

A population-based questionnaire survey on the prevalence of peanut, tree nut, and shellfish allergy in 2 Asian populations

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Background: There has been a substantial increase in the prevalence of peanut and tree nut allergy in Western populations in the last 2 decades. However, there is an impression that peanut and tree nut allergy is relatively uncommon in Asia.

Objective: To evaluate the prevalence of peanut, tree nut, and shellfish allergy in schoolchildren in 2 Asian countries (Singapore and Philippines).

Methods: A structured written questionnaire was administered to local and expatriate Singapore (4-6 and 14-16 years old) and Philippine (14-16 years old) schoolchildren.

Results: A total of 25,692 schoolchildren responded to the survey (response rate, 74.2%). Of these, 23,425 responses fell within the study protocol's 4 to 6 and 14 to 16 year age groups and were included in the analysis. The prevalence of convincing peanut and tree nut allergy were similar in both local Singapore (4-6 years, 0.64%, 0.28%; 14-16 years, 0.47%, 0.3%, respectively) and Philippine (14-16, 0.43%, 0.33%, respectively) schoolchildren, but was higher in the Singapore expatriates (4-6 years, 1.29%, 1.12%; 14-16 years, both 1.21%, respectively; 4-6 years, expatriates vs local Singaporeans: peanut, $P = .019$; tree nut, $P = .0017$; 14-16 years, $P > .05$). Conversely, shellfish allergy was more common in the local Singapore (4-6 years, 1.19%; 14-16 years, 5.23%) and Philippine (14-16 years, 5.12%) schoolchildren compared with expatriate children (4-6 years, 0.55%; 14-16 years, 0.96%; $P < .001$). When data were pooled, respondents born in Western countries were at higher risk of peanut (adjusted odds ratios [95% CIs]: 4-6 years, 3.47 [1.35-8.93]; 14-16 years, 5.56 [1.74-17.76]) and tree nut allergy (adjusted odds ratios [95% CIs]: 4-6 years, 10.40 [1.61-67.36]; 14-16 years, 3.53 [1.00-12.43]) compared with those born in Asia.

Conclusion: This study substantiates the notion that peanut and tree nut allergy is relatively low in Asian children, and instead shellfish allergy predominates. Environmental factors that are yet to be defined are likely to contribute to these differences. (*J Allergy Clin Immunol* 2010;126:324-31.)

Key words: Peanut allergy, tree nut allergy, shellfish allergy, food allergy, anaphylaxis, epinephrine autoinjectors, Singapore, Philippines, Asia

In recent decades, the prevalence of food allergy, in particular peanut allergy, has increased at alarming rates in the Western world, with increases of peanut allergy at rates of up to 2-fold, with prevalence rates of more than 1% of the population by the early 2000s.¹ The prevalence of sensitization in 3-year-olds in the United Kingdom increased from 1.3% to 3.2% between 1989 and 1995,² and in the United States, peanut allergy had increased in young children from 0.4% to 0.8% between 1997 and 2002.³ The estimated prevalence of peanut allergy in Canadian children is 1.34%.⁴ Similar increases have been observed in Australia.⁵

Based on data from food anaphylaxis registries, peanut is also the most common food trigger of fatal anaphylaxis in these communities.^{6,7} There is a suggestion that this increase in prevalence is also accompanied by more severe allergic reactions as reflected by increasing trends in hospitalization.⁸ In addition, the increasing importance of food allergy is reflected by the later age at which tolerance to early childhood food allergens such as milk is developed.⁹ Although the epidemiology of shellfish allergy is less well documented, it is another common cause of food allergy. A US population survey reported a 2% prevalence for shellfish allergy,¹⁰ which is also a common cause of food-induced anaphylaxis in the United States¹⁰ and Europe.¹¹

Despite the growing peanut allergy epidemic in Western populations, there is an impression that the prevalence of peanut allergy in Asia is relatively low. This notion, however, has not been well documented formally with population-based studies. In contrast with peanut allergy, shellfish has been found to be one of the most common causes of food-induced anaphylaxis in several Asian populations,¹²⁻¹⁵ indicating that the pattern of food allergy may vary between populations. This study set out to evaluate on a population basis the prevalence of peanut, tree nut, and seafood allergy among schoolchildren in 2 Asian populations. This survey involved the use of a structured questionnaire that has established criteria for convincing allergy¹⁶ to provide accurate information on convincing allergy in the Singapore and Philippine populations. This study would provide important insights to the epidemiology of peanut allergy in Asia and therefore provide a global perspective on this common and potent food allergen.

METHODS

Survey methods

This was a cross-sectional study involving schoolchildren in 2 age groups, 4 to 6 years and 14 to 16 years, conducted in Singapore and Metro Manila, the Philippines (August 2007 to February 2008). The selection of schools was

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Abbreviation used

adjOR: Adjusted odds ratio

based on cluster sampling. Schools were sampled randomly from a list of preschools (Singapore only) and secondary schools in Singapore and Manila, Philippines. Preschoolers were not surveyed in the Philippines because of difficulty in accessing the subjects. For these study populations, 2 age groups of students were targeted: the children 4 to 6 years old (preschoolers) and 14 to 16 years old (high school). The age difference of about 10 years between the age groups was chosen to provide a means to evaluate the prevalence of food allergy in young and adolescent children.

In addition, 3 large expatriate/international schools out of the 13 schools in Singapore were invited to participate in this survey with the aim to provide some data on children born outside Asia. Children from the age groups 4 to 6 and 14 to 16 years were selected for evaluation and comparison with the local Singapore and Philippine schoolchildren. This study was approved by the National University of Singapore's ethics committee, the Department of Education, Philippines, and the Ministry of Education, Singapore.

Questionnaire

The survey was conducted by using a structured questionnaire that has been used in the US population.³ The questionnaire was conducted in 2 parts (Appendix 1, Online Repository). All students in the respective age groups from the selected schools responded to part 1 of the survey, in which data on demography, country of birth, and physician diagnosis of allergic disorders (asthma, eczema, and allergic rhinitis) were obtained. Questions pertaining to peanut, tree nut (almond, Brazil, cashew, hazelnut, macadamia, pecan, pine, pistachio, walnut), crustacean shellfish (prawns, crab, lobster, crayfish), and mollusk (squid, scallops, clams, oysters, mussels, snails) allergy were asked in separate questions. Part 1 of the survey was completed by the parents for children 4 to 6 years old and by the students 14 to 16 years old.

All respondents with a positive response to the presence of any of the specified food allergies proceeded to answer part 2 of the questionnaire, which was completed with the help of their parents. This section of the survey obtained information on specific symptoms of the food allergy to ascertain the presence of convincing immediate food allergy as previously developed by Sicherer et al.^{3,10} Reactions were considered convincing if the organ systems affected and symptoms were typical of those involved in allergic reactions (skin: hives and angioedema; respiratory system: trouble breathing, wheezing, and throat tightness; gastrointestinal system: vomiting and diarrhea) and occurred within 2 hours of ingestion. Although skin prick testing and food challenge are the ideal instruments for evaluating food allergy, this study involving a large number of subjects relied on this standardized questionnaire to indicate IgE-mediated food allergy.

The questionnaire was translated into the Chinese and Malay languages for parents who were not literate in English. No translation was required for the Philippines survey. The English questionnaire was used for all the students because this is the medium of teaching in Singapore and the Philippines.

Statistical power of study

We sought to accrue 12,000 children each from Singapore and the Philippines to enable us to estimate the prevalence of food allergy to within at least $\pm 0.06\%$ with a 95% CI, allowing for a low prevalence estimated at 0.1% or less for peanut allergy. These estimates were made after taking into account cluster sampling with a design effect of 1.14 as determined from the International Study of Allergies and Asthma survey conducted in Singapore.¹⁷

Statistical analysis

SUDAAN V10.0.1 (Research Triangle Institute, Research Triangle Park, NC) was applied for statistical analyses. Weighted prevalence rates, 95% CIs and comparisons between age groups and populations were calculated by using SUDAAN to account for the cluster sampling survey design and to

adjust for selection probability and nonresponse. Weights were calculated on the basis of the selection probability of schools in the 2 regions, Singapore and the Philippines, and the response probabilities (estimated using response rate at school level). A sampling design without replacement was chosen in estimation of prevalence.

For studying associated risk factors with food allergy conditions, weighted multiple logistic regression models were applied with adjustment for potential confounding factors: sex, ethnic group, country of birth, and comorbid conditions (asthma, allergic rhinitis, eczema, anaphylaxis and hives). A *P* value $< .05$ was considered statistically significant for all analyses.

RESULTS

Participation rate and demographic characteristics

The survey was sent to 34,628 subjects, and 25,692 responded (response rate, 74.2%). Of these, 23,425 responses fell within the study protocol's age groups of 4 to 6 and 14 to 16 years and were included in the analysis. The details of the number of subjects surveyed and the demographics of each age group and country are summarized in Fig 1 and Table I.

Reported prevalence rates of peanut, tree nut, and shellfish allergy

Table II summarizes the prevalence of peanut, tree nut, and shellfish allergy in the 2 age groups (4-6 years, 14-16 years) of the 3 categories (Singapore schools, Singapore expatriate schools, Philippine schools) of students surveyed. In all groups, the prevalence of self-reported allergy for all groups was higher than that of convincing allergy symptoms.

The prevalence of convincing peanut allergy and tree nuts was very similar for Singapore (peanut 0.47%; tree nuts 0.30%) and the Philippines (peanut 0.43%; tree nuts 0.33%) in the children 14 to 16 years old, and only slightly higher for peanut allergy in Singapore children 4 to 6 years old (peanut 0.64%; tree nuts 0.28%). In contrast, the prevalence of convincing shellfish allergy was higher than peanut and tree nut allergy, and remarkably similar in both Singapore (5.2%) and Philippine (5.1%) children 14 to 16 years old ($P = .850$), but lower in the Singapore children 4 to 6 years old (1.2%) compared with Singapore children 14 to 16 years old ($P < .001$). The types of shellfish reported to cause allergic symptoms, in decreasing order of frequency, were shrimp, crab, squid, mussels, lobster, clams, oysters, snails, scallops, and crayfish. For tree nuts, they were cashew, hazel, almond, walnuts, macadamia, pistachio, pecan, pine, and Brazil nuts, also in decreasing order of frequency.

On the contrary, the Singapore expatriate population showed a reverse pattern compared with that seen in the Asian schoolchildren in that the prevalence of convincing peanut (4-6 years, 1.29%; 14-16 years, 1.21%) and tree nut allergy (4-6 years, 1.12%; 14-16 years, 1.21%) was higher than that of shellfish in the children 4 to 6 years old (0.55%; $P = .096$) and 14 to 16 years old (0.96%; $P = .316$), although these differences were not statistically significant.

Influence of demographic factors on prevalence of peanut, tree nut, and shellfish allergy

To evaluate the influence of demographic factors, country of birth, and a history of other allergic disease, the data were pooled and analyzed by using weighted multiple logistic regression models. The data are summarized in Table III. The results showed

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