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ORIGINAL RESEARCH

Exploring the Role of Allergenic Components in Children with House Dust Mite-Induced Allergic Diseases

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Purpose: To investigate the main characteristics of HDM-induced allergic diseases in children and to explore allergen component-specific sensitization patterns, features, and correlations with clinical symptoms.

Methods: Serum samples were collected from children with HDM-induced allergic diseases. Information on age, sex, and clinical symptoms was recorded. A protein chip method was used to detect specific IgE (sIgE) against HDM components, including *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, *Der p* 5, *Der p* 7, *Der p* 10, *Der p* 21, and *Der p* 23.

Results: 116/120 (96.67%) exhibited positive reactions to HDM components. The highest positive rates were for *Der p* 1 (95.83%) and *Der f* 1 (95.83%), followed by *Der p* 2 (86.67%), *Der f* 2 (85.83%), and *Der p* 23 (62.50%). *Der p* 5, 7, and 23 positivity increased with age. Notably, *Der p* 23 positivity was higher in the allergic asthma (AA) group than in the non-AA, atopic dermatitis (AD), and allergic rhinitis (AR) groups and higher in AR with AA than AR-only. *Der p* 2 and *Der f* 2 had higher positive rates in respiratory allergies than in AD alone. The impact of other HDM components on different allergic diseases was minimal. Pearson correlation analysis demonstrated strong positive correlations between sIgE concentrations for various HDM components, especially between *Der p* 2 and *Der f* 2 ($r = 0.96$, $p < 0.01$).

Conclusion: *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, and *Der f* 23 are the major allergens, with *Der p* 5, 7, and 23 showing age-specific sensitization patterns. *Der p* 2 and *Der f* 2 are closely associated with respiratory allergies, whereas *Der p* 23 is particularly linked to the development of asthma. There is a general positive correlation among the sIgE concentrations of various HDM components.

Keywords: allergens, allergic diseases, child, component-resolved diagnosis, mites

Introduction

In recent decades, the prevalence of allergic diseases has increased worldwide.[1] Approximately 500–550 million individuals are affected by bronchial asthma or food allergies,[2] and 400 million suffer from allergic rhinitis (AR),[3] presenting a substantial public health challenge worldwide.[4,5] Allergic diseases not only impact patients' quality of life but also impose significant medical and economic burdens on families and society. A national cross-sectional study conducted in China on the epidemiology of allergen sensitization among patients with AR and allergic asthma (AA) revealed a nearly 10% increase in sensitization to house dust mites (HDMs) from 2008 to 2018.[6] In Korea, *Dermatophagoides farinae* (*D. farinae*) emerged as the most prevalent sensitizing aeroallergen, affecting 45.9% of the population between January 2009 and December 2018.[7] In Japan, sensitization to HDMs was observed in 58.5% of subjects who exhibited positive sensitization to at least one aeroallergen.[8] HDMs are acknowledged as the most prevalent

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indoor allergens worldwide, contributing to a spectrum of allergic conditions including AR, allergic conjunctivitis, AA, and atopic dermatitis (AD).

The diagnosis of allergen sensitization currently relies on allergen-specific IgE (sIgE) detection and allergen skin prick tests. With the advancement of precision medicine, there has been a shift toward examining allergen components for a more precise diagnosis. Component-resolved diagnosis (CRD) has emerged as a leading approach in the precise diagnosis and treatment of allergic disorders.[9,10] This shift towards CRD has allowed for a better understanding of the molecular mechanisms underlying HDM sensitization and has led to the development of novel therapeutic strategies. Over 40 molecular allergens have been identified from *D. pteronyssinus* and *D. farinae*, with *Der p* 1, *Der p* 2, *Der p* 5, *Der p* 7, *Der p* 21, and *Der p* 23 identified as the predominant or moderately significant allergenic components.[11] Approximately 71% to 94% (data from www.allergen.org) of individuals with HDMs have sIgE positive responses to *Der p* 1, *Der f* 1 (a cysteine protease), and/or *Der p* 2, *Der f* 2 (NPC2 family), which are crucial indicators of HDM sensitization.[12,13] *Der p* 23 is considered the second most important allergen component after *Der p* 1, *Der f* 1, *Der p* 2, and *Der f* 2, with a detection rate of 74% among individuals with HDMs.[14] *Der p* 7 and *Der p* 21 are potential factors in the development of non-respiratory allergic diseases, such as AD.[15] The interaction between sensitization to HDM components and food has attracted considerable attention, including cross-reactivity between tropomyosin *Der p* 10 and crustacean and mollusk foods, such as shrimp and crab.[16] Studies suggest that the severity of allergic symptoms may not directly correlate with the concentrations of HDM sIgE.[17] The analysis of allergen components is essential for identifying primary allergenic proteins, distinguishing cross-reactivity among allergens, enhancing accurate allergen detection, reducing the risk of severe allergic reactions, and guiding allergen immunotherapy.[9,13,18] Therefore, studies on HDM components and their associations with allergic conditions have received considerable attention.[19,20]

Childhood AD and AR are closely related to the development of asthma and the severity of asthma in adulthood. Research indicates that as children grow older, AR may develop into asthma, ultimately leading to the development of allergic rhinitis and asthma syndrome (ARAS).[21] Therefore, it is crucial for early prevention, early identification, precise treatment, and personalized management of childhood allergic diseases. In China, HDM is the main aeroallergen responsible for AR and asthma.[22] Currently, there is little research on the sensitization patterns of HDM components in children, and their role in allergic diseases in children remains unclear. This study aims to analyze the main component characteristics of allergic diseases caused by HDMs in children, investigate specific sensitization patterns and epidemiological characteristics of HDM components, and explore their correlation with allergic diseases. These findings will provide valuable insights for the diagnosis and treatment of pediatric allergic diseases.

Material and Methods

Study Population and Design

The serum samples used in this study were collected from the pediatric department of Suzhou Hospital, Affiliated Hospital of Medical School, Nanjing University from March 2023 to July 2023. The study included 120 patients who met the following criteria: (1) Patients were diagnosed with allergic diseases such as AD, AR, and AA by pediatric specialists according to clinical guidelines.[23–25] (2) The allergic symptoms were associated with HDM allergy, and sensitization to *D. pteronyssinus* and/or *D. farinae* was observed. (3) Serum samples were tested for *D. pteronyssinus* and *D. farinae* sIgE using the BioCLIA® magnetic particle chemiluminescent allergen detection platform from HOB Biotech Group Corp., Ltd. (Suzhou, China), with sIgE concentrations ≥0.35 kU/L considered positive. The detection platform has an intra-assay variability of less than 10% and a detection limit below 0.1 kU/L. Exclusion criteria: (1) Patients using allergen-specific immunotherapy or omalizumab were excluded. (2) Patients with major underlying diseases, such as immune system disorders, autoimmune diseases, and cancer, were excluded. Clinical data, such as age, sex, and allergic symptoms were documented, and serum samples were obtained from the participants for analysis of HDM components.

The study protocol was approved by the Ethics Committee of Suzhou Hospital, Affiliated Hospital of Medical School, Nanjing University (IRB2024058). Written informed consent was obtained from the guardians of all subjects prior to the study. This study was conducted in accordance with the Declaration of Helsinki.

Detection of the HDM Component sIgE

Using HDM recombinant protein component reagents and a high-throughput automatic immunoblotting instrument, the sIgE concentrations of *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, *Der p* 5, *Der p* 7, *Der p* 10, *Der p* 21 and *Der p* 23 in the serum samples were determined via the protein chip method. A DX–Autoblot 50 automatic immunoassay analyzer was used to determine sIgE concentrations (reagents and instruments were provided by Hangzhou Zheda Dixun Biological Gene Engineering Co., Ltd., Hangzhou, China). The specific detection method used has been described in a published article.[20] The sIgE concentration is expressed in standardized units of kU/L, and the evaluation criteria are as follows: sIgE levels are divided into 0–6 levels according to concentration, specifically, sIgE < 0.35 kU/L is level 0; 0.35 kU/L ≤ sIgE < 0.70 kU/L is level 1; 0.70 kU/L ≤ sIgE < 3.50 kU/L is level 2; 3.50 kU/L ≤ sIgE < 17.50 kU/L is level 3; 17.50 kU/L ≤ sIgE < 50.00 kU/L is level 4; 50.00 kU/L ≤ sIgE < 100.00 kU/L is level 5; and sIgE ≥ 100.00 kU/L is level 6. A positive result is defined as an sIgE concentration ≥ 0.35 kU/L.

Statistical Analysis

Statistical analyses were performed using SPSS 26.0 (IBM SPSS, Chicago, IL, USA). The positive rates among the groups were compared using either the χ^2 test or Fisher's exact test. Fisher's exact test was used when any theoretical frequency was less than 1, or the total sample size was less than 40, or was greater than or equal to 40 with at least one theoretical frequency between 1 and 5. The Kruskal–Wallis test was used to compare sIgE concentrations. P values < 0.05 were considered statistically significant. GraphPad Prism 8.0 (GraphPad Software, San Diego, CA, USA) was used for data visualization. The associations between allergens were depicted in a matrix diagram via the "corrplot" package in R (http://www.r-project.org/, R Foundation for Statistical Computing, Vienna, Austria). The Pearson correlation coefficient was used to assess the correlation between allergens.

Results

Study Population

During the period from March to July 2023, we collected 120 serum samples from children who met the specified inclusion criteria. Among these, 69 (57.50%) were male and 51 (42.50%) were female, aged between 3 and 15 years (mean ± SD: 7.74 ± 2.65). The most common allergic disease was AR, with 102 cases (85.00%), followed by AD with 61.67% of the children, whereas AA was the lowest at 35.83%. A total of 48 patients (40.00%) had a single allergic disease, and 45 (37.50%) had two concurrent diseases. Specifically, 32 (26.67%) had AD and AR, 4 (3.33%) had AD and AA, and 9 (7.50%) had AR and AA. 27 (22.50%) had all three diseases simultaneously.

Characteristics of HDM Components and Sensitization Patterns in Different Age Groups

A total of 116 out of 120 patients (96.67%) tested positive for sIgE to at least one of the nine components of HDM. The highest positive rates were observed for *Der p* 1 (95.83%) and *Der f* 1 (95.83%), followed by *Der p* 2 (86.67%), *Der f* 2 (85.83%), and *Der p* 23 (62.50%) (Table 1). The concentrations of sIgE for these five components were significantly higher than those for the remaining four components ($p < 0.001$) (Figure 1A), and the rate of positivity for these five components exceeded that of the other four components (Figure 1B). Notably, *Der p* 1 and *Der f* 1 had higher positive rates than *Der p* 2 and *Der f* 2 ($p < 0.05$), whereas the sIgE concentrations for *Der p* 1 were lower than those for *Der f* 1 ($p < 0.001$), *Der p* 2 ($p < 0.01$), and *Der f* 2 ($p < 0.001$). Conversely, *Der p* 10 had the lowest positive rate (5.83%), which was significantly lower than those of the other eight HDM components (all $p < 0.05$). The distribution of sIgE levels across the HDM components is illustrated in Figure 1C.

In the three age groups (3–6 years, 7–12 years, and 13–15 years), no significant variation was observed between the sexes. With respect to disease incidence, AD had the highest incidence among those aged 3–6 years, with a rate of 73.81%, which significantly differs from that of the 7–12 age group. While AR had the lowest prevalence in the 3–6-year-old group, there was no significant difference compared to the other groups. Similarly, although the incidence of AA is notably greater in the 13–15-year-old group, the difference was not statistically significant. In the analysis of HDM components, the positivity rates of *Der p* 5, *Der p* 7, and *Der p* 23 gradually increased with age ($p < 0.05$). Specifically,

Table 1 Demographics and Characterization of the Study Population in the Four Age Groups

	3–6 Years (n=42)	7–12 Years (n=68)	13–15 Years (n=10)	Total	p-Value
Gender (male/female)	23/19	39/29	7/3	69/51	0.693
Diagnosis of allergic disease, n (%)					
AD	31 (73.81%)	37 (54.41%)*	6 (60.00%)	74 (61.67%)	0.132
AD+AR and/or AA	22 (52.38%)	33 (48.53%)	4 (40.00%)	59 (52.50%)	0.821
AR	33 (78.57%)	61 (89.71%)	8 (80.00%)	102 (85.00%)	0.192
AA	15 (35.71%)	23 (33.82%)	5 (50.00%)	43 (35.83%)	0.622
AR+AA	13 (30.95%)	19 (27.94%)	4 (40.00%)	36 (30.00%)	0.683
HDM component, n (%)					
Der p 1	40 (95.24%)	65 (95.59%)	10 (100.00%)	115 (95.83%)	1
Der f 1	40 (95.24%)	65 (95.59%)	10 (100.00%)	115 (95.83%)	1
Der p 2	35 (83.33%)	60 (88.24%)	9 (90.00%)	104 (86.67%)	0.837
Der f 2	35 (83.33%)	59 (86.76%)	9 (90.00%)	103 (85.83%)	0.920
Der p 5	11 (26.19%)	15 (22.06%)	6 (60.00%)#	32 (26.67%)	**0.047**
Der p 7	3 (7.14%)	20 (29.41%)*	3 (30.00%)	26 (21.67%)	**0.006**
Der p 10	5 (11.90%)	2 (2.94%)	0 (00.00%)	7 (5.83%)	0.157
Der p 21	9 (21.43%)	18 (26.47%)	4 (40.00%)	31 (25.83%)	0.459
Der p 23	17 (40.48%)	50 (73.53%)*	8 (80.00%)*	75 (62.50%)	**0.001**

Notes: * indicates statistical significance ($p < 0.05$) in the bivariate comparison (13–15 years vs 3–6 years, and 7–12 years vs 3–6 years). # indicates statistical significance ($p < 0.05$) between 13–15 years and 7–12 years. Bolded values indicate statistical significance ($p < 0.05$).
Abbreviations: AD, Atopic dermatitis; AR, Allergic rhinitis; AA, Allergic asthma.

the positive rates of *Der p* 23 in the 7–12 and 13–15 age groups were 73.53% and 80.00%, respectively, significantly surpassing the 40.48% in the 3–6 age group, with a notable significant difference ($p < 0.05$) (Table 1). Although the concentrations of *Der p* 23 sIgE in the first two groups exceeded those in the latter group, only the 7–12-year-old age group was significantly different from the 3–6-year-old age group ($p < 0.05$). No significant statistical differences in sIgE concentrations were detected among the remaining eight HDM components across the three age groups ($p > 0.05$) (Figure 2A).

Characteristics of HDM Components Among Different Diseases

In the AD, AR, and AA groups, the positive rates of *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, *Der p* 7, and *Der p* 23 were notably greater in the AA group than in the other two groups. However, only the positive rate of *Der p* 23 was significantly different between the AD and AR groups ($p < 0.05$) (Table 2). Despite the elevated sIgE concentrations of *Der p* 23 in the AA group relative to those in the other groups, this difference did not reach statistical significance ($p > 0.05$) (Figure 2B).

In our analysis of the relationship between single AD and respiratory allergic diseases, including AR and/or AA, we observed that children with respiratory allergic diseases presented higher positive rates of *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, *Der p* 7, *Der p* 21, and *Der p* 23 compared to those with single AD. Notably, only the positive rates of *Der p* 2 and *Der f* 2 exhibited significant statistical differences between the two groups ($p < 0.05$) (Figure 3A). Excluding *Der p* 21, the concentrations of sIgE to HDM components were typically greater in children with respiratory allergic diseases than in those with single AD. However, no statistically significant differences were observed ($p > 0.05$) (Figure 3B).

Among the 102 AR patients, the positive rates of *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, *Der p* 21, and *Der p* 23 in the 36 AR patients with AA were greater than those in the 66 AR patients without AA. However, only the positive rate of *Der p* 23 showed a significant statistical difference ($p < 0.05$) (Figure 3C). Additionally, the sIgE concentrations of *Der p* 1, *Der f* 1, *Der p* 2, *Der p* 7, *Der p* 21, and *Der p* 23 were found to be elevated in AR patients with AA compared to those without AA, although this difference was not statistically significant ($p > 0.05$) (Figure 3D).

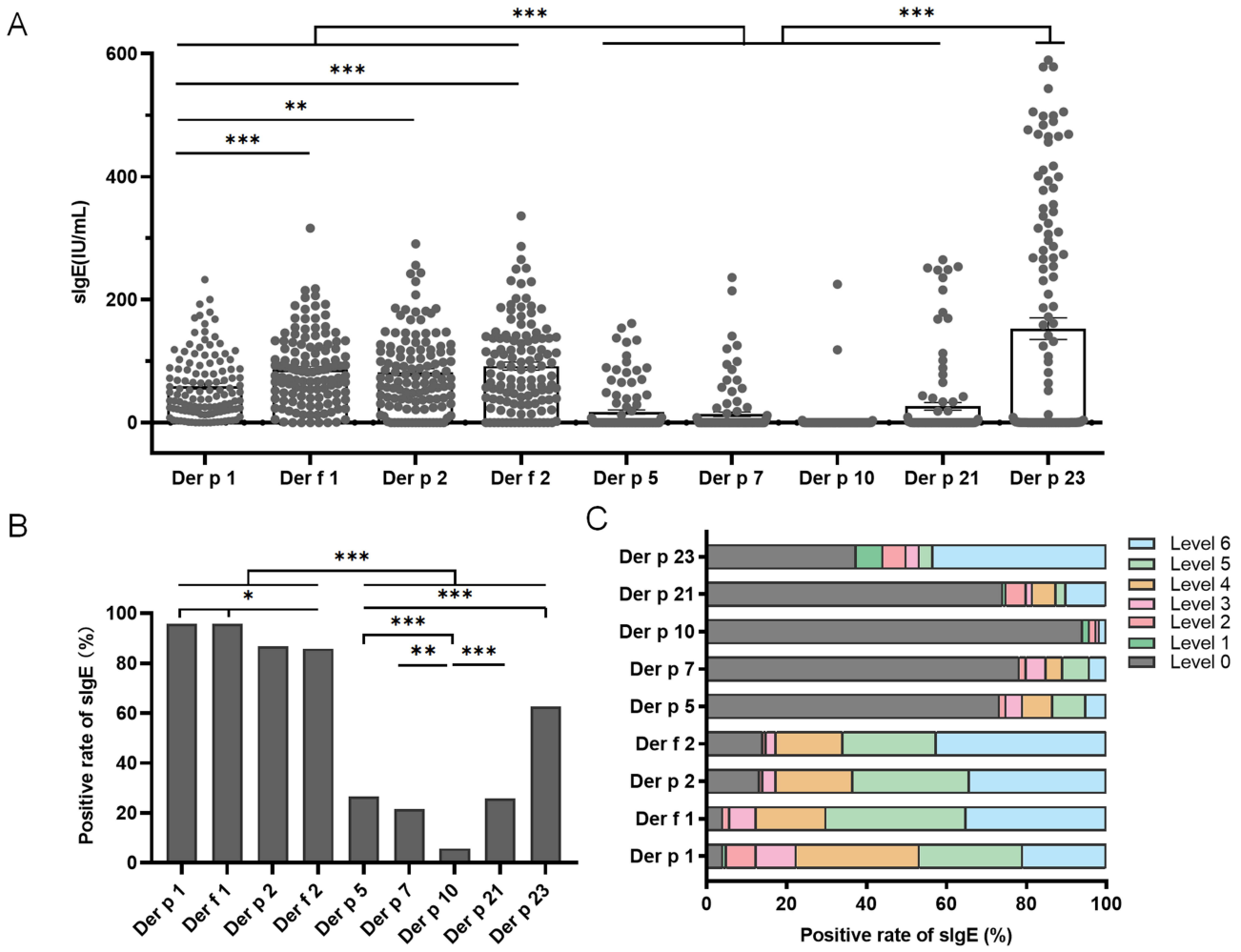

Figure 1 The serum samples of 120 patients were tested. (**A**) Distribution of HDM components and concentrations of sIgE; (**B**) Positive rates of the HDM component sIgE; (**C**) Distribution of sIgE levels for the nine HDM components. *p < 0.05, **p < 0.01, ***p < 0.001.

Correlation Between sIgE of HDM Components

A Pearson correlation coefficient was used to assess the relationship between the sIgE concentrations of the allergens. The results revealed a wide range of positive correlations among the components of HDM, with the highest correlation observed between *Der p* 2 and *Der f* 2 (r = 0.96, p < 0.01). *Der p* 1 was moderately correlated with *Der f* 1, *Der p* 2, and *Der f* 2 (r = 0.52, 0.47 and 0.42, respectively; all p < 0.01). Similarly, *Der f* 1 exhibited moderate positive correlations with *Der p* 2 and *Der f* 2, *Der p* 5 and *Der p* 21 (r = 0.47, 0.46, and 0.53, respectively; all p < 0.01). Weak associations were found between *Der p* 1 and *Der p* 5, *Der p* 7, and *Der p* 23, as well as between *Der p* 5 and *Der f* 1, *Der p* 2, *Der f* 2, and *Der p* 7, and between *Der p* 23 and *Der p* 2, *Der p* 7, and *Der p* 21 (r = 0.25–0.35; p < 0.05) (Figure 4).

Discussion

The development of precision medicine is highly important for improving diagnostic and treatment levels, advancing the progress of medical science, optimizing medical resources, and enhancing health management.[26] CRD is emerging as a promising tool in precision medicine for allergology, where distinct profiles of allergic molecules play critical roles in the onset, progression, and severity of allergic conditions.[9,13] Targeting specific HDM components in patients has the potential to increase the effectiveness of allergen-specific immunotherapy.[9,13] Therefore, understanding the molecular concentration of allergens is crucial for the development of targeted immune therapies for HDMs. Our study investigated

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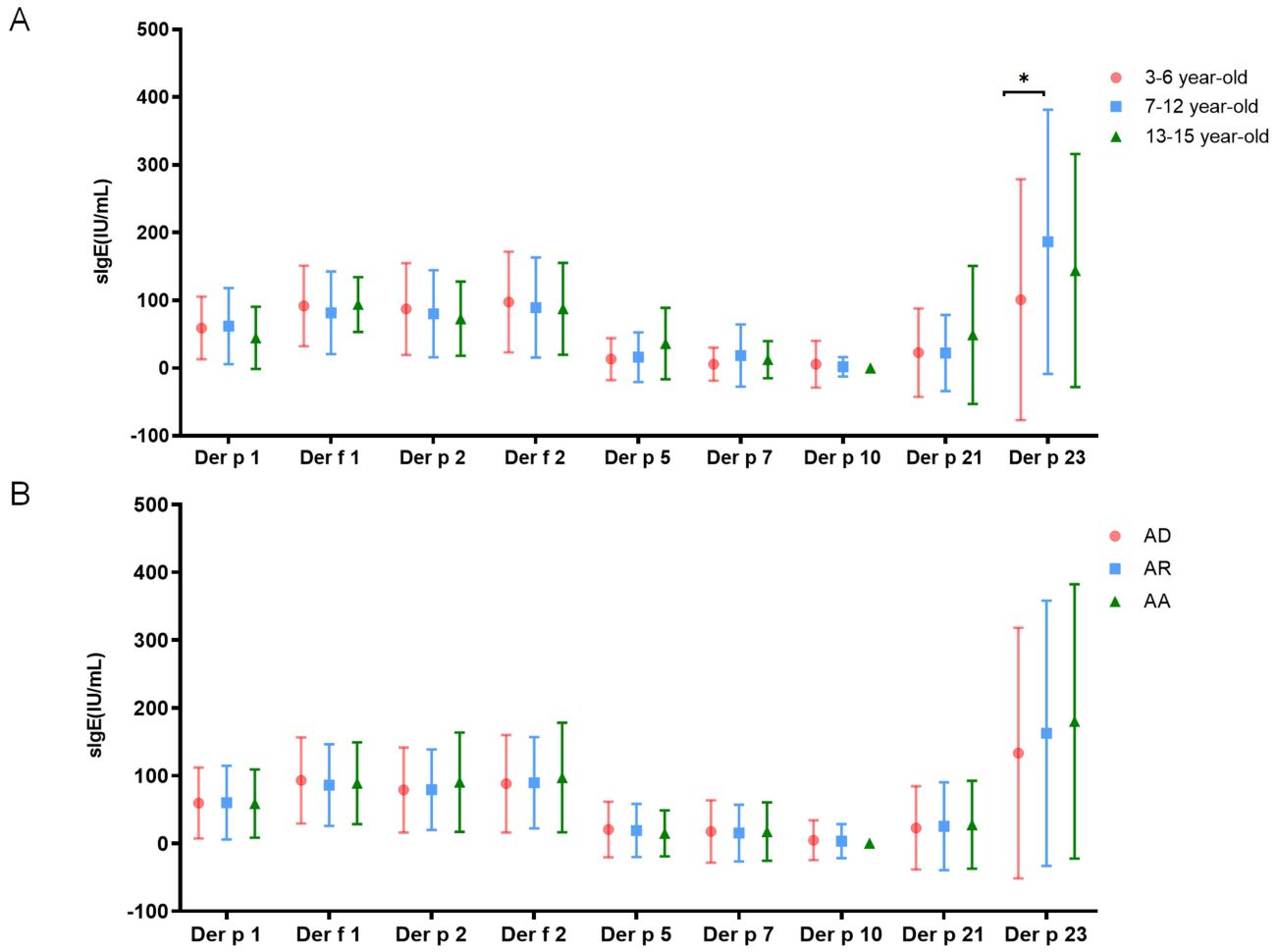

Figure 2 Distribution of sIgE concentrations between the different groups. (**A**) Distribution of the sIgE concentrations between different ages; (**B**) Distribution of the sIgE concentrations between different diseases. *p < 0.05.

the molecular sensitization patterns and characteristics of HDM components in children with allergic diseases in Suzhou, East China, emphasizing age-specific effects. We also explored the correlation between various HDM components and allergic diseases, as well as the relationships among sIgE concentrations for HDM components.

Table 2 Positive Rate of sIgE in HDM Components in Different Diseases

	AD (n=74)	AR (n=102)	AA (n=43)	p-Value
Age (years)	7.42±2.63	7.77±2.56	8.36±2.55	0.186
Gender (male/female)	44/30	63/39	23/20	0.651
HDM-sIgE				
Der p 1	72 (97.30%)	98 (96.08%)	43 (100.00%)	0.578
Der f 1	72 (97.30%)	98 (96.08%)	43 (100.00%)	0.578
Der p 2	63 (85.14%)	90 (88.24%)	39 (90.70%)	0.659
Der f 2	62 (83.78%)	89 (87.25%)	38 (88.37%)	0.729
Der p 5	23 (31.08%)	29 (28.43%)	10 (23.26%)	0.663
Der p 7	16 (21.62%)	23 (22.55%)	10 (23.26%)	0.978
Der p 10	6 (8.11%)	5 (4.90%)	2 (4.65%)	0.661
Der p 21	18 (24.32%)	28 (27.45%)	11 (25.58%)	0.894
Der p 23	45 (60.81%)	66 (64.71%)	34 (79.07%) *#†	0.123

Note: *and # Indicate statistical significance (p < 0.05) in the bivariate comparison (AA vs AD and AA vs AR). † Indicates statistical significance (p < 0.05) in the statistical analysis of the positive rate data of the AD and non-AD, AR and non-AR, AA and non-AA groups.

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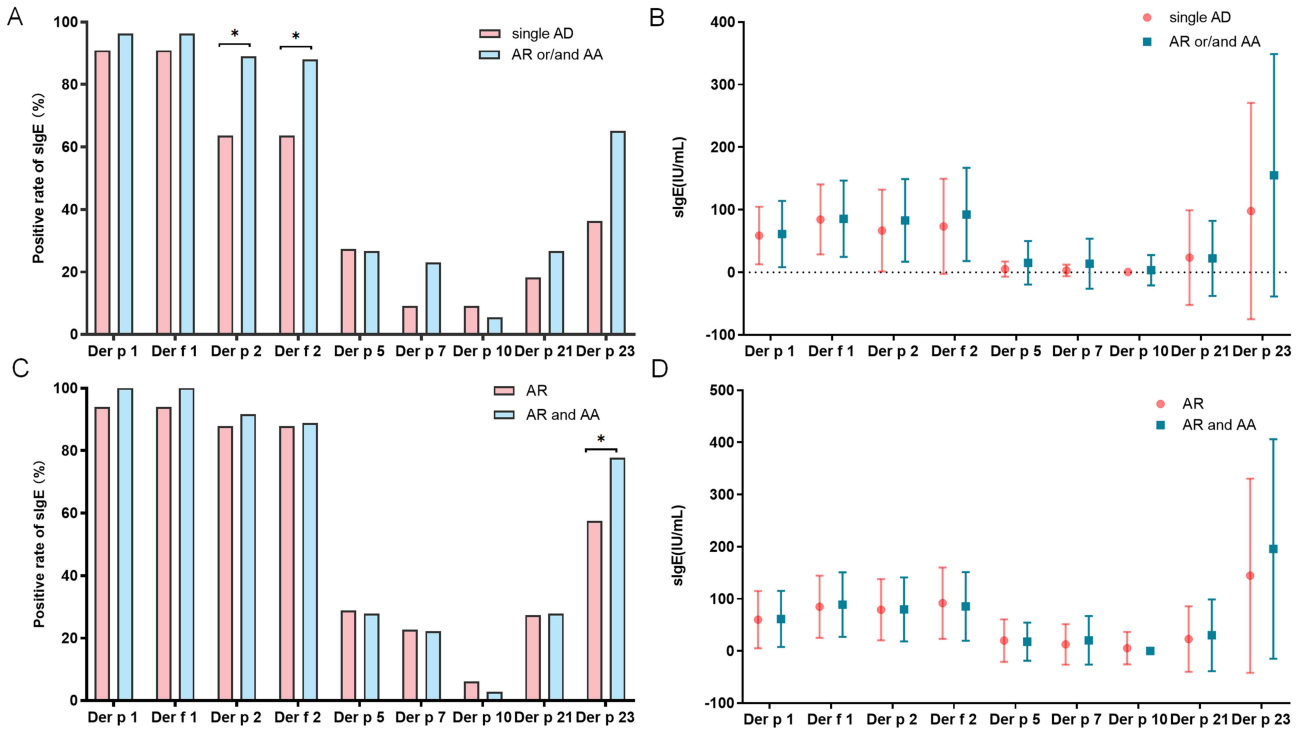

Figure 3 Distribution of sIgE-positive rates and concentrations for each HDM component among different diseases. (**A**) Distribution of sIgE-positive rates between single AD (not including AR and AA) and respiratory allergic diseases (including AR and/or AA). (**B**) Level of sIgE between single AD and AR and/or AA. (**C**) Distribution of the sIgE positive rate between AR and AR with AA. (**D**) Level of sIgE between AR and AR with AA. *p < 0.05.

In our study, we observed similar sensitization rates for *Der p* 1 (95.83%), *Der f* 1 (95.83%), *Der p* 2 (86.67%), *Der f* 2 (85.83%), and *Der p* 23 (62.50%) compared with those reported in southern China, Japan, and Europe,[19,27–29] suggesting a common response pattern to HDM exposure across different regions and ethnic groups. We also found that the sIgE concentrations of these five HDM components were significantly greater than those of the other components, further indicating that these five HDM components are the main components of local HDMs. The sensitization rates of *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, and *Der p* 23 are higher than those in northern China,[20] possibly due to geographical variations, climate conditions, living environments, lifestyle differences and population demographics. While minor components including *Der p* 5, *Der p* 7, and *Der p* 21 have been implicated in yielding stronger and more frequent IgE responses and respiratory symptoms, such as asthma,[30] and *Der p* 10 is one of the major thermostable allergens with cross-reactivity across various invertebrates,[31] our study reveals a low sensitization rate (0.83%) for these components in eastern China. Furthermore, there is no consistent sensitization pattern observed for these minor components, suggesting that their detection may not be necessary in this region. Identifying major allergens remains crucial for accurate diagnosis.

A previous study revealed an increased incidence of diseases caused by HDMs during the first decade of life.[32] During this period, IgE reactions exhibit plasticity, which is followed by the establishment of a stable IgE recognition spectrum. These findings align with our research and are consistent with the work of Tuten Dal et al.[33] Previous studies have indicated that age can impact sIgE concentrations.[33,34] However, our data suggest that variations in sIgE concentrations exist among individuals sensitized to different allergens. With the exception of *Der p* 23, IgE concentrations exhibit a consistent pattern across different age groups, possibly influenced by variations in patient selection across studies. In the present study, *Der p* 23 emerged as a prominent local allergen due to its high sensitization rate, which is comparable to rates reported in Japan and Europe, albeit lower than those of *Der p* 1, *Der f* 1, *Der p* 2 and *Der f* 2. We also observed a significant age-related increase in the sensitization rate and concentration of *Der p* 23, which is consistent with previous research by Tuten Dal et al.[33] These findings suggest an age-related sensitization pattern for this allergen, which is influenced by factors such as the duration of allergen exposure, allergen intensity, genetic predisposition, and immune system development in children. Similarly, age-related sensitization patterns were observed for *Der p* 5 and *Der*

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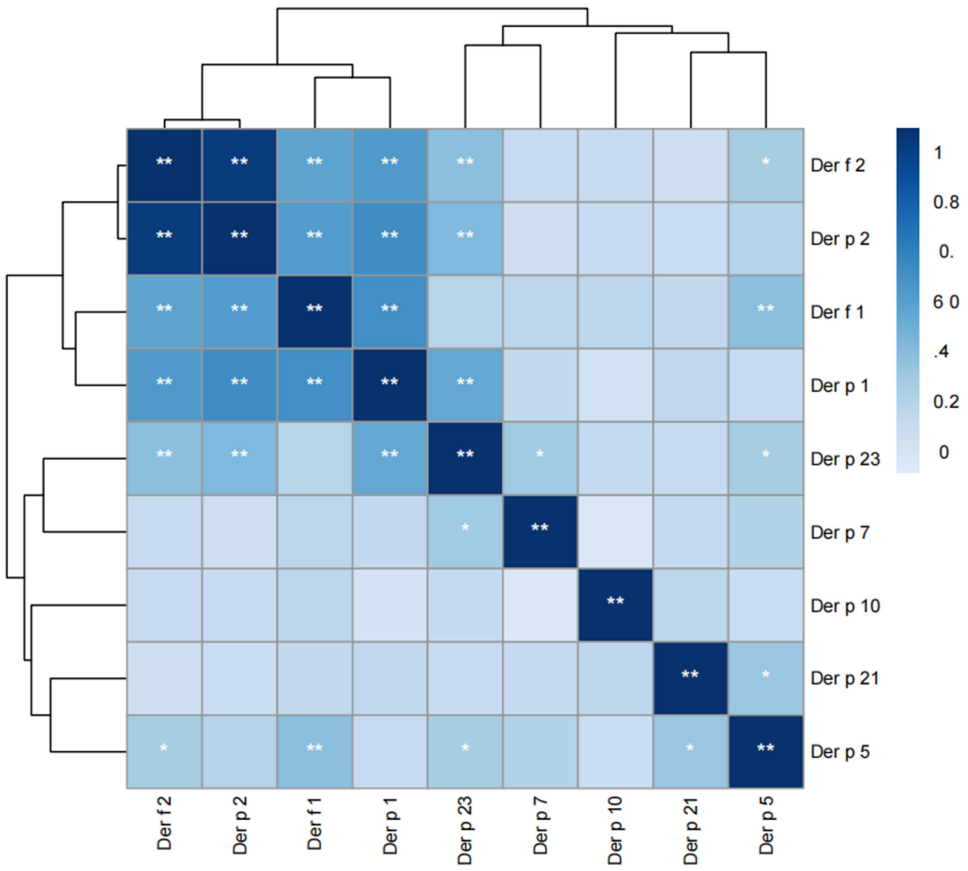

Figure 4 Correlation matrix diagram of sIgE concentrations of HDM components. In the matrix diagram, blue represents a positive correlation in the sIgE concentrations of two allergens, and red represents a negative correlation. The deeper the color, the stronger the correlation. A Pearson correlation coefficient of 0.80–1.00 was considered a very strong correlation, 0.60–0.80 a strong correlation, 0.40–0.60 a moderate correlation, 0.20–0.40 a weak correlation, and 0.00–0.20 a negligible correlation. *p < 0.05; **p < 0.01.

p 7. A study on the Lithuanian population revealed that the sensitization rate for *Der p* 5 rose from 19.49% in children to 30.65% in adolescents, while the sensitization rate for *Der p* 7 increased from 16.41% to 17.74%,[35] indicating an age-related sensitization pattern consistent with our results. Therefore, when assessing allergen components in children of different age groups, age-specific characteristics should be carefully considered.

In our study, we observed a greater prevalence of AD in younger children, whereas older children tended to have concurrent asthma, which was in line with the atopic march.[36] The distinct roles of various HDM components in different allergic conditions provide a critical basis for targeted prevention and treatment approaches. Specifically, *Der p* 1, 2, 5, 7, 21, and 23, which are predominantly present in mite fecal matter, are airborne and can sensitize the respiratory tract, triggering elevated IgE responses.[30] Our findings indicate that while the sensitization rates for *Der p* 1, *Der f* 1, *Der p* 7, *Der p* 21, and *Der p* 23 all exhibited varying degrees of increase in respiratory allergic disorders, only *Der p* 2 and *Der f* 2 were significantly elevated in patients with these disorders, suggesting a potentially more prominent role for *Der p* 2 and *Der f* 2 in such conditions. Our results support the notion of a stronger association between *Der p* 2 and *Der f* 2 and allergic airway diseases.[20]

A recent study indicated a higher sensitization rate to *Der p* 5 and *Der p* 21 in patients with AD.[15] In our study, the sensitization rate of *Der p* 5 in children with AD was greater than that in those with respiratory allergies, although the difference was not statistically significant. This finding partially supports the potential role of *Der p* 5 in AD. However, the sensitization pattern for *Der p* 21 did not show a similar trend. The prevalence of *Der p* 10 sensitization was slightly greater in patients with skin allergies than in those with respiratory allergies, possibly due to its presence in HDMs and its potential to trigger AD through cross-reactivity with homologous food allergens. Unfortunately, we did not observe any significant correlation between the marked HDM components and the occurrence of AD. *Der p* 23 is a prominent allergenic component in this region, followed by *Der p* 1/*Der f* 1 and *Der p* 2/*Der f* 2. The sensitization rate to *Der p* 23

is notably greater in children with AA than in those without AA. Furthermore, in children with AR and AA, the sensitization rate of *Der p* 23 is significantly greater than that in AR patients without AA, suggesting its potential as a risk factor for AA development. Our research findings are consistent with various studies conducted both domestically and internationally. In northern and eastern China, *Der p* 23 contributes to the development of asthma, while reduced *Der p* 23 sIgE levels are indicative of enhanced asthma control.[10,20] The German Multicenter Allergy Study (MAS) cohort study in Germany found that *Der p* 23 sensitization peaks at age 13 in children and is a predictor of mite-associated AR and asthma.[37] In Italy, *Der p* 23 has been identified as a significant new component of HDM. 74% of HDM allergic patients exhibited IgE reactivity to *Der p* 23, which was associated with asthma occurrence, and severity of asthma based on IgE levels.[38] Therefore, for asthmatic children, identifying the key allergen *Der p* 23 can provide critical information for effective and personalized treatment of AA. In a recent study conducted in Eastern China, it was found that the concentrations of sIgE for *Der p* 2 and *Der f* 2 in children with AR combined with AA were significantly higher compared to those with AR alone.[39] However, we did not observe this phenomenon in our study, and this difference may be due to the different sample sizes. Furthermore, lipophilic allergens such as *Der p* 2, *Der p* 5, *Der p* 7, and *Der p* 21 have been linked to immediate allergic reactions and are closely associated with the onset of asthma.[30,40] However, due to limitations in sample size and population diversity, our study did not observe this phenomenon.

Our research revealed a wide range of significant positive correlations among various components of the HDMs. Specifically, we observed a strong correlation between *Der f* 2 and *Der p* 2, and moderate positive correlations between *Der p* 1 and *Der f* 1, *Der p* 2 and *Der f* 2, as well as between *Der f* 1 and both *Der p* 2 and *Der f* 2. Furthermore, moderate positive correlations were also found between *Der p* 5 and *Der p* 21. These correlations may be attributed to the similarity in amino acid sequences and structural homology among components, which play crucial roles in cross-reactivity. Therefore, considering these correlations is essential when conducting allergen testing to ensure the accuracy and reliability of the results. Interestingly, despite their high sequence homology (83%) and similar molecular weights (24 and 27 kDa), *Der p* 1 and *Der f* 1 exhibit a lower correlation than *Der p* 2 and *Der f* 2, as demonstrated in Tuten Dal et al's research.[33]

Research on the molecular sensitization of HDM components in children is limited, making this study valuable for understanding the characteristics of HDM allergen components in this region. However, several limitations should be noted. First, the age distribution of our research subjects may not be representative of all childhood stages, as serum samples were not collected from children under 3 years of age and only 10 samples were obtained from children aged 13–15 years, and the overall sample size is small, potentially introducing bias to our results. Second, the lack of data on mono-sensitizing components hinders our ability to investigate the impact of single versus multiple sensitizers on allergic diseases. Third, due to the retrospective nature of our analysis, there was a lack of assessment of the severity of the included patients, limiting our ability to explore the correlation between allergen component concentrations and disease severity.

Conclusion

In summary, understanding the sensitization patterns of HDM components is crucial for improving precise diagnosis, personalized treatment, and long-term management of allergic diseases in children. Our study has provided insights into the sensitization patterns and characteristics of HDM components in children in this region, highlighting the associations between HDM components and allergic diseases. *Der p* 1, *Der f* 1, *Der p* 2, *Der f* 2, and *Der f* 23 are identified as the primary allergens in this region, with *Der p* 2 and *Der f* 2 closely linked to respiratory allergies, and *Der p* 23 strongly associated with asthma development. Age-related sensitization patterns are observed for *Der p* 5, 7, and 23, and there are notable correlations among various allergen components. Future research will focus on investigating the detailed mechanisms of the effects of HDM components on allergic diseases, particularly in children of different age groups.

Abbreviations

AA, allergic asthma; AD, atopic dermatitis; AR, allergic rhinitis; CRD, component-resolved diagnosis; HDMs, house dust mites; sIgE, specific IgE.

Data Sharing Statement

All data are available from the corresponding author upon request.

Ethics Approval and Consent

The study protocol received approval from the Ethics Committee of Suzhou Hospital, Affiliated Hospital of Medical School, Nanjing University (IRB2024058), ensuring its compliance with the principles set forth in the Declaration of Helsinki.

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Author Contributions

All authors participated in the study design, data collection, and analysis, as well as in the statistical analysis. They were involved in drafting and revising the article, gave final approval for publication, and agreed on the journal to which the article was submitted. Furthermore, they agreed to be accountable for all aspects of the work.

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Disclosure

The author(s) report no conflicts of interest in this work.

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