

# Prevalence and distribution of sensitization to foods in the European Community Respiratory Health Survey: a EuroPrevall analysis

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## Keywords

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## Abstract

**Background:** Reports of adverse reactions to foods are increasing, but there is limited information on the comparative prevalence of sensitization to food allergens using standardized methods.

**Methods:** Sera from the 'random sample' of young adults seen during the second phase of the European Community Respiratory Health Survey were analysed for IgE against 24 foods using ImmunoCAP. Sera were tested on five food mixes, and subsequently on individual foods in each positive mix.

**Results:** Sera from 4522 individuals living in 13 countries were tested for at least one food allergen mix. Prevalence of sensitization to any of the 24 food allergens ranged from 24.6% in Portland (USA) to 7.7% in Reykjavik (Iceland). With few exceptions, the relative prevalence of sensitization to different foods was similar in all countries. Sensitization rates to egg, fish and milk were each less than 1%, and the most common sensitizations are not represented in current commercial mixes. The prevalence of sensitization to foods was not related to that of sensitization to aeroallergens but was related to the geometric mean total IgE for the country.

**Conclusions:** Sensitization to foods is common but highly variable. The relative prevalence of sensitization to different foods is more consistent than would be expected by chance, suggesting that quantity of consumption of specific foods does not determine prevalence. The aetiology of food sensitization is only partly similar to that for aeroallergens but is related to local levels of total IgE. This may provide an important clue to the origins of food sensitization.

A substantial proportion of the population in Europe reports adverse reactions to food. In the centres included in the European Community Respiratory Health Survey (ECRHS), 19% of the population reported 'illness or trouble' caused by eating particular foods, and 12.2% reported that they nearly always experienced this illness following ingestion of particular foods (1). There were significant differences between the countries ranging from just over 4% in Spain to 18% in Sweden and 19% in Australia.

Relatively, few of these complaints represent true IgE-mediated responses, and there is limited information on the prevalence and distribution of sensitization to foods. Recent reviews of the literature (2, 3) have provided very heterogeneous results, but the conditions under which these studies have been undertaken are rarely standardized, and

cross-site comparisons are confounded by many other differences between the studies. Nevertheless, sensitization to foods may be quite common and appears to be increasing (4) as is true of sensitization to airborne allergens (5, 6). In the United Kingdom, at least, reports of hospital admissions with food allergy and anaphylaxis, which is often associated with food allergy, are also increasing (7). In an earlier analysis from four Scandinavian centres taking part in the ECRHS, there were limited data available on IgE to foods (8, 9), and in a similar study from Melbourne, there has been analysis of a few skin prick tests to common allergens including foods (10). The commonest sensitizers, among those tested for in these areas, were peanut, wheat and soya bean. There was relatively poor association between complaints and specific IgE or positive skin prick tests against the implicated food,

although this discrepancy is not unique to food-associated allergens.

As part of the EuroPrevall integrated project on food allergy, we now report on the distribution of sensitization to 24 foods in the ECRHS cohort.

## Methods

### Sampling

The ECRHS is described more fully elsewhere (11, 12). Briefly, in 1991–1992, collaborating centres undertook a screening survey of 3000 adults aged 20–44 in defined areas with populations of at least 150 000. These areas were mostly in Western Europe. Of those who replied to this questionnaire, a random sample of 600 subjects was invited to more extensive investigation that included questions on adverse effects from food, lung function testing, skin tests to common airborne allergens and serum collection for assessment of total IgE and some specific IgE. A further symptomatic sample from the initial survey was also assessed in the same way but is not part of this analysis. Around the year 2000, a follow-up study was conducted on those who had been part of the more extensively analysed population (ECRHS II). On this occasion, the same questions on food intolerance were asked, and serum was also collected for IgE testing. During ECRHS I, skin testing was undertaken using Phazets (Pharmacia, Uppsala, Sweden) coated with lyophilized antigens including birch. Those responding with a wheal greater than the negative control were deemed positive (13, 14).

The research protocol was approved by the relevant ethics committees, and all participants gave written informed consent.

### Serology

Blood samples were collected on each occasion into gel separator tubes, left to coagulate either for 3–6 h at room temperature or overnight at 4°C. The blood was centrifuged at 2500–3000 rpm for 10–15 min, and the serum aliquoted into 2-ml polypropylene tubes (Sarstedt, Nümbrecht, Germany). Samples were stored at –20°C. Samples were originally analysed for five allergens, timothy grass, *Dermatophagoides pteronyssinus*, cat, *Cladosporium herbarum* and a local allergen that was either birch, *Parietaria judaica* or ragweed and for total IgE using ImmunoCAP (15). The samples analysed in this study are the residual samples from the second survey and were shipped to Manchester for analysis in an ImmunoCAP 250 immunoassay instrument (Phadia, Uppsala, Sweden). Because the timing and follow-up were slightly different in each centre, we confined the analysis to samples collected from subjects less than 40 years of age at the initial survey to ensure comparability between centres. The samples were first screened using five allergen mixes, three of which were prepared specifically for the study by Phadia. When mixes were positive ( $\geq 0.35$  kU<sub>A</sub>/l of specific IgE), the individual foods were tested separately. These in turn were reported positive if the specific IgE was  $\geq 0.35$  kU<sub>A</sub>/l.

### Analysis

To assess the prevalence of sensitization to foods in the different centres, we needed to assess the possible effects of missing data. To have serum samples available, the patients had to have responded to the detailed survey in 1991–1992, and to the second survey in 2000, and to have agreed to have a blood sample taken. As in all surveys, there was a possibility of ‘volunteer bias’ affecting our estimates of prevalence, and we noted that attendance at the clinical examination was associated with a higher prevalence of symptoms recorded on the screening questionnaire – in particular with nasal allergies. Of those tested for at least one mix, 25.3% had nasal symptoms, compared with 23.1% of those screened at the same centres, suggesting that those with nasal symptoms had a slightly greater chance of having serology. The sample tested was also slightly older than the screened sample (56.7% aged 30 or more compared with 50.8%). To estimate the proportion at each centre who were positive to a mix, we applied sampling weights to give an estimate appropriate to a population divided evenly over the two sexes and two age groups (<30 and  $\geq 30$  years), and with a prevalence of nasal symptoms for each combination of sex and age group as found in the screening survey. Data were also missing if there was an insufficient quantity of serum. As these were the residual samples from the initial serological analyses, amounts varied, and some samples were exhausted by the initial screening against the five mixes. We were not able to test for all the individual food allergens in 25% of those positive to fx5 (cow’s milk, egg white, fish, soya bean, peanut and wheat); 33% of those positive to fx6 (sesame, buckwheat, corn and rice); 26% of those positive to epcx1 (hazelnut, walnut, celery, tomato and carrot); 32% of those positive to epcx2 (mustard, shrimp, sunflower seed, poppy seed and lentil); and 41% of those positive to epcx3 (banana, kiwi, apple, peach and melon). Prevalences of sensitization to individual foods at each centre were therefore estimated as the proportion positive to the relevant mix multiplied by the proportion positive to each respective food (among those tested) in those positive to the mix. Where no subjects at a centre were tested for a food, the prevalence was not estimated at that centre. Country prevalence was determined by averaging over centres within that country, and overall prevalence was determined by averaging over all centres in the study.

Because the prevalence of sensitization to ‘any food’ is strongly influenced in some centres by the food with the highest prevalence, we ranked countries according to the prevalence of sensitization for each food and compared countries using their average rank. Two countries – Switzerland and Estonia – were excluded from this analysis, because at these centres, some foods were not tested in any subjects who were positive to the relevant mix, meaning that prevalence could not be estimated using the method described previously. We assessed the agreement between the countries’ ranks for different foods and the foods’ ranks in different countries using Kendall’s coefficient of concordance with a *P*-value from a Friedman test. We also compared the average rank of a country according to prevalence of food sensitization with

the prevalence of sensitization to aeroallergens and with the geometric mean of total IgE concentrations.

## Results

When we linked the serology results to the other data, 15 of the subjects were found to be from the nonrandomly selected 'symptomatic' sample and were excluded from further analysis to avoid bias in the estimates of prevalence. A further 17 were dropped as they fell into the wrong age group. Of the rest, 4494, 4456, 4291, 4278 and 4260 samples were screened for the five mixes of foods, respectively, with 4220 being tested for all five mixes. Table 1 shows the numbers tested at each centre. The age range of those tested for at least one mix was 20–39 years at each centre, with mean age ranging from 29.8 to 33.7 years.

Table 2 shows the prevalence of sensitization to each food by country. The allergens tended to be ranked in a similar order by different countries (Kendall's coefficient of concordance 0.65,  $P < 0.001$ ), and this is displayed graphically in Fig. 1 for the two countries that generally had the highest prevalences (Germany and Italy), the country in the middle (Australia) and the two countries with the lowest prevalences (Iceland and the United Kingdom). Note that the countries in Table 2 are ordered according to how they were typically ranked by allergens, but that this does not equate to the prevalence of sensitization to 'any food'. The USA, for instance, appears in the middle of the table, as it did not typically have a high prevalence of sensitization to individual foods, but it did have the highest prevalence of sensitization to any food. Table 2 also shows the effect of excluding all those with a positive response to birch pollen. Although some prevalence rates are greatly reduced, the rank order of the food allergens changes relatively little, peach, hazelnut, shrimp and wheat remaining the most common four.

Countries also tended to be ranked in a similar order by different allergens (Kendall's coefficient of concordance 0.45,  $P < 0.001$ ). However, there were obvious exceptions

(Table 2). The USA, which was typically ranked in the middle, had the highest relative prevalence of sensitization to hazelnut, cow's milk, peanut, soya and rice. In Sweden, with moderate to low prevalence of sensitization to most foods, there was a relatively high prevalence of sensitization to hazelnut and apple. Australia had a high prevalence of wheat sensitization. Table 3 gives the mean rank of each country according to the prevalences of the different allergens. This can be seen to be high in Germany, Italy and France and low in the Nordic countries, particularly Iceland, and also in the United Kingdom and Spain. Table 3 and Fig. 2 show the ecological association of sensitization to foods with (i) the geometric mean total IgE and (ii) sensitization to aeroallergens. Countries ranking highly on food sensitization had a high geometric mean total IgE (Spearman correlation 0.71,  $P = 0.015$ ), but there was no obvious relation with sensitization to aeroallergens (Spearman correlation 0.35,  $P = 0.28$ ).

## Discussion

This is the first study that has looked at a large multicountry sample to determine the prevalence of food sensitization. It has demonstrated a relatively high prevalence of sensitization to hazelnut, apple, peach and shrimp but a low prevalence of sensitization to fish, egg and milk in this young adult sample. Despite local variations in consumption of foods that people are sensitized to, there is more consistency in the prevalence of sensitization to different foods in each country than would be expected. Unexpectedly, countries with a high prevalence of sensitization to foods are not those with a high prevalence of sensitization to aeroallergens, but they do tend to have a higher total IgE.

There are challenges in interpreting data from samples that are incomplete for a variety of reasons; however, our assessment of the effects of differential testing shows that there is relatively little evidence of bias in the results reported from this source.

Interpretation of the results is complicated by the known cross-reactions between food allergens and aeroallergens from other sources. There is little evidence that such cross-reactions can explain these results. The commonest cross-reaction is that reported between birch pollen and foods such as hazelnut, peach and apple. Undoubtedly, this has some effect on the results reported here. Sweden and Norway, for instance, which have high prevalence of sensitization to birch, have a higher prevalence of sensitization to hazelnut and apple than would be predicted from their overall prevalence of sensitization to foods (Table 2). However, the effect is relatively small. When all birch allergic subjects are excluded from the population (Table 3), hazelnut and peach remain among the four most common food sensitizations and in Italy, where sensitization to birch is relatively rare, the prevalence of apple sensitization is still the third highest of the 11 countries studied.

For any form of sensitization, the main potential drivers can be broadly classified as genetic susceptibility, exposure to the allergen and exposure to other environmental factors that

**Table 1** Numbers of people tested with the food allergen mixes

| Country        | Tested for<br>at least one mix | Tested for<br>all five mixes |
|----------------|--------------------------------|------------------------------|
| Australia      | 220                            | 220                          |
| Belgium        | 323                            | 316                          |
| Estonia        | 137                            | 98                           |
| France         | 467                            | 450                          |
| Germany        | 372                            | 370                          |
| Iceland        | 326                            | 320                          |
| Italy          | 253                            | 248                          |
| Norway         | 415                            | 411                          |
| Spain          | 703                            | 659                          |
| Sweden         | 617                            | 602                          |
| Switzerland    | 208                            | 49                           |
| United Kingdom | 394                            | 391                          |
| USA            | 87                             | 86                           |
| Total          | 4522                           | 4220                         |

**Table 2** Prevalence of sensitization to different food allergens by country, and overall,\* also showing the effect on overall prevalence of excluding people with a positive skin test for birch pollen

|            | Germany (%) | Italy (%) | France (%) | Belgium (%) | USA (%) | Australia (%) | Spain (%) | Norway (%) | Sweden (%) | United Kingdom (%) | Centres with incomplete data |                 |             | Overall (%) | Overall, excluding birch positive (%) |
|------------|-------------|-----------|------------|-------------|---------|---------------|-----------|------------|------------|--------------------|------------------------------|-----------------|-------------|-------------|---------------------------------------|
|            |             |           |            |             |         |               |           |            |            |                    | Iceland (%)                  | Switzerland (%) | Estonia (%) |             |                                       |
| Fish       | 0.9         | 0.0       | 0.0        | 0.0         | 0.0     | 0.0           | 0.5       | 0.3        | 0.3        | 0.2                | 0.0                          | –               | 0.0         | 0.2         | 0.1                                   |
| Egg        | 0.3         | 0.0       | 0.1        | 0.6         | 0.0     | 0.5           | 0.3       | 1.5        | 0.5        | 0.5                | 0.4                          | –               | 0.0         | 0.4         | 0.2                                   |
| Cow's milk | 1.3         | 2.1       | 0.1        | 0.6         | 2.3     | 1.1           | 0.1       | 1.3        | 1.3        | 0.5                | 0.0                          | –               | 0.0         | 0.8         | 0.7                                   |
| Mustard    | 2.2         | 0.5       | 2.5        | 0.0         | 0.0     | 1.0           | 0.9       | 0.3        | 0.4        | 0.5                | 0.3                          | 0.0             | 0.0         | 0.9         | 0.8                                   |
| Melon      | 1.8         | 2.8       | 3.6        | 3.4         | 0.0     | 2.1           | 1.2       | 0.6        | 0.5        | 0.5                | 0.0                          | 0.0             | 0.0         | 1.6         | 1.0                                   |
| Poppy seed | 3.2         | 3.6       | 4.1        | 0.8         | 2.0     | 1.9           | 1.1       | 0.7        | 0.6        | 0.5                | 0.0                          | 0.0             | 0.0         | 1.8         | 1.4                                   |
| Soya       | 3.3         | 3.6       | 3.2        | 1.7         | 4.7     | 1.8           | 1.9       | 0.8        | 0.6        | 1.0                | 0.0                          | –               | 1.2         | 2.1         | 1.4                                   |
| Sunflower  | 3.7         | 2.1       | 4.8        | 2.0         | 2.0     | 1.9           | 1.9       | 1.3        | 1.2        | 1.5                | 0.0                          | 0.0             | 0.0         | 2.1         | 1.8                                   |
| Walnut     | 3.3         | 3.1       | 3.7        | 2.5         | 2.1     | 2.1           | 3.1       | 0.6        | 1.1        | 0.8                | 0.0                          | 0.0             | 0.0         | 2.2         | 1.8                                   |
| Banana     | 3.0         | 4.2       | 4.4        | 4.5         | 0.0     | 2.6           | 2.4       | 2.2        | 1.6        | 1.0                | 1.0                          | 0.0             | 0.0         | 2.5         | 2.4                                   |
| Peanut     | 4.2         | 3.6       | 3.0        | 2.0         | 9.3     | 3.0           | 1.9       | 0.8        | 1.0        | 1.5                | 1.2                          | –               | –           | 2.6         | 1.8                                   |
| Buckwheat  | 3.8         | 3.7       | 3.6        | 2.0         | 2.5     | 3.6           | 2.2       | 1.8        | 1.0        | 1.9                | 1.0                          | 9.7             | –           | 2.8         | 2.2                                   |
| Rice       | 3.8         | 4.7       | 3.9        | 1.7         | 4.9     | 2.3           | 3.0       | 1.1        | 0.8        | 1.9                | 0.3                          | 4.9             | –           | 2.9         | 2.2                                   |
| Tomato     | 5.6         | 4.5       | 3.8        | 3.7         | 4.2     | 4.1           | 3.5       | 1.6        | 1.8        | 2.7                | 0.8                          | 0.0             | –           | 3.3         | 2.3                                   |
| Corn       | 5.7         | 5.2       | 3.9        | 2.9         | 4.9     | 3.4           | 3.2       | 1.4        | 1.7        | 2.0                | 0.7                          | 3.2             | –           | 3.3         | 2.6                                   |
| Celery     | 8.6         | 6.5       | 4.3        | 4.6         | 4.2     | 2.1           | 1.0       | 2.9        | 4.0        | 1.4                | 0.0                          | 0.0             | –           | 3.5         | 1.8                                   |
| Kiwifruit  | 7.0         | 6.3       | 5.0        | 5.2         | 5.2     | 4.1           | 1.8       | 3.2        | 3.4        | 1.5                | 0.7                          | 0.0             | 0.0         | 3.6         | 2.7                                   |
| Carrot     | 7.7         | 6.2       | 4.4        | 4.3         | 2.1     | 3.1           | 1.7       | 3.5        | 3.1        | 1.7                | 0.0                          | 3.8             | 3.9         | 3.6         | 2.0                                   |
| Sesame     | 5.6         | 4.1       | 4.2        | 3.2         | 4.9     | 5.1           | 3.1       | 2.2        | 2.1        | 2.1                | 1.0                          | 9.7             | –           | 3.7         | 2.8                                   |
| Apple      | 10.3        | 5.7       | 4.7        | 7.0         | 1.7     | 2.6           | 2.2       | 5.4        | 5.1        | 1.8                | 0.0                          | 4.8             | 0.0         | 4.2         | 2.0                                   |
| Wheat      | 6.0         | 6.7       | 5.5        | 4.3         | 6.1     | 7.9           | 3.4       | 3.0        | 2.3        | 3.9                | 0.7                          | 7.3             | –           | 4.6         | 3.4                                   |
| Shrimp     | 4.4         | 10.2      | 7.0        | 5.1         | 0.0     | 2.4           | 4.9       | 6.3        | 4.8        | 6.2                | 2.8                          | 0.0             | –           | 5.4         | 5.2                                   |
| Peach      | 11.7        | 7.5       | 5.5        | 8.2         | 3.5     | 3.1           | 3.8       | 2.7        | 6.5        | 2.9                | 0.3                          | 9.6             | 0.0         | 5.4         | 2.8                                   |
| Hazelnut   | 14.7        | 7.7       | 5.0        | 6.0         | 14.9    | 4.1           | 2.6       | 12.8       | 11.8       | 4.9                | 0.4                          | 12.6            | 3.9         | 7.2         | 3.1                                   |
| Any food   | 21.8        | 21.9      | 14.1       | 16.8        | 24.6    | 15.4          | 11.1      | 21.7       | 17.2       | 14.5               | 7.7                          | –               | –           | 16.2        | 12.3                                  |

\*For each food, each country's prevalence is determined by averaging over centres within that country, and overall prevalence is determined by averaging over all centres in the study.

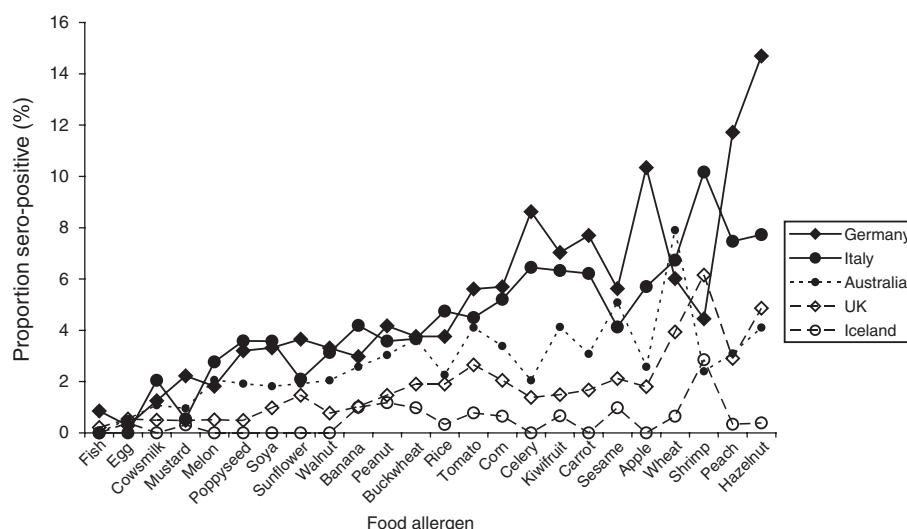


**Figure 1** Prevalence (%) of sensitization for different foods for the two countries with the highest prevalence (Germany and Italy) the

country with the median prevalence (Australia) and the two countries with the lowest prevalence (United Kingdom and Iceland).

make people more or less likely to become sensitized to a food that they are exposed to.

There is little evidence on the genetic determinants of sensitization to foods, although there have been some analyses (16). It is unlikely that these will have a major impact on local prevalence of disease. Risk ratios for individual polymorphisms are typically small, and although variation in genotypes between populations is well recognized, such variation would have to be large to have a major impact on local prevalence. In addition, the large increase in sensitization to common aeroallergens over the last 50 years (5, 6) suggests that the genotype of most populations is permissive of the sensitization of a large part of the population given conducive environmental circumstances.

**Table 3** Sensitization to foods, geometric mean total IgE and sensitization to aeroallergens (timothy grass, mite, cat, *Cladosporium* or local allergen), by country

| Country        | Mean rank<br>by sensitization<br>to individual foods | Geometric<br>mean<br>total IgE | Prevalence of<br>sensitization to<br>any of five<br>aeroallergens<br>% |
|----------------|------------------------------------------------------|--------------------------------|------------------------------------------------------------------------|
| Germany        | 9.3                                                  | 32.6                           | 37.3                                                                   |
| Italy          | 8.7                                                  | 45.0                           | 27.5                                                                   |
| France         | 7.9                                                  | 50.9                           | 33.1                                                                   |
| Belgium        | 6.8                                                  | 29.9                           | 35.9                                                                   |
| USA            | 6.5                                                  | 24.4                           | 43.4                                                                   |
| Australia      | 6.4                                                  | 38.8                           | 45.0                                                                   |
| Spain          | 5.2                                                  | 34.4                           | 28.7                                                                   |
| Norway         | 4.8                                                  | 27.4                           | 26.7                                                                   |
| Sweden         | 4.5                                                  | 23.1                           | 33.0                                                                   |
| United Kingdom | 4.2                                                  | 27.3                           | 36.7                                                                   |
| Iceland        | 1.6                                                  | 13.3                           | 23.6                                                                   |

The role of allergen exposure has been much less emphasized in recent years as it is clearly possible for large parts of the population to remain unsensitized in the presence of large quantities of allergen. The clearest example is presented by children brought up on farms with very high exposure to grass pollen allergens, who are nevertheless less likely to be sensitized to grass pollen (17). However, in those who are exposed, the allergens that people are sensitized to will be those that they are more likely to encounter, at least in moderate doses. In places where house dust mites are rare, such as most of Sweden, sensitization to house dust mites also tends to be rare. In the data reported here, there is a similarity in the rankings of the foods within each country that is greater than would be expected by chance ( $P < 0.001$ ). The exceptions to this are either in the very rare sensitizations, where the rankings are unreliable, or are potentially related to exposure and sensitization to pollen allergens that are known to cross-react with foods. This includes the relatively high prevalence of sensitization to hazelnut, and to a lesser extent apple, in Sweden, which may be related to sensitization to birch pollen and the high prevalence of sensitization to wheat in Australia which may be related to the high prevalence of rye grass pollen sensitization. Rye grass sensitivity was only tested in Australia. It was one of few local allergens that substantially altered the estimated prevalence of atopy (18). In Australia, if rye grass-sensitive participants were excluded, there were no wheat-sensitive subjects found. In a few cases, relatively high rankings of some sensitization rates may be attributed to greater exposure, such as the high ranking of sensitization to peanut, rice and soya in the USA. Without detailed information on exposure to different food allergens in the different places, this is difficult to clarify further.

The similarity in ranking for the different allergens in the different countries could indicate either that the relative expo-

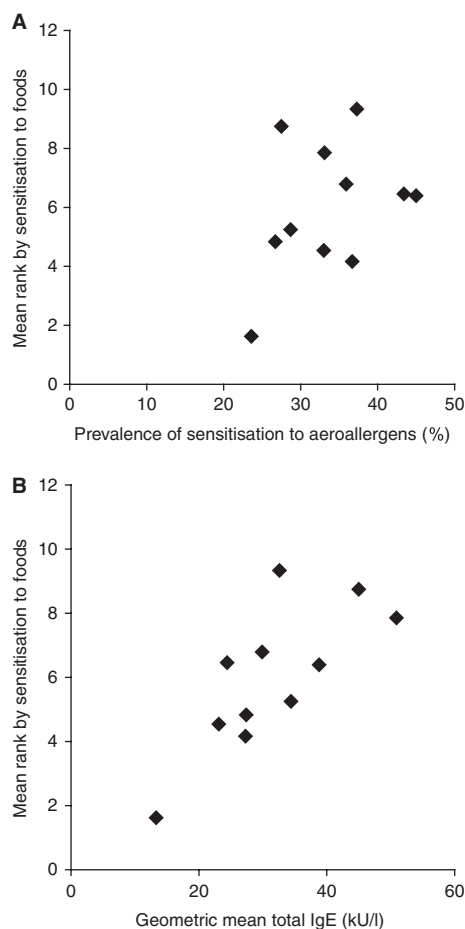


**Figure 2** Mean rank prevalence of sensitization to 24 food allergens by (A) prevalence (%) of sensitization in the local population to any of four allergens: *Dermatophagoides pteronyssinus*, cat, Timothy grass or *Cladosporium herbarum* and (B) geometric mean total IgE (kU/l) for the population.

sure to the different foods is similar in all these countries or that rates are determined by an underlying risk factor for sensitization to all foods, or even all allergens. As the prevalence of sensitivities to foods seems to be increasing along with sensitization to other aeroallergens, it would be reasonable to assume that there is a common environmental risk factor for sensitization to all allergens. Although this could still be true, the evidence from this study is that there are also important differences between the risks of sensitization to foods and the risks of sensitization to aeroallergens. There is no overall association between the prevalence of sensitization to these two groups of allergens and the countries with the highest prevalence of sensitization to foods, Germany, Italy and France all have a moderate or even low prevalence of aeroallergen sensitivity (15). Conversely, there is a strong association between the prevalence of food sensitization and the geometric mean total IgE for the country. This is not the case for aeroallergens. This suggests a common risk factor for raised total IgE and food sensitization. Although it could

be argued that the high total IgE was attributed to the high prevalence of food sensitization, the geometric mean total IgE in a country is still negatively correlated with the mean ranking on food sensitization when the food-sensitized subjects are excluded (Spearman rank correlation  $-0.65$ ,  $P = 0.029$ ).

Sensitization to foods is common in Western Europe, the USA and Australia. The most common sensitizations are to hazelnut, shrimp, peach and apple. The prevalence of sensitization to cow's milk, egg and fish, contrary to what is reported by patients, is very rare in this sample of young adults. Allergens tend to appear in a similar order in each place, although there are some important exceptions to this. Some of these exceptions could be explained by cross-reaction with pollen allergens, although some could relate to the probability of encountering the allergen. With the exception of some cross-reacting allergens, the prevalence of sensitization to foods is not related to that of sensitization to aeroallergens, and this may give a clue that their aetiology is at least partly separate. Unlike for aeroallergens, there is a relationship between sensitization to food and the geometric mean of the total IgE. The reason for this is unexplained.

#### Disclosure

All authors discussed the results and have read and approved the final version of the article. P Burney co-ordinated the ECRHS and drafted the paper. C Summers analysed the samples using ImmunoCAP tests designed by J Lidholm and R van Ree. S Chinn and R Hooper analysed the data.

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