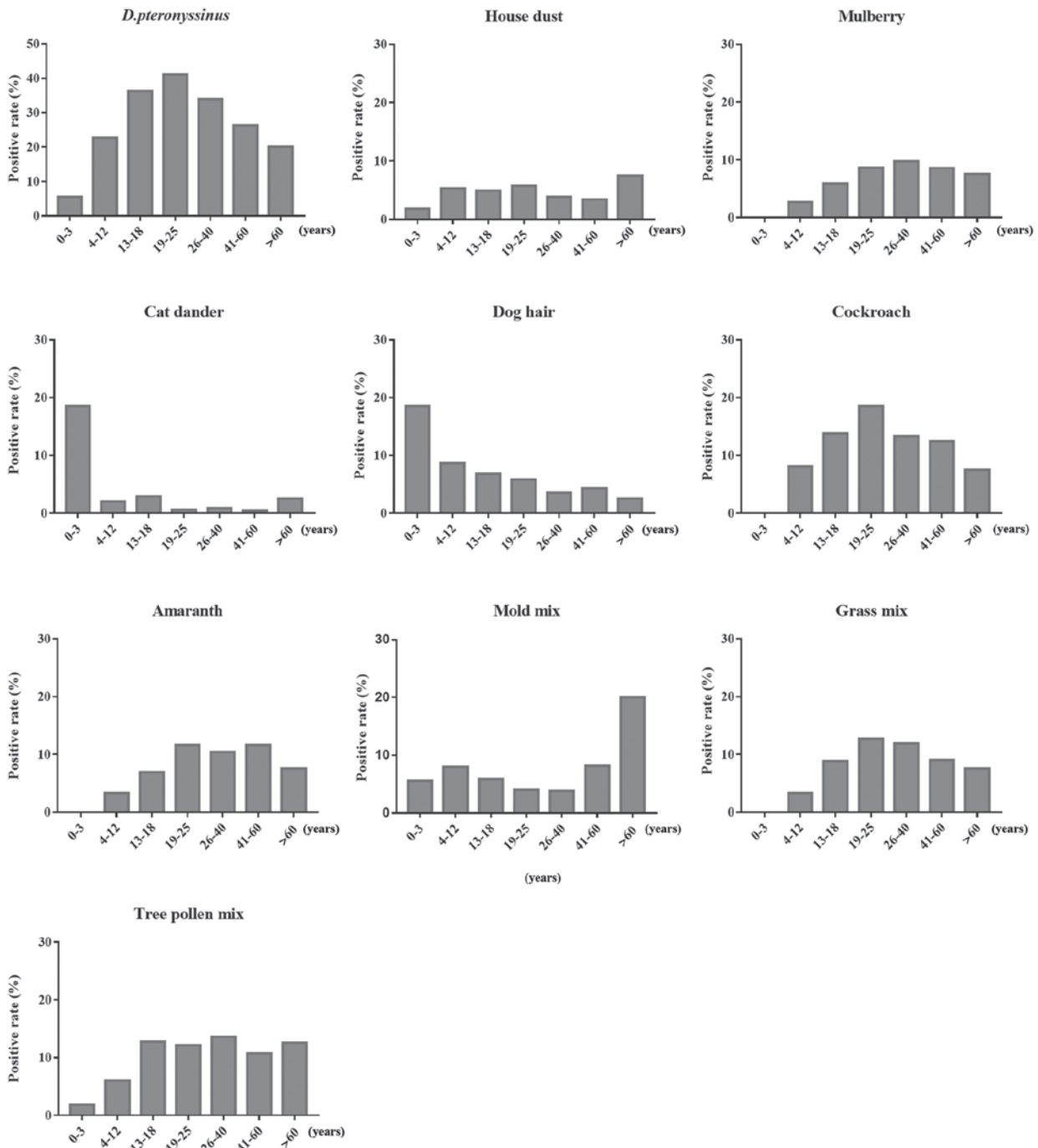


Figure 2. Sensitization to inhaled allergens in individuals of different age groups. Total number of cases in each age group: 0-3 years (n=54), 4-12 years (n=150), 13-18 years (n=103), 19-25 years (n=173), 26-40 years (n=338), 41-60 years (n=233) and >60 years (n=40).

at a ‘Low’ level. As for cowry, there was an equivalent amount of ‘High’- and ‘Low’-level cases, but the overall positive rate was relatively low (Fig. 3).

**Discussion**

Urticaria, a common skin disorder, is a member of the group of severe allergic diseases, which may not only cause a decline in the quality of life of affected individuals, but also in their performance at work and school (1). Symptomatic treatment, including anti-histamines, is currently the most frequently used form of management, but after discontinuation of medications a rapid

relapse of symptoms commonly occurs (1). Therefore, identification of the responsible allergens prevalent in a particular region may facilitate early diagnosis and the development of strategies to prevent this disease. In the present study, the prevalence of allergen sensitization in recent years in Henan province, where no allergen profile of patients with urticaria has been reported to date, to the best of our knowledge, was investigated.

The present results indicated that 48.0% (524) of the subjects were sIgE-positive to at least one of the 19 allergens tested, which was comparable with the rates in central China (42.9%) (6), Italy (41%) (7) and northern China (52.4%) (8). These results indicated that only half of the patients with

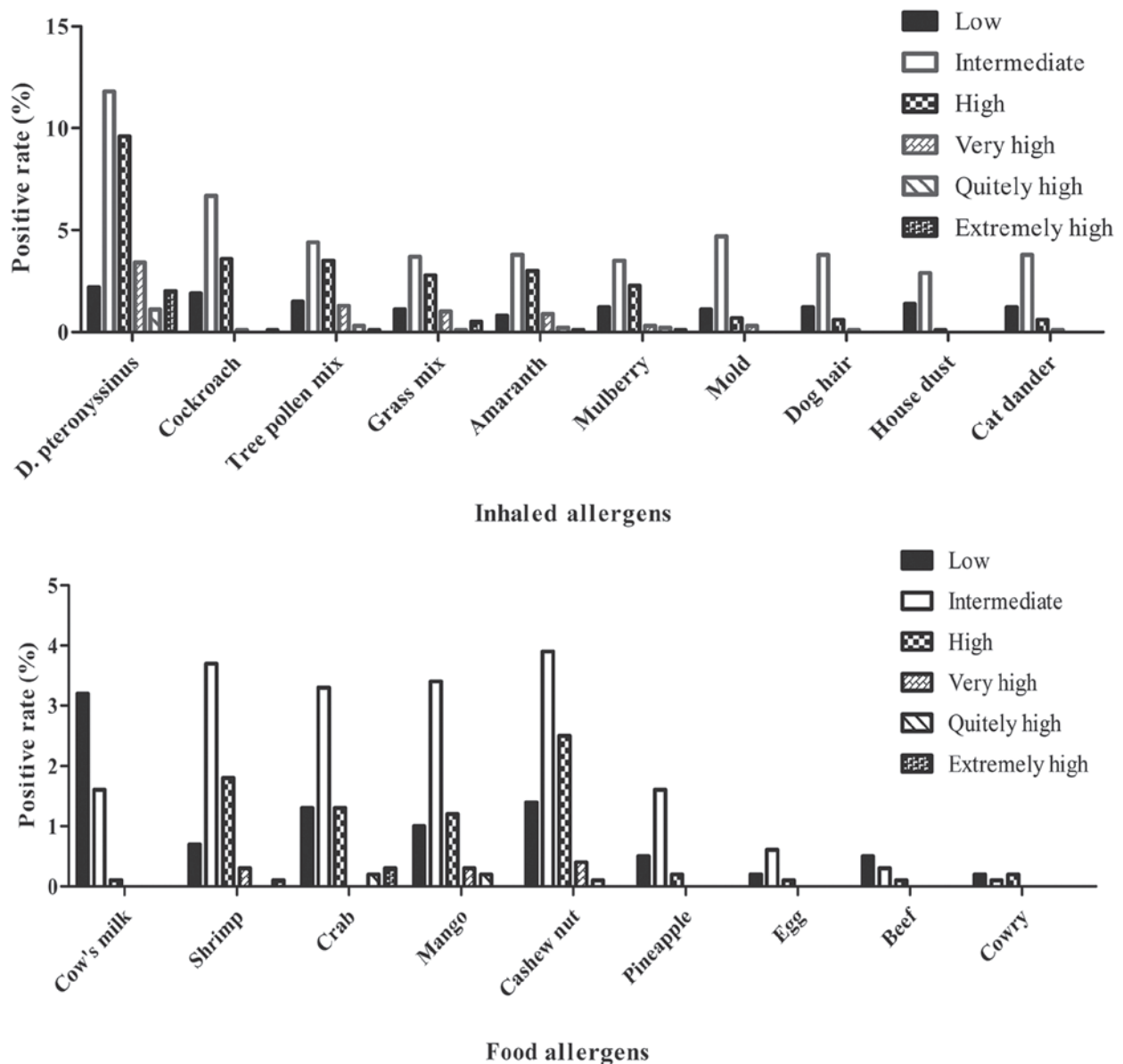


Figure 3. Comparison of the degree of allergic reactions to inhaled and food allergens in patients with urticaria: Class 0 (<0.35 IU/ml, undetectable), class 1 (0.35-0.70 IU/ml, low), class 2 (0.70-3.50 IU/ml, intermediate), class 3 (3.5-17.5 IU/ml, high), class 4 (17.5-50 IU/ml, very high), class 5 (50-100 IU/ml, quite high), class 6 (>100 IU/ml, extremely high).

urticaria had contact sensitization. However, at present, there isn't any one biomarker with sufficient ability to reflect urticaria. As urticaria is a heterogeneous disease, other reliable indicators, including histamine and cytokines, are helpful to indicate the patients' condition in association with allergens and may be added to support a diagnosis of urticaria in the future. Compared with food allergens, inhaled allergens were the major components in patients with urticaria (the positive rate ranged from 1.4 to 34.5% vs. 0 to 8.1%). In China, the majority of patients with urticaria choose to, or rather they are instructed by their physicians, to eliminate certain foods from their diet without undergoing any further diagnostic procedures. The present results suggested that the contribution of food allergens to urticaria was limited. This was similar to the results of a study by Hsu and Li (9), which indicated that food avoidance is common among patients with CU in China but was revealed to be mostly ineffective, and part of

the reason is that allergic disorders in adults generally involve environmental factors through the respiratory tract rather than through food. Furthermore, according to the present data, sensitivity to multiple allergens was more common than that to a single allergen, indicating that sensitization to multiple allergens is common in urticaria. As is known, excessive accumulation of seasonal and perennial allergens above the clinical relevance threshold may give rise to symptoms of allergy (10). It is necessary to develop comprehensive plans to avoid allergens and help patients remain below the clinical relevance threshold. Of note, although sIgE-positivity for certain allergens is likely to be a reaction from other allergic diseases, including rhinitis and asthma, patients were excluded if they were diagnosed with any other allergic diseases in the present study. Patients with known sIgE positivity avoiding those specific allergens may reduce the incidence of urticaria, as previously reported by Chen *et al* (11).

The present results indicated that of the 19 allergens tested, patients reacted most frequently to the inhaled allergen *D. pteronyssinus*, cockroach and tree pollen mix, which is similar to the results of a previous study on urticaria (8) or studies on other allergic diseases (12-14). However, cashew nut, shrimp and crab were identified to be the most common food allergens in Henan province, which was inconsistent with a previous study (8), whose results suggested that egg and cow's milk were the most frequent food allergens with positivity in northern China, but the prevalence of them was similar to commonly reported allergens worldwide (15). It is known that the climate determines the types of flora and fauna in a particular geographical area, which may affect airborne and food allergens (16). Henan is a province in the center of China characterized by a high population density and dry weather conditions, providing a relatively suitable environment for dust mite and cockroach. Moreover, the imbalanced economic development and sanitation in Henan may also have played a part. Zhengzhou, the capital of Henan Province, is commonly referred to as a 'green city' due to its environment with plenty of vegetation. This may explain the common sensitivity to tree pollen mix allergen. Furthermore, with the development of economy and transportation in this region in recent years, access to seafood, including shrimp and crab, has increased, which explains for the inconsistent results between the present study and traditional food allergens in northern China. However, as the tested allergen sources were not identical to those of/among previous studies, it was not possible to directly compare them. Of note, the present study indicated that positive reactions to several allergens, including *D. pteronyssinus*, dog hair, cockroach, mold mix, tree pollen mix and shrimp were more frequent in the CU group than in the AU group, suggesting that sensitization to allergens, particularly inhaled ones, had a crucial role in the relapse and duration of urticaria.

Among the 1,091 patients with urticaria, a difference in the sensitization to certain allergens was observed between males and females. The positive rates to 10 allergens (*D. pteronyssinus*, mulberry, dog hair, cockroach, amaranth, tree pollen mix, cow's milk, cowry, crab and cashew nut) were higher in males than in females. This phenomenon has been reported in several previous studies (6,17,18), but the reacting allergen types between genders were inconsistent. This may be due to different rates of contact to allergens and the difference in immune sensitivity between males and females.

In addition, certain allergens were reported to be associated with age (19,20). The rates of sIgE positivity for six allergens (*D. pteronyssinus*, mulberry, cockroach, amaranth, grass mix and crab) were low in the younger groups. Subsequently, they increased with age and peaked or plateaued in the 19-25-year-old group followed by a modest decline (the rate for mulberry peaked in the 26-40 year-old group), but they still remained at a relatively high level in the highest age group. For cat dander, dog hair, egg and cow's milk, the positive rates were the highest in the 0-3-year-old group and declined with age. These results were similar to those of previous studies (21-23). Regarding the high sensitization to cat dander and dog hair, one explanation may be that children are more likely to be in close contact with pets whilst playing with them or tend to crawl on the ground where pet hair/dander may accumulate (24). Furthermore, cow's milk and eggs have been reported to be the primary food allergens in children worldwide, including

China. It has been indicated that avoidance of pets and breast-feeding in infants and young children were effective to prevent urticaria (25). As for whether any genetic predisposition or hormone secretion has a role in these pathological processes, further research is required in the future.

Furthermore, the present study indicated that the degree of positivity for most allergens was mainly at an 'Intermediate' or 'High' level in positive cases, indicating that the intensity of sensitization to these allergens was obvious but not extremely high in patients with urticaria. As, hypersensitivity occupied an important position in the pathological process of urticaria (7,26), it is necessary for patients in this area to identify and avoid major allergens in order to remain below the clinical relevance threshold.

The prevalence and distribution of allergens among patients with urticaria revealed by the present study provided information that may be utilized for the prevention, diagnosis and management of urticaria in Henan province. For instance, although the scoring system dividing the intensity of the positivity of sIgE into seven levels has been widely used in clinical research for allergic diseases (5,12), based on the allergen distribution data of the present study, a novel scoring system may be proposed to assist the diagnosis of urticaria, integrating the clinical symptoms of patients with urticaria, as well as histamine, cytokines and other reliable indicators with the consultation of dermatologists. However, further comprehensive, in-depth and multi-center research is still required.

Of note, the present study had certain limitations. First, the tests included a variety of allergens in the environment but the reactivity to only 19 allergens was assessed in the present study. Furthermore, the difference in tested allergen sources limits the comparability with other studies (27). In addition, due to the heterogeneity of urticaria, only part of the cases featured IgE production and type I hypersensitivity (26,28). Further studies are required to explore the pathogenic mechanism of urticaria. Furthermore, healthy controls are not included and there may be bias associated with patient selection due to the retrospective nature of the present study and the severity of this disease cannot be assessed with allergen distribution patterns in detail. Furthermore, patients with urticaria are no longer tested for allergen sensitization after treatment in clinical practice at our hospital, and whether the dynamic changes of the allergen distribution patterns reflect the treatment response still requires to be investigated in further studies.

In conclusion, the prevalence and distribution of several allergens among patients with urticaria in Henan province exhibited differences in terms of gender, age and type of urticaria (CU or AU). The characteristics of allergen sensitization revealed in the present study may facilitate the prevention, diagnosis and management of urticaria in this area, particularly in terms of allergen avoidance management for this disease.

#### Acknowledgements

Not applicable.

#### Funding

This work was supported by the National Natural Science Foundation of China (grant no. 81501715).

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Authors' contributions

JP, JZ and LM conceived and designed the study. JZ, JP, XS, FW, ZJ, ZC, LZ, HX and JY reviewed the literature, collected the data and performed critical analysis. JP and JZ drafted the manuscript. All authors have read and approved the final manuscript.

### Ethics approval and consent to participate

The current study was approved by the Medical Ethics Committee of the First Affiliated Hospital of Zhengzhou University (Zhengzhou, China). Written informed consent was obtained from each patient.

### Patient consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

### References

- Zuberbier T, Aberer W, Asero R, Abdul Latiff AH, Baker D, Ballmer-Weber B, Bernstein JA, Bindslev-Jensen C, Brzoza Z, Buense Bedrikow R, *et al*: The EAACI/GA<sup>2</sup>LEN/EDF/WAO guideline for the definition, classification, diagnosis and management of urticaria. *Allergy* 73: 1393-1414, 2018.
- Dressler C, Werner RN, Eisert L, Zuberbier T, Nast A and Maurer M: Chronic inducible urticaria: A systematic review of treatment options. *J Allergy Clin Immunol* 141: 1726-1734, 2018.
- Maurer M, Altrichter S, Schmetzer O, Scheffel J, Church MK and Metz M: Immunoglobulin E-mediated autoimmunity. *Front Immunol* 9: 689, 2018.
- de Vos G: Skin testing versus serum-specific IgE testing: Which is better for diagnosing aeroallergen sensitization and predicting clinical allergy? *Curr Allergy Asthm Rep* 14: 430, 2014.
- Sun XX, Zhao JW, Wang QY, Shi G, Yang JJ and Ming L: Prevalence of allergen sensitization among 15,534 patients with suspected allergic diseases in Henan Province, China. *Asian Pac J Allergy Immunol* 37: 57-64, 2019.
- Chen H, Liu G, Huang N, Li W, Dong X and Zhu R: Incidence of allergic contact sensitization in central Chinese subjects with chronic urticaria. *An Bras Dermatol* 91: 168-172, 2016.
- Guerra L, Rogkakou A, Massacane P, Gamalero C, Compalati E, Zanella C, Scordamaglia A, Canonica WG and Passalacqua G: Role of contact sensitization in chronic urticaria. *J Am Acad Dermatol* 56: 88-90, 2007.
- Li LF and Wang J: Patch testing and aeroallergen intradermal testing in suspected allergic contact dermatitis, unclassified endogenous eczema and non-atopic chronic urticaria. *Contact Dermatitis* 45: 84-88, 2001.
- Hsu ML and Li LF: Prevalence of food avoidance and food allergy in Chinese patients with chronic urticaria. *Br J Dermatol* 166: 747-752, 2012.
- Protudjer JLP, Middelveld R, Dahlén SE and Ahlstedt S; FoodHE Investigators: Food allergy-related concerns during the transition to self-management. *Allergy Asthma Clin Immunol* 15: 54, 2019.
- Chen H, Liu G, Huang N, Li W, Dong X and Zhu R: Incidence of allergic contact sensitization in central Chinese subjects with chronic urticaria. *An Bras Dermatol* 91: 168-172, 2016.
- Chang ML, Shao B, Liu YH, Li LL, Pei LC and Wang BY: Analysis of allergens in 5 473 patients with allergic diseases in Harbin, China. *Biomed Environ Sci* 26: 886-893, 2013.
- Ojeda P, Ibáñez MD, Olaguibel JM, Sastre J and Chivato T; Investigators participating in the National Survey of the Spanish Society of Allergology and Clinical Immunology *Alergológica* 2015: *Alergológica* 2015: A National survey on allergic diseases in the Spanish pediatric population. *J Investig Allergol Clin Immunol* 28: 321-329, 2018.
- Jiang XD, Li GY, Dong Z and Zhu DD: Correlation analysis of two serum-specific immunoglobulin E test systems and skin-prick test in allergic rhinitis patients from northeast China. *Am J Rhinol Allergy* 25: 116-119, 2011.
- Patel BY and Volcheck GW: Food allergy: Common causes, diagnosis, and treatment. *Mayo Clin Proc* 90: 1411-1419, 2015.
- Jenerowicz D, Silny W, Dańczak-pazdrowska A, Polańska A, Osmola-mañkowska A and Olek-hrab K: Environmental factors and allergic diseases. *Ann Agric Environ Med* 19: 475-481, 2012.
- Lin H, Lin R and Li N: Sensitization rates for various allergens in children with allergic rhinitis in Qingdao, China. *Int J Environ Res Public Health* 12: 10984-10994, 2015.
- Chung BY, Cho YS, Kim HO and Park CW: Food allergy in Korean patients with chronic urticaria. *Ann Dermatol* 28: 562-568, 2016.
- Gonzalez-Estrada A, Silvers SK, Klein A, Zell K, Wang XF and Lang DM: Epidemiology of anaphylaxis at a tertiary care center: A report of 730 cases. *Ann Allergy Asthma Immunol* 118: 80-85, 2017.
- Kim HS, Kang SH, Won S, Lee EK, Chun YH, Yoon JS, Kim HH and Kim JT: Immunoglobulin E to allergen components of house dust mite in Korean children with allergic disease. *Asia Pac Allergy* 5: 156-162, 2015.
- Chan JCK, Peters RL, Koplin JJ, Dharmage SC, Gurrin LC, Wake M, Tang MLK, Prescott S and Allen KJ; HealthNuts Study: Food challenge and community-reported reaction profiles in food-allergic children Aged 1 and 4 Years: A population-based study. *J Allergy Clin Immunol Pract* 5: 398-409, 2017.
- Yazıcı S, Güneş S, Kurtuluş-çokboz M, Kemer Ö, Baranlı G, Aşık-akman S and Can D: Allergen variability and house dust mite sensitivity in pre-school children with allergic complaints. *Turk J Pediatr* 60: 41-49, 2018.
- Palosuo K, Kukkonen AK, Pelkonen AS and Mäkelä MJ: Gal d 1-specific IgE predicts allergy to heated egg in Finnish children. *Pediatr Allergy Immunol* 29: 637-643, 2018.
- Hesselmar B, Hicke-Roberts A, Lundell AC, Adlerberth I, Rudin A, Saalman R, Wennergren G and Wold AE: Pet-keeping in early life reduces the risk of allergy in a dose-dependent fashion. *PLoS One* 13: e0208472, 2018.
- Herbert LJ, Jacobs M, Ramos A, DiGiacomo D, Balas K and Robbins KA: Perceived food allergy, sensitivity, or intolerance and its impact on breastfeeding practices. *J Allergy Clin Immunol Pract* 143: pii: S2213-S2198, 2019.
- Church MK, Kolkhir P, Metz M and Maurer M: The role and relevance of mast cells in urticaria. *Immunol Rev* 282: 232-247, 2018.
- Lakin E, Church MK, Maurer M and Schmetzer O: On the lipophilic nature of Autoreactive IgE in chronic spontaneous urticaria. *Theranostics* 9: 829-836, 2019.
- Ferrer M: Immunological events in chronic spontaneous urticaria. *Clin Transl Allergy* 5: 30, 2015.



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) License.