Distribution of Allergens in Children with Different Atopic Disorders in Central Taiwan

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*Allergic disorders, including asthma, allergic rhinitis, and eczema, are the most common chronic childhood diseases. Exposure to house dust mites (HDMs) can exacerbate allergic disorders in sensitized individuals. The data for sensitization to HDMs and other frequent allergens amongst atopic children in Taiwan is limited. We studied 498 children (aged 2–16 years) with atopy in central Taiwan with CAP testing (Cationic Antimicrobial Protein system). Our results revealed a high prevalence of sensitization to Dermatophagoides pteronyssinus (Der p) (90.2%), Dermatophagoides farinae (Der f) (88.2%), Dermatophagoides microceras (Der m) (79.5%), and Blomia tropicalis (Blo t) (76.7%) amongst the children. In contrast to HDM, the sensitization rates for other aeroallergens including cockroaches, dog dander, cat dander, Aspergillus fumigatus, Candida albicans, Cladosporium herbarum, Penicillium notatum were not common among the study children. With respect to age, inhaled allergen sensitization predominated in older children, whereas the inverse occurred with food allergens. In addition, a relatively higher proportion of co-sensitization between Der m and the other three antigens, including Der p, Der f, Blo t was found. Our results suggest that HDMs, including Der p, Der f, Der m, and Blo t allergens, act as important inducers of symptoms in Taiwanese allergic children. (Acta Paediatr Tw 2006; **47**:127-34)*

Key words: atopic disorder, allergen, children

INTRODUCTION

Allergic disorders, including asthma, allergic rhinitis, and eczema, are the most common chronic childhood diseases, and their prevalence has been rising in developed and developing countries, including Taiwan.[1] The clinical significance of serum allergen-specific immunoglobulin E (IgE) in allergic disorders is recognized.[2] The presence of allergen-specific IgE antibody in the serum of a patient is highly predictive of the likelihood that the individual will exhibit immediate hypersensitivity upon exposure to the allergen. The determination of allergen-specific IgE antibodies, combined with total serum IgE, is a very sensitive first-order test for allergic disease. Skin prick tests (SPT) and serology tests (Cationic Antimicrobial Protein [CAP] system, Pharmacia, Sweden) are sensitive indicators of allergen-specific IgE antibodies. In addition, excellent correlation was revealed between skin prick tests and CAP testing in asthmatic children.[2,3]

Exposure to various environmental factors including allergens and nonspecific irritants are well-established risk factors for the development of allergies.[4] House dust mites (HDMs) are found in all houses.[5] Furthermore, the high temperature and high relative humidity of Taiwan optimize the growth conditions for HDMs.[6] Allergy to HDM is a hypersensitivity reaction to proteins excreted by dust mites. The protein enzyme irritates the respiratory passages, and aggravates atopic disorders in people who have a tendency toward atopy.[7] Previous studies have shown that *Dermatophagoides pteronyssinus* (Der p), *Dermatophagoides farinae* (Der f), and *Blomia tropicalis* (Blo t) were the most prevalent house dust mites and the principal etiologic agents of respiratory allergies,[8] while

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Dermatophagoides microceras (Der m) was rarely reported. In addition, the allergenicity of Der m has not previously been characterized, and some degree of cross-allergenicity may exist amongst Der m, Der p, and Der f.[9] Previously, Der m sensitivity in atopic children is described only in the Western countries,[10-13] but the distribution of Der m in the rest of the world has not been well documented. In addition, food allergies involve an abnormal response of the immune system to a particular food or food component. Exposure to food allergens was also demonstrated to elicit atopic symptoms.[14] Nonetheless, data on sensitization to frequent aeroallergens and food allergens amongst atopic children in Taiwan are limited. We designed a hospital-based study and conducted CAP testing to determine the distribution of serological sensitization to HDM and other aeroallergens and food allergens amongst atopic children in central Taiwan.

MATERIALS AND METHODS

Patients

In the current study, 498 children with atopic disorders were recruited as our study cases, and all participants agreed to be assessed. Participants included patients from the pediatric allergy and asthma outpatient clinic of Chung-Shan Medical University Hospital from January 2003 to December 2005. All of these patients with atopic disorders had histories of bronchial asthma (BA, n = 86), allergic rhinitis (AR, n = 104), eczema (AD, n = 45), bronchial asthma with allergic rhinitis (BA+AR, n = 148), bronchial asthma with eczema (BA+AD, n = 23), allergic rhinitis with eczema (AR+AD, n = 37), or bronchial asthma with allergic rhinitis and eczema (BA+AR+AD, n = 55), and all had positive IgE tests. The clinical diagnoses of asthma, allergic rhinitis, and eczema were made by a pediatrician and were based on clinical symptoms and pulmonary function testing (PFT) or SPT. Allergy was also defined as clinical expression of atopic disease.

Allergen testing, measurement of total IgE, and allergen-specific IgE

Venous blood was collected in vaccutainer tubes from all subjects, centrifuged, and the serum samples stored at –20°C until analysis. Serological sensitization to allergens was determined by CAP testing (Pharmacia) to given allergens in the panel, including aeroallergens such as Der p, Der f, Der m, Blo t, cockroaches, dog dander, cat dander, *Aspergillus fumigatus* (Asp), *Candida (Monilia) albicans*, *Cladosporium herbarum* (Clado), and *Penicillium notatum* (Pen) and food allergens such as egg white, milk, codfish, crab, shrimp, wheat, peanut, soybean, yeast, and melon. The CAP system is an immunoassay based on a cellulose polymer encased in a capsule and was performed in accordance with the manufacturer's instructions using reagents purchased from Pharmacia Corporation, Sweden. Briefly, fifty microliters of sera and standard were added to Immuno CAP and incubated for 30 min. After washing, 50 μL of enzyme (β-Galactosidase)-anti-IgE were added. After incubation for 150 min, each sample was washed, and 50 μL of development solution (0.01% 4-Methylumbelliferyl-β-D-galactoside with 0.05% Kathon CG) was added. Incubation for 10 min was followed by the addition of stop solution (4% Sodium carbonate). Fluorescent eluate from Immuno CAP was measured in FluoroCount 96 and was determined by comparing with the values from the standard curve.

Total IgE was also measured in serum using the CAP system. Results were expressed as kU/L. Elevated total IgE was defined as IgE > 200 kU/L in children older than 10 years. For younger children, the normal value of IgE was adjusted by age as follows: 3-years-olds, < 29.2 kU/L; 4-years-olds, < 90 kU/L; 5-years-olds, < 108 kU/L; 6-years-olds, < 126 kU/L; 7-years-olds, < 142 kU/L; 8-years-olds, < 160 kU/L; 9-years-olds, < 176 kU/L; 10-years-olds, < 192 kU/L; as described previously.[6] Similarly, allergen-specific IgE was measured in serum using the CAP system, which has six score classes: the 0 class includes all results < 0.35 kU/L, and the sixth class includes all results > 100 kU/L. Any level equal to or greater than class 1 (i.e., ≧0.35 kU/L) was considered positive for allergen-specific IgE, as a previously study reported.[15]

Statistical analysis

The prevalence rate of aeroallergens and food allergens in different atopic diseases was analyzed according to disease category. Demographic factors of age and gender were also analyzed by disease category. Furthermore, Kappa test and corresponding 95% confidence intervals (CI) were used to evaluate the concordance of tested allergens present by allergen-specific IgE amongst the atopic children.

RESULTS

A total of 498 atopic children (86 with bronchial asthma (BA), 104 with allergic rhinitis (AR), 45 with atopic dermatitis (AD), 148 with BA+AR, 23 with BA+AD, 37 with AR+AD, and 55 with BA+AR+AD) were recruited into the study. Distribution of atopic diseases according to age and gender are shown in Table 1. The mean age of atopic children was 9.4 years. Younger children were found in the atopic dermatitis

Table 1. Demographic Data of Studied Patients According to Age and Sex Group, and Mean Age and Total IgE Level in Different Categories of Atopic Diseases

	Number (%)	Mean (y)	Age			Gender			Mean total IgE
			2-6 y n (%)	7-11 y n (%)	12-16 y n (%)	Male n (%)	Female n (%)	Sex ratio	
Total	498 (100.0%)	9.4	144(28.9%)	180(36.2%)	174(35.9%)	261(52.4%)	237(47.6%)	1.10	423.36 ± 218.45
Bronchial asthma (BA)	86 (17.3%)	9.7	23(26.7%)	29(33.7%)	34(39.6%)	45(52.3%)	41(47.7%)	1.10	416.23 ± 213.36
Allergic rhinitis (AR)	104 (20.9%)	10.3	26(25.0%)	40(38.5%)	38(36.5%)	58(55.8%)	46(44.2%)	1.26	386.14 ± 201.24
Atopic dermatitis (AD)	45 (9.0%)	6.8	20(44.4%)	12(26.7%)	13(28.9%)	20(44.4%)	25(55.6%)	0.80	322.00 ± 182.06
BA+AR	148 (29.7%)	10.1	37(25.0%)	56(37.8%)	55(37.2%)	80(54.1%)	68(45.9%)	1.18	437.35 ± 223.33
BA+AD	23 (4.6%)	8.4	10(43.5%)	8(34.8%)	5(21.7%)	11(47.8%)	12(52.1%)	0.92	367.26 ± 158.70
AR+AD	37 (7.4%)	7.8	15(40.6%)	13(35.1%)	9(24.3%)	17(45.9%)	20(54.1%)	0.85	298.30 ± 177.24
BA+AR+AD	55 (11.0%)	8.3	13(23.6%)	22(40.0%)	20(36.4%)	30(54.5%)	25(45.5%)	1.20	519.85 ± 221.21

group. We also observed rises in sensitization rates to allergens with increasing age for the bronchial asthma group. Both the gender and the total IgE levels showed no significant difference among the different groups of atopic children.

Respiratory allergies (BA, AR, and BA+AR) were the most prevalent atopic diseases (67.9%) for all age groups. The relationship of sensitization to each allergen by different age groups is shown in Table 2. The presence of allergen-specific IgE to inhaled and/or food allergens was variable among atopic children with different age. Based on the detection of allergen-specific IgE by CAP testing, the seroprevalence rates of four types of HDM, including Der p (90.2%), Der f (88.2%), Der m (79.5%), and Blo t (76.7%), were found to be more predominant in atopic children of all age groups. We also found that atopic children 7–16 years of age were highly allergic to multiple aeroallergens, especially to HDM allergens. However, less than 22% of atopic children tested positive for the corresponding allergen-induced specific IgE from other aeroallergens such as cockroach, dog dander, cat dander, *Aspergillus fumigatus*, *Candida albicans*, *Penicillium notatum*, or *Cladosporium herbarum*. Lower positive prevalence (< 12%) was also detected for food allergens including shrimp, crab, milk, egg white, peanut, wheat, soybean, codfish, yeast, and melon. Comparing the aeroallergen and food allergen groups, we found that sensitization to food allergens predominated among the younger age groups (2–6 years) and sensitization to inhaled allergens predominated in older age groups (7–16 years). Significantly lower rates of sensitization to mold allergens were observed among atopic children.

Frequencies of response to aeroallergens and food allergens by different atopic diseases are shown in Table 3. Children with respiratory allergies (BA, AR, and BA+AR) had a greater frequency of positive responses to inhalant allergens. The rate of sensitization to HDMs was much higher than those of other allergens, especially in children with BA, AR, BA+AR, AR+AD, and BA+AR+AD. About 18.2% to 25.0% of those with respiratory allergies were also sensitized to cockroaches in our study. Of the animal allergens, sensitization to dog dander was significantly higher than to cat dander. Nevertheless, 9.3% to 11.6% of those with respiratory allergies were sensitized to shrimp, crab, and milk; high

Table 2. Positive Prevalence of Various Allergen-Specific IgE Levels in Children with Atopic Disorders Stratified by Age

Allergens	Age groups			
	2–6 y n = 144	7–11 y n = 180	12–16 y n = 174	All n = 498
Aeroallergens				
Dermatophagoides pteronyssinus (Der p)	122 (84.7%)	167 (92.8%)	160 (92.0%)	449 (90.2%)
Dermatophagoides farinae (Der f)	118 (81.9%)	164 (91.1%)	157 (90.2%)	439 (88.2%)
Dermatophagoides microceras (Der m)	94 (65.3%)	156 (86.7%)	146 (83.9%)	396 (79.5%)
Blomia tropicalis (Blo t)	89 (61.8%)	152 (84.4%)	141 (81.0%)	382 (76.7%)
Cockroach	25 (17.4%)	36 (20.0%)	44 (25.3%)	105 (21.1%)
Dog dander	6 (4.2%)	17 (9.4%)	12 (6.9%)	35 (7.0%)
Cat dander	2 (1.4%)	4 (2.2%)	5 (2.9%)	11 (2.2%)
Aspergillus fumigatus (Asp)	3 (2.1%)	7 (3.9%)	7 (4.0%)	17 (3.4%)
Candida albicans	4 (2.8%)	5 (2.8%)	4 (2.3%)	13 (2.6%)
Penicillium notatum (Pen)	3 (2.1%)	6 (3.3%)	4 (2.3%)	13 (2.6%)
Cladosporium herbarum (Clado)	2 (1.4%)	3 (1.7%)	2 (1.1%)	7 (1.4%)
Food allergens				
Shrimp	14 (9.7%)	23 (12.7%)	20 (11.5%)	57 (11.4%)
Crab	15 (10.4%)	20 (11.1%)	15 (8.6%)	51 (10.2%)
Milk	19 (13.2%)	14 (7.8%)	13 (7.5%)	46 (9.2%)
Egg white	12 (8.3%)	10 (5.6%)	7 (4.0%)	29 (5.8%)
Peanut	6 (4.2%)	6 (3.3%)	4 (2.3%)	16 (3.2%)
Wheat	5 (3.5%)	5 (2.8%)	4 (2.3%)	14 (2.8%)
Soybean	5 (3.5%)	3 (1.7%)	2 (1.1%)	10 (2.0%)
Codfish	3 (2.1%)	2 (1.1%)	2 (1.1%)	7 (1.4%)
Yeast	2 (1.4%)	3 (1.7%)	2 (1.1%)	7 (1.4%)
Melon	2 (1.4%)	2 (1.1%)	1 (0.6%)	5 (1.0%)

Table 3. Positive Prevalence of Various Allergen-Specific IgE Levels in Children with Atopic Disorders Stratified by Disorder

Allergens	BA n = 86	AR n = 104	AD n = 45	BA+AR n = 148	BA+AD n = 23	AR+AD n = 37	BA+AR+AD n = 55
Aeroallergens							
Dermatophagoides pteronyssinus (Der p)	81 (94.2%)	98 (94.2%)	33 (73.3%)	135 (91.2%)	17 (73.9%)	33 (89.2%)	52 (94.5%)
Dermatophagoides farinae (Der f)	80 (93.0%)	96 (92.3%)	30 (66.7%)	135 (91.2%)	15 (65.2%)	32 (86.5%)	51 (92.7%)
Dermatophagoides microceras (Der m)	70 (81.4%)	86 (82.7%)	27 (60.0%)	123 (83.1%)	13 (56.5%)	31 (83.8%)	46 (83.6%)
Blomia tropicalis (Blo t)	69 (80.2%)	84 (80.8%)	28 (62.2%)	120 (81.1%)	12 (52.2%)	29 (78.4%)	40 (72.7%)
Cockroach	20 (23.3%)	26 (25.0%)	10 (22.2%)	27 (18.2%)	3 (13.0%)	7 (18.9%)	12 (21.8%)
Dog dander	7 (8.1%)	8 (7.7%)	3 (6.7%)	11 (7.4%)	0 (0.0%)	2 (5.4%)	4 (7.3%)
Cat dander	2 (2.3%)	3 (2.9%)	0 (0.0%)	4 (2.7%)	0 (0.0%)	0 (0.0%)	2 (3.6%)
Aspergillus fumigatus (Asp)	3 (3.5%)	4 (3.8%)	1 (2.2%)	5 (3.4%)	1 (4.3%)	1 (2.7%)	2 (3.6%)
Candida albicans	3 (3.5%)	4 (3.8%)	1 (2.2%)	3 (2.0%)	0 (0.0%)	1 (2.7%)	1 (1.8%)
Penicillium notatum (Pen)	2 (2.3%)	3 (2.9%)	1 (2.2%)	4 (2.7%)	1 (4.3%)	1 (2.7%)	1 (1.8%)
Cladosporium herbarum (Clado)	1 (1.2%)	2 (1.9%)	0 (0.0%)	2 (1.4%)	0 (0.0%)	1 (2.7%)	1 (1.8%)
Food allergens							
Shrimp	10 (11.6%)	12 (11.5%)	6 (13.3%)	16 (10.8%)	2 (8.7%)	4 (10.8%)	7 (12.7%)
Crab	8 (9.3%)	11 (10.6%)	6 (13.3%)	14 (9.5%)	2 (8.7%)	3 (8.1%)	7 (12.7%)
Milk	8 (9.3%)	10 (9.6%)	4 (8.9%)	14 (9.5%)	2 (8.7%)	3 (8.1%)	5 (9.1%)
Egg white	5 (5.8%)	6 (5.8%)	3 (6.7%)	9 (6.1%)	1 (4.3%)	2 (5.4%)	3 (5.5%)
Peanut	3 (3.5%)	4 (3.8%)	2 (4.4%)	4 (2.7%)	0 (0.0%)	1 (2.7%)	2 (3.6%)
Wheat	2 (2.3%)	3 (2.9%)	1 (2.2%)	5 (3.4%)	1 (4.3%)	1 (2.7%)	1 (1.8%)
Soybean	2 (2.3%)	2 (1.9%)	1 (2.2%)	3 (2.0%)	0 (0.0%)	1 (2.7%)	1 (1.8%)
Codfish	1 (1.2%)	2 (1.9%)	0 (0.0%)	3 (2.0%)	0 (0.0%)	0 (0.0%)	1 (1.8%)
Yeast	1 (1.2%)	2 (1.9%)	1 (2.2%)	2 (1.4%)	0 (0.0%)	0 (0.0%)	1 (1.8%)
Melon	1 (1.2%)	2 (1.9%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	1 (1.8%)

Abbreviations: BA, bronchial asthma; AR, allergic rhinitis; AD, atopic dermatitis.

Table 4. Correlation of Seroprevalence of Four House Dust Mites Detected by Allergen-Specific-IgE among Children with Atopic Disorders

Variables	*D. microceras* (Der m)		Probability of	Kappa-value
	Negative	Positive	concordance	(95% CI)
D. pteronyssinus (Der p)				
Positive	65	384	84.5%	0.412
Negative	37	12		(0.301-0.523)*
D. farinae (Der f)				
Positive	52	387	87.8%	0.554
Negative	50	9		(0.454-0.654)*
Blomia tropicalis (Blo t)				
Positive	53	329	75.9%	0.296
Negative	49	67		(0.198-0.394)*

*$P < 0.01$.

proportions (8.9%-13.3%) of sensitization to these three foods were also observed among those with atopic dermatitis.

Furthermore, we evaluated the concordance of tested allergens present by specific allergen-IgE among the 498 atopic children (see Table 4). The presence of Der m and Der p allergens (probability of concordance = 84.5%; Kappa = 0.412, 95% CI = 0.301-0.523) in children with allergy correlated significantly. The presence of Der m and Der f allergens (probability of concordance = 87.8%; Kappa = 0.554, 95% CI = 0.454-0.654); Der m and Blo t allergens (probability of concordance = 75.9%; Kappa = 0.296, 95% CI = 0.198-0.394) also correlated well. In addition, the correlations of the presence of Der p and Der f allergens (probability of concordance = 94.4%; Kappa = 0.710, 95% C. I. = 0.608-0.811), Der p and Blo t allergens (probability of concordance = 80.9%; Kappa = 0.332, 95% CI = 0.219-0.445), and Der f and Blo t allergens (probability of concordance = 79.7%; Kappa = 0.315, 95% CI = 0.206-0.424) in children with allergy also reach statistical significance, respectively (data not shown).

DISCUSSION

The natural history of allergic disease and its potential for prevention merit close examination because of the explosive worldwide increase in the prevalence and morbidity of atopic disorders. As reported, sensitization to allergens plays a crucial role in the development of atopic disorders in children. We found that our atopic children had high rates of sensitization to HDMs (Der p, Der f, Der m, and Blo t). The high sensitization to HDMs is a reflection of the persistence of mite exposure in the environment. Previous studies conducted in Taiwan showed that the HDM sensitization rates in northern and southern Taiwan were 83-87% for Der p, 82-85% for Der f, 84% for Der m, and 65-74% for Blo t.[16,17] CAP test results demonstrated that our atopic children also had high prevalence rates of sensitization to Der p, Der f, Der m, and Blo t. Exposure to high levels of house dust mite allergens is associated with increased morbidity in asthmatic children.[18,19] Interestingly, the prevalence rates of asthma were significantly lower in central Taiwan (6.7% in 1998 and 9.3% in 2001)[20] compared with southern (11%) and northern Taiwan (13%).[21] Because the climatic conditions of humidity and temperature and the rate of sensitization to HDM are all similar in the studies from these three regions of Taiwan, these factors do not appear to be able to explain the differences in asthma prevalence.

Individuals suffering from allergic diseases are commonly sensitized to multiple allergens. Our results also support the previously described phenomenon of multiple sensitization due to the presence of different mite species in the patients' dwellings or by the existence of cross-reactivity between species of within one family or between different mite families.[22] Previous studies have shown that Der p, Der f and Blo t were the most prevalent house dust mites and the principal etiologic agents of respiratory allergies,[8] while Der m was rarely reported. In addition, the allergenicity of Der m has not previously been characterized, and some degree of cross-allergenicity may exist among Der m, Der p, and Der f.[9] Der m sensitivity in atopic children is found mostly in the European countries such as Great Britian (80%),[11] Sweden (58%),[12] and the United States (31%),[13] but the distribution of Der m in the rest of the world has not been well documented. In our present study, 79.5% of atopic children were sensitized to Der m as determined by CAP testing, which is comparable to the frequencies reported in previous studies from European countries[10] such as England,[11] and is also similar to the result in a

previous study performed in Taiwan (84.0%).[16] Furthermore, Der m was also observed to be highly co-sensitized with Der p, Der f, and Blo t in our atopic children. Taken together, the result of our study suggested that Der m comprises many allergenic sources that might induce allergenic symptoms in atopic children in Taiwan. The isolation and sequence of the component should be further investigated so as to establish it as a good candidate for diagnostic antigen for the mite allergy.

In addition to house dust mites, a small proportion of atopic children are also sensitive to other inhaled allergens, such as cockroaches, animal dander, and fungus in this study. Sensitization to cockroaches is considered to be a strong risk factor for asthma in children of lower socioeconomic class or children living in the inner-city.[23] Previous study performed in northern Taiwan showed a rate of sensitization to cockroaches at 38.3%.[24] However, sensitization to cockroaches was lower (21.1%) in our study, which may be explained by less crowded living conditions in our population. Previously, studies also reported that rates of sensitization to dog dander at 10.1-26.3%, and cat dander at 4.2-10.0% in northern[24] and southern Taiwan.[25] However, the finding that the prevalence rates for dog (7.0%) and cat dander (2.2%) sensitivity in our study was lower may be explained by the lower popularity of raising pets in our study subjects. Sensitization to fungi was least prevalent among the aeroallergens tested in our study. *Aspergillus fumigatus* was the most predominant fungal allergen, followed by *Candida albicans* and *Cladosporium herbarum*. The specific IgE titers to fungi in our sample were lower; this might have been due to lower exposure to such allergens. Our data suggest that compared to HDMs, other non-mite allergens are less important allergens and play minor roles in causing allergic disease in Taiwan, as indicated by the comparatively low prevalence of sensitivity.

In our study, inhaled allergens (Der p, Der f, Der m, Blo t, and cockroach) also predominated in prevalence over food allergens (shrimp, crab, cow's milk, and egg white). The prevalence of food allergies was estimated at 1.0% to 11.4% and represented only a small proportion of all allergies among our atopic children. However, three food allergies, including shrimp, crab, and egg white, were common in children with atopic dermatitis. Furthermore, compared to older children, younger children (2–6 years) also had higher rates of sensitization to milk, egg white, peanuts, wheat, and soybeans. By comparison, food allergens are relatively rare triggers of acute asthma attacks. It is inhaled allergens (HDM, grass pollens, and animal dander) rather than food allergens that contribute to airway inflammation in asthma.

In this study, we also observed that specific IgE levels of aeroallergens increased substantially with increasing age, while specific IgE levels of food allergens decreased with increasing age. Aeroallergen sensitization (especially to HDM) was predominant in older children (7–16 years) (Table 2) and in those with clinical disorders of BA, AR, BA+AR and BA+AR+AD (Table 3). On the contrary, higher proportion of food allergy was observed in younger children (2–6 years). An explanation for higher allergen-specific IgE levels and delay in aeroallergen sensitization in older age children may be due to increased IgE synthesis related to frequent and insidious exposure of the airways to aeroallergens. Previous studies also report sharp increases in frequencies of allergic responses to aeroallergens after 3 years of age.[25,26] In our study, a high prevalence rate of sensitization to HDMs already existed in atopic children at the age of 2 to 6 years. Sensitization to HDMs among children may occur before the development of atopic disorders including asthma or rhinitis due to early exposure. De Blay et al.[27] also suggested that patients with positive *in vitro* test results for HDMs might not exhibit clinical manifestations if they do not experience sufficiently prolonged exposure in their environment. However, the subject number of our atopic children was small in this age group (2–6 years), because in clinical practice, it is often not possible to make a definitive diagnosis of asthma for very young children with proven sensitization to allergens.

Total IgE is often elevated in people with allergies, but it may be influenced by age, genetic predisposition, ethnicity, immune status, and some disease processes.[28] For these reasons, measuring total IgE levels has limited value as a screening test for allergic disease. On the contrary, serum-specific IgE reflects an individual's susceptibility to allergen sensitization, while assays for specific IgE antibodies to suspect allergens are of greater clinical use for etiological diagnoses.[28,29] There are some limitations associated with our study. As with all retrospective analyses, there may be a sample selection bias. We have attempted to minimize this weakness by applying strict clinical and laboratory inclusion criteria. Only patients with well-documented clinical symptoms of atopic disorders and a doctor's diagnosis confirmed by specialist examination were included in the analysis. However, a prospective assessment will be a better tool for evaluating the impact of HDMs sensitization and clinical outcomes in our atopic children population.

In conclusion, sensitivity to HDMs including Der p, Der f, Der m, and Blo t proved to be more important than sensitivity to other inhaled allergens and food allergens amongst atopic children in Taiwan.

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