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A Survey of Serum Specific-IgE to Common Allergens in Primary School Children of Taipei City

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SUMMARY Environmental factors and eating habits have had a significant impact on the increased sensitization to allergens in children. This study investigated changes in common allergen sensitivities among children in Taipei City, Taiwan. A total of 142 primary schools in Taipei City, which included 25,094 students aged 7-8 years, were surveyed using an ISAAC questionnaire to screen for allergies. For positive responders, serum allergen-specific IgE was confirmed using the Pharmacia CAP system. A total of 1,500 students (5.98%) had confirmed sensitivities to allergens. Dust mite sensitivity among these children was nearly 90%. The prevalences of sensitivities to *Dermatophagoides pteronyssinus*, *D. farinae* and *Blomia tropicalis* were 90.79%, 88.24%, and 84.63%, respectively. Dog dander (29.95%) was the second most common aeroallergen to induce sensitivity. Allergies to cat dander (8.69%) and to cockroach (15.48%) had decreased dramatically compared with previous analyses. Among the food allergens studied, the most common allergens that induced sensitization were (in order of prevalence) crab, milk, egg white, and shrimp (88.08%, 22.45%, 24.23%, and 21.44%, respectively). Mold and pollen sensitization was identified in fewer than 2% of the schoolchildren. Dust mites remain the most common allergen to induce allergic sensitization among children in Taipei City, while cockroach and mold sensitivities have dramatically declined. Food allergens should also be considered as a trigger of respiratory allergy. Except for dust mites, American cockroach and crab, allergens commonly reported to induce sensitization in other Asian counties are not common in Taiwan.

Children are the most often affected by respiratory allergies, primarily due to their exposures to indoor or outdoor aeroallergens. Primary or secondary prevention, in addition to the use of inhaled corticosteroids alone or combined with long-acting beta-agonists, are key treatment strategies. Counseling and educating children on avoiding allergens is also effective for those with non-atopic and atopic asthma.[1]

The increasing prevalence of respiratory allergic diseases and atopic dermatitis are supported by studies worldwide. These trends have been observed in different age groups in different populations during recent decades.[2,3] It is difficult to single out any one specific reason for this increasing prevalence. Although there is evidence that the major etiologic factors are atopic, it has also been hypothesized that environmental factors and lifestyles, rather than genetic causes, are responsible for this upward trend.[4] Moreover, increased specific immunoglobulin E (IgE) levels, together with a possible increase in IgE

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reactivity to major allergens or changes in tolerance, may have occurred over time.[5,6]

Spontaneous decreases in sensitivities to food allergens have been reported as children develop, which correlate with the increases with age of the percentages of those with high total serum IgE levels and contrasts with the progressive decreases of food-specific IgE levels reported from 4 to 6 years of age.[7] In Belgium, among patients with respiratory allergies, the frequency of birch pollen sensitization significantly increased from 13% to 34% within 16 years, which was not associated with an increase in environmental birch pollen counts.[8] It has been documented that most children with cow's milk and hen's egg allergies develop clinical tolerance over time. Shek *et al.*[9] reported that the rate of decrease in food allergen serum IgE levels over time could be used to predict the likelihood of developing tolerance to milk and egg allergy in children. In addition, as reported in one study, sensitization to food allergens is less common by the age of 6 years, whereas sensitization rates to inhalant allergens increases in children with a family history of atopy.[10] Overall, 29.7% of children with food allergy develop hypersensitivities to inhalant allergens. In 20.9% of children with food allergies, sensitivities to inhalants increase with age, so that the incidence of aeroallergen hypersensitivity rises to 31.4% by age 8 and to 56.4% by age 12. Thus, the incidence of food allergy decreases with age, but the incidence of inhalant allergy increases.[11]

However, cross-reactivity can be observed, as for instance between plane tree pollen and some vegetable-based foods. Specific immunotherapy with plane tree pollen has a positive impact on food allergy in plane-tree-pollen-allergic subjects.[12] Thus, there are strong associations between sensitization within allergen groups, as well as between groups where sensitization is suspected.[13] Increased sensitization to previously known allergens and the development of new allergens throughout the country may contribute to the increase in atopic conditions and may reflect the prevalence of specific IgE positivity to allergens.[14]

In order to evaluate current trends of allergen sensitivities in Taiwan, we screened a large cohort of primary school children in Taipei City.

MATERIALS AND METHODS

This study evaluated 24,095 students aged 7-8 years who were enrolled in 142 primary schools in Taipei City, Taiwan, from July 2007 to March 2008. The Institutional Review Board of the Taipei City Department of Health approved the study protocol. A CONSORT statement was given to each school's administrative staff that clearly explained the background of the project and the methods that would be used to follow all participants in the trial, from the time they were randomized until they left the study. Each student's parents or guardians provided informed consent.

The International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire was used to screen students for asthma, allergic rhinitis and atopic eczema. All allergic students were then tested for allergen-specific IgE antibodies using the Phadiatop (inhalant atopy screen; IBT Laboratories, Lenexa, KS, USA) and the Pharmacia CAP System™ radio-allergosorbent (RAST) test. The lower limit of detection and cut off point for RAST are 0.1 kU/l and 0.35 kU/l, respectively.

The Statistical Package for the Social Sciences (SPSS version 1.2™ for Windows™, SPSS, Inc., Chicago, IL, USA) computer software was used to generate histograms for the frequencies of allergen sensitization. A p value < 0.05 was considered statistically significant.

RESULTS

A total of 25,094 students aged 7-8 years participated in the ISAAC questionnaire screening, and 3,694 children (14.72%) were considered to have allergic diseases. After testing with the Phadiatop infant mixed allergen screening test, only 1,500 (5.98%) had confirmed allergen sensitivities. RAST tests were then used to identify allergen-specific IgE antibodies to specific allergens.

D. pteronyssinus, *D. farinae*, *B. tropicalis*, dog dander, German cockroach, crab, egg white, milk and shrimp were the 9 most common allergens identified that induced sensitization (Fig. 1). In both boys and girls, dust mite allergens most frequently induced sensitization. Aeroallergen sensitization fre-

quency, from most frequent to least frequent, was as follows: dust mites, dog dander, cockroach, cat dander, guinea pig epithelium, pigeon feathers, molds and pollens (Fig. 2). Interestingly, egg white- and milk-specific IgE antibodies remained high in the 7- and 8-year-olds. Among seafood allergens, crab and shrimp were the most frequently identified (83.08% and 21.44%, respectively) (Fig. 3).

With the exception of house dust mites, cockroaches and crab, there were significant differences in common allergens reported to induce sensitization in other Asian countries and in this study area. For instance, mollusks, feather, molds and yeast more commonly induce sensitization in other Asian countries.

DISCUSSION

Many epidemiologic studies have suggested an increased incidence of asthma in children in many different regions of the world, although the exact reasons remain unclear. Nevertheless, environmental factors operating during different developmental stages probably underlie this upward trend in asthma.[15,16] Moreover, it has been hypothesized that the recent increased prevalence of asthma may have partly been a consequence of changes in diet, and that childhood asthma may be influenced by maternal diets during pregnancy and by diets during early childhood.[17]

There is also a marked difference in the prevalence of new cases between urban and rural regions. One study proposed that asthma cases were disproportionately higher among inner city residents, particularly those from lower socio-economic groups, ethnic minorities and children.[18]Sensitization to environmental allergens is also an important risk factor for the development of asthma. Host-environment interactions must occur in order to target the chronic allergic inflammatory response in the lower airways, as not everyone who is allergically sensitized develops asthma.[19-21]

Environmental factors and lifestyles play critical roles in allergen sensitization and asthma development. Taiwan is a developing country and, in Taipei City, an industrialized and westernized lifestyle is being rapidly adopted. Thus, it is important to identify the specific and often differing combinations of poor housing conditions, outdoor air pollution and noxious land use that contribute to the high incidence of asthma in impoverished urban neighborhoods. Furthermore, in order to develop effective preventive interventions, it will be necessary

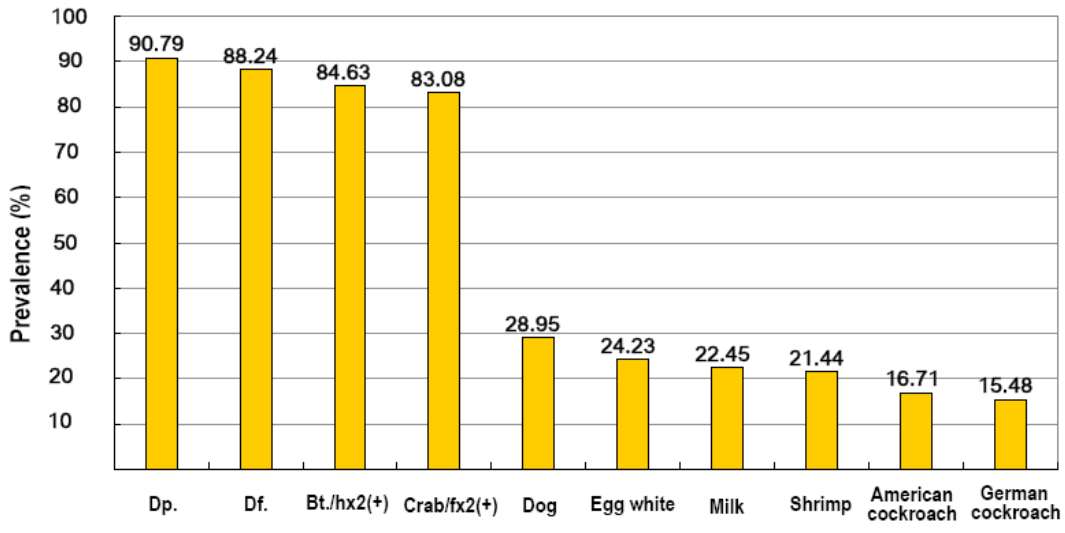

Fig. 1 Common allergens that induced sensitization in Taipei City primary school children. The prevalence rates of 3 species of dust mites ranged from 90.79% to 84.63%.

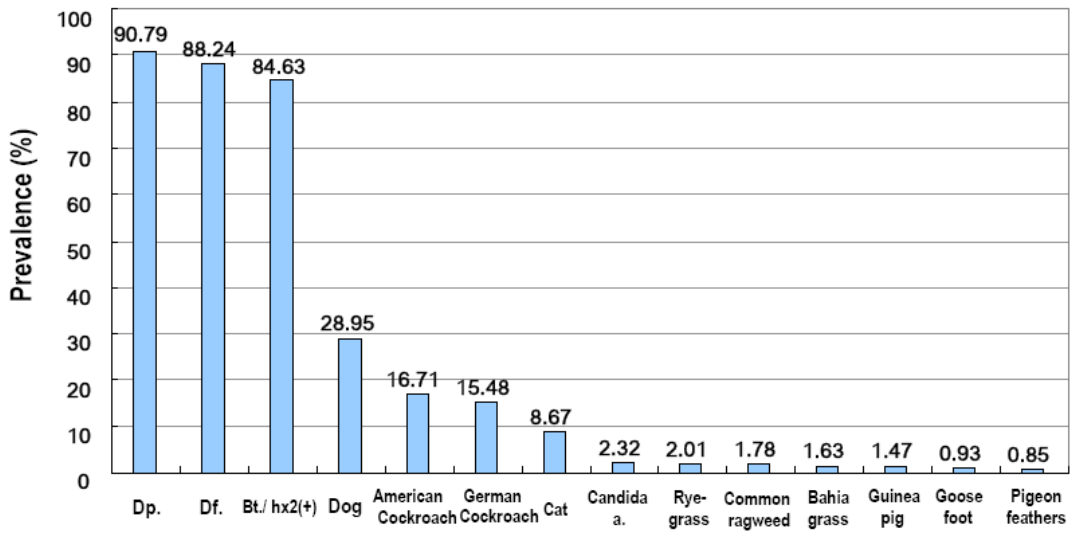

Fig. 2 Prevalence of aeroallergen sensitivities among children in this study. The 3 species of dust mites were the most common aeroallergens to induce sensitivities among the 7- to 8-year-olds, followed by dog dander.

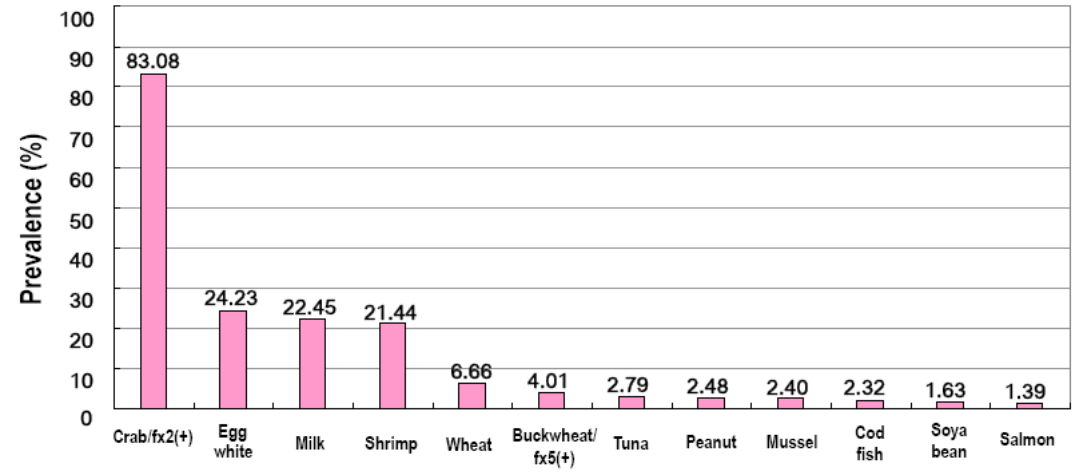

Fig. 3 Prevalence of food allergen sensitivities in this study group. The prevalence ranged from a high of 83.08% due to crab to 1.3% due to salmon. Unlike many other pediatric populations, peanuts were not among the most sensitizing allergen and had a prevalence of 2.48% in this study.

to gain a better understanding of the heterogeneous nature of the disease in early childhood, improved characterizations of relevant environmental exposures and long-term follow-up of birth cohorts with reliable and valid measures of allergy and asthma outcomes.

In the current study of 1,500 school children with allergic diseases, house dust mites were the major sensitizing allergens, with a prevalence of more than 90% (Fig. 1). This high incidence may be due to the fact that young children spend more than 90% of their time in the household environment where they

are exposed to dust mites. Damp dwellings increase the risk for house dust mite infestation, especially in subtropical zones like Taiwan. Moreover, building construction independently affects respiratory morbidity and sensitization, suggesting that not only does this construction worsen symptoms, but that it may also have a causal relationship with disease development.[22] *B. tropicalis* affected at least 84% of the students in this study and is another important source of dust mite allergen in Taiwan (Fig. 1).

Among inhaled aeroallergens that induced sensitization, the second most common was dog dander (29.95%). One study proposed that homes with many dogs and high levels of endotoxins may be conducive to reduced wheezing in infants.[23] However, growing evidence suggests a negative association between dog ownership and the development of atopic diseases in early childhood, and this relationship is only observed in families without a history of atopic disorders.[24] Thus, dog dander still plays an important role in children with a history of allergy. Interestingly, dogs and cats are the favored pets in Taipei City, although the incidence of sensitization to dog dander (29.95%) is much higher than to cat dander (8.69%) among school children.

A previous study conducted in northern Taiwan showed a 38.3% rate of sensitization to cockroaches. In the current survey, cockroach sensitivity prevalence dropped to 15.48%. This trend can be explained by modernization and improved sanitation in Taipei City. In Taiwan, more than 90% of cockroaches are German cockroaches, although the school children in the current study also showed sensitization to American cockroaches (16.71%). Thus, cross-reactions to allergens are highly suspected. Feathers, molds and pollen sensitizations affected fewer than 2% of the children, which indicate that allergic symptoms are not affected by inhaled aeroallergens alone (Fig. 1).

As for food allergens, crab and shrimp were the most frequent seafood allergens to induce sensitivities (83.08% and 21.44%, respectively). The prevalence of sensitization to other types of seafood was < 3%. Peanut sensitivity, a common pediatric allergen, had a prevalence of only 2.48% among the students in the current study. In contrast, wheat, a less frequently mentioned allergen among Chinese people, had a prevalence rate of 6.66%, and buckwheat, with a prevalence of 4.01%, showed an increasing prevalence. Sensitizations to cow's milk and egg whites (22.45% and 24.23%, respectively) remained high in school children aged 7- to 8-years (Fig. 2). In general, tolerance to milk and egg whites begins around 5- to 6-years of age,[26,27] which suggests that intolerance to certain foods at this age may be a risk factor for increased aeroallergen sensitivity.[13]

The common allergens inducing sensitization in neighboring countries, including India, Japan, Korea, Singapore, Malaysia, Thailand, China and in the city of Hong Kong, are mainly dust mites, cockroach, mouse, feather, house flies, mosquito, molds, yeast, crab, mollusks, buckwheat and latex.[28-38] However, except for dust mite, cockroach and crab, these were not common allergens inducing sensitization among the school children of this study. This points out that the risk of allergic symptoms and sensitization and their associations vary widely in different Asian countries.

In conclusion, the current survey shows that house dust mites (*D. pteronyssinus*, *D. farinae*, and *B. tropicalis)*, crab, dog dander, egg white, milk, shrimp and cockroach (German and American) are the common allergens that induce the manifestations of atopy in Taipei City school children (Fig. 3).

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