

# Study of food allergy on Spanish population

M.I. Alvarado<sup>a</sup> and M. Pérez<sup>b</sup>

<sup>a</sup>Ciudad de Coria Hospital. Allergy Unit. Cáceres. Spain. <sup>b</sup>Infanta Cristina Hospital. Internal Medicine Department. Badajoz. Spain.

## ABSTRACT

**Background:** The aim of the study was to investigate the prevalence of food allergy in patients referred to our Allergy Unit and to evaluate the diagnostic methods used.

**Methods:** We selected 674 patients referred to the Allergy Unit of our hospital from May 2002 to October 2004. The prevalence of symptoms was determined by a standardized questionnaire, prick-prick test, and serum specific IgE. In a second phase, double-blind oral challenge tests were administered.

**Results:** Food allergy was found in 106 patients (15.7 %): 71 adults (67 %) and 35 children (33 %). The prevalence of food allergen sensitization was 14 % in adults and 20.8 % in children. A total of 89.6 % of the patients experienced symptoms immediately. Only 29.2 % the patients of sought medical attention and adrenaline was administered to five (16.1 %). The foods most frequently involved in allergic reactions were fruits (56.6 %) and tree nuts (22.6 %). The most common symptoms were oral allergy syndrome (46.2 %), urticaria (32.1 %), and anaphylaxis (14.2 %).

Combining the results of the questionnaire with those of prick-prick tests in patients whose allergy was confirmed by double-blind, placebo-controlled food challenge (9.1 %) showed a sensitivity of 95.5 %, a negative predictive value of 96 %, a specificity of 75 % and a positive predictive value of 73 %.

**Conclusions:** 1. The prevalence of food allergy in our sample was 9.1 %. 2. The foods most frequently involved in allergic reactions were fruits and tree nuts. 3. The most common symptoms were oral allergy syndrome, urticaria, and anaphylaxis. 4. Combining our questionnaire with *in vivo* tests allowed us to diagnose 75-96 % of patients with no food allergy and 95 % of food allergy patients.

**Key words:** Prevalence. Food allergy. Diagnosis. Challenge tests.

The European Academy of Allergy and Clinical Immunology (EAACI) defines the hypersensitivity food reactions according to the mechanisms which produce them. The food allergy is a disorder in which a little quantity of food induces an immunological reaction. Foods can provoke allergic reactions through several mechanisms. The most important and the one that has undergone more studies is the IgE mediated reaction type I since it can be life threatening. However, there are different immunological non-IgE mediated mechanisms such as the type IV retarded reactions. The food hypersensitivity reactions non-mediated immunologically (what used to be known as intolerance reactions) may be due to pharmacology, metabolic and toxic causes<sup>1</sup>.

There isn't patgnomonic clinical of food allergies. The most rateable element in the anamnesis is that the relation is close in time. The more frequent symptoms are urticaria and angioedema. Both, acute rhinitis and rhinorrea whether accompanied by conjunctivitis or not are often observed in challenges. It is estimated that foods provoke a third of the anaphylactic shocks

### Correspondence:

M.I. Alvarado Izquierdo, MD  
Ciudad de Coria Hospital  
Cervantes, 75. 10800 Coria. Cáceres. Spain  
E-mail: maralviz@yahoo.es.

Nowadays, the incidence and prevalence of allergic diseases is on the increase in industrial countries, specially those food allergies which present a high mortality rate and are life threatening. This is related to the deterioration of life-quality and to an increase in social and sanitary costs, and also to work and school absenteeism.

The usual diagnostic instruments are satisfactory only for class 1 food allergy in which the sensitization process occurs in the gastrointestinal tract. This kind of food allergy is rare in adults and one of the first manifestations in children. Class 2 food allergy is mainly seen in adults and develops as a consequence of an allergic sensitization to inhalant allergens, the majority of these proteins are difficult to extract and highly labile. Therefore, diagnostic setups using natural extracts for in vivo and in vitro assays are in many cases unsatisfactory<sup>2</sup>. The lack of reliable extracts makes us carry out challenges with the consequent waste of time and the possible risk for the patient undergoing the test. The challenge procedure is difficult to carry out since the food should be fresh and be taken immediately in the case of SAO. Nowadays the challenge procedures are not standardised and that is why it isn't possible to compare the results between different centres and different populations. There are no direct comparative studies in scientific protocols available in the literature that directly compares the various parameters: timing between two subsequent challenges or increment of the dose for the challenge. Moreover, these tests cannot be performed on all the individuals, there are certain types of patients who require standardized programmes and those tests must be adjusted according to the nature and severity of the reaction: atopic eczema dermatitis syndrome, patients with controversial symptoms often of subjective nature such as chronic fatigue syndrome, chronic urticaria, patients with isolated late reactions in the digestive system. On certain occasions it is not advisable to perform the test: patients with a clear case history of anaphylaxis, in patients with acute infection, seasonal allergy, chronic atopic disease, pregnant women and patients taking medication (antihistamines, neuroleptics, oral steroids, aspirins and other NSAIDs, ACE-inhibitors, beta-blockers). The challenge procedure requires trained personnel and adequate equipment, this method is expensive and dangerous<sup>3</sup>.

The present study investigates the prevalence of food allergy in children and adults referred to our Allergy unit and it evaluates the use of a new questionnaire and in vivo and in vitro tests for food allergy diagnosis: prick by prick tests and specific IgE determinations.

## METHODS

### Study design

We selected our study from 674 successive patients referred to the Allergy Service of our hospital from May 2002 till October 2004. There were 168 children aged 0-14 years and 506 adults aged > 15 years. The place subjected to the study was Coria and its smaller municipalities which include about 50,000 inhabitants; these belong to Cáceres a region in the southeast of Spain.

The prevalence of symptoms was determined by a questionnaire, in vivo and in vitro tests. In a second phase the patients with probability of food allergy underwent double-blind placebo controlled food challenge (DBPCFC).

### Adverse food reaction questionnaire

The questionnaire included questions about reactions to food, pulmonary symptoms, allergic illnesses and atopic family history. Other relevant information was gathered such as age, occupation, diagnosis by a physician, and other allergic illnesses. Participants were asked whether they had ever suffered from any trouble due to food ingestion and whether this response occurred always after eating the same food, what type of food was it, type and severity of reaction and treatment. Only those who responded positively to the questions were considered to have suffered an adverse food reaction.

### Skin prick tests (SPT)

SPT was performed on the flexor surface of the forearm with a standard range of extracts of food: milk, egg white, egg yolk, blue and white fish, crustaceans, molluscs, tree nuts, legumes, fruits and vegetables (Leti, Spain) and inhalant allergens (Alk-Abelló, Spain); the allergen panel consisted of *Dermatophagoides pteronyssinus*, rye grass, ragweed, birch and olive tree, *Alternaria*, cat and dog, positive (histamine) and negative controls. Wheals were measured after 15 minutes. A positive SPT result was defined as a wheal of 3 mm in diameter. SPT was performed by the prick-prick technique using offending fresh unprocessed food (s) mentioned in the history<sup>4</sup> (PPT).

### IgE-specific antibodies

Blood samples were drawn in case of probable food allergy by questionnaire and/or SPT positive.

The CAP system (Pharmacia, Spain) was the technique used<sup>4</sup>.

### Food Challenges (DBPCFC)

Patients who responded positively to the questionnaire and had SPT, PPT or/and IgE-specific antibodies positive were invited to realize a challenge with offending food (s).

The DBPCFC were performed according to EAACI guidelines<sup>3</sup>, in accordance with the NOE method<sup>5</sup>.

### Statistical Analyses

Descriptive statistics were calculated to assess the frequency of self-reported and confirmed food allergy. Statistical analyses were performed with the logistic regression so as to evaluate the predictive accuracy of the diagnosis tests of food allergy which are used into clinical practice. SPSS 11.0 was the statistical program used.

## RESULTS

### Patients characteristic

674 patients were enrolled in the study, 386 female (56.7 %), 288 male (42.3 %). 168 children aged 0-14 years and 506 adults aged 15 and above. Food allergy was the third pathology in our clinical practice (fig. 1). Estimate foods hypersensitivity was recorded in 106 patients (15.7 %), (52,8 females and 47.2 males), 71 adults and 35 children. The age range that presented the highest number of adverse reactions was from 15 to 20 years.

The prevalence of food allergen sensitization was 14 % in adult and 20.8 % in children population. The 89.6 % of patients experienced symptoms immediately. Only 29.2 % of people came up to the doctor and adrenaline was administered to 5 people (16.1 %). The principal foods involved in allergic reactions were: fruits (57.7 %), tree nuts (23.9 %) and crustaceans (12.7 %) in adults; and fruits (54.2 %), tree nuts (20 %), legumes (14.3 %) and fish (14.3 %) in children. The most common implicated symptoms were the oral allergy syndrome (46.2 %), urticaria (32.1 %) and anaphylaxis (14.2 %), table I. Anaphylaxis was most frequent in adults (12 patients, 16.9 %) that children (3 patients, 8.6 %), tree nuts were the most frequent foods eliciting an anaphylactic reaction, table II.

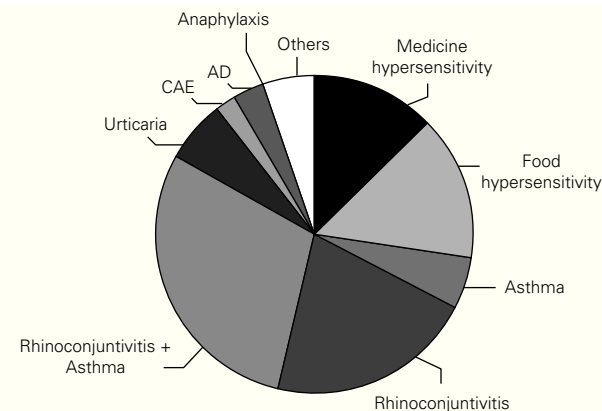


Figure 1.—Allergy pathology.

### Evaluation of diagnosis methods

Data were obtained from 674 subjects. 106 answered positively to the questionnaire. 72 out of the 106 presented prick-pricks and 59 specific IgE determinations were positive. We carried out 50 food challenges to 31 patients, 22 were positive; in 18 persons the food allergy was confirmed, we observed a food allergy prevalence of 9.1 %. We also carried out tests in vivo to 59 persons who responded negatively, 3 patients had positive prick-pricks. In the vivo tests, the results were: sensibility 96 %, specificity 62 %, positive predictive value 68 % and negative predictive value was 95 %. Nevertheless, when we combined the results of the questionnaire with the prick-prick tests in patients whose allergy was confirmed by DBPCFC, the sensibility was 95.5 %, NPV 96 %, specificity 75 % and PPV 73 %. In adults the specificity and PPV were 100 %, sensibility 89 % and NPV 91 %, while in children the sensibility and NPV were 100 %, but specificity and PPV were 61, we think that this reduction may be put down to a temporary allergy in children. The accuracy for in vitro test undergoing challenge was worse than prick-prick tests: sensibility 84 %, specificity 43 %, PPV 50 % and NPV 80 %.

We performed a regression logistic analysis (table III) and observed that the prick-prick tests were the only variable statistical significant in the accuracy of food allergy; so this allows us to make a correct estimate in 84.3 % of the cases (75.9 % negative and 95.5 % positive), table IV.

### Challenges safety

The persons who had suffered anaphylaxis by food didn't undergo the challenges according to the EAACI guidelines<sup>3</sup>. Only 1 person who suffered an anaphy-

**Table I**  
**Patients' characteristics**

	Children	Adults	Patients
Food allergy prevalence	35 (20.8 %)	71 (14 %)	106 (15.7 %)
Foods	Fruits (54.2 %) Tree nuts (20 %) Legumes (14.3 %) Fish (14.3 %)	Fruits (57.7 %) Tree nuts (23.9 %) Shellfish (12.7 %)	Fruits (56.6 %) Tree nuts (22.6 %)
Symptoms	OAS (45.7 %) Urticaria (34.3 %) Anaphylaxis (8.6 %) Digestives (8.6 %) Pulmonary (2.9 %)	OAS (46.5 %) Urticaria (31 %) Anaphylaxis (16.9 %) Digestives (4.2 %) Pulmonary (1.4 %)	OAS (46.2 %) Urticaria (32.1 %) Anaphylaxis (14.2 %) Digestives (5.7 %) Pulmonary (1.9 %)
Time (*)			
Immediately	31 (88.6 %)	64 (90.1 %)	95 (89.6 %)
15 a 30 min	1 (2.9 %)	2 (2.8 %)	2 (1.9 %)
30 min a 1 h	3 (8.6 %)	1 (1.4 %)	1 (0.9 %)
1 a 2 h		1 (1.4 %)	2 (1.9 %)
< 4 h		1 (1.4 %)	4 (3.8 %)
Treatment:			
Yes	8 (22.9 %)	23 (32.4 %)	31 (29.2 %)
No	27 (77.1 %)	48 (67.6 %)	75 (70.8 %)
Adrenaline	1	4	5 (16.1 %)

lactic shock when he was 1 year old produced by egg underwent prick-prick tests that were negative, and he experienced tolerance. Patients suffered skin symptoms with the challenges (urticaria, angioedema, OAS) only 1 subject experienced digestive symptoms. The reactions were cured immediately (> 1 hour) with antihistamines and corticoids, table V.

## DISCUSSION

Food allergy in Spain is an important pathology, 3.6 % of patients of allergologist consult have got some sensitization to some food. This disease is the fifth in the clinical practice. In our population it is the third cause for allergy consult.

Several groups have been investigated about food hypersensitivity and their results of perceived prevalence range from 12 to 20 %<sup>6-9</sup>. Bender et al find out a 33 % of subjects who avoided some foods because they caused "unpleasant physiological reactions"<sup>10</sup>. Burr and Merrett realized a questionnaire and adverse effects of some foods were reported by 19 % of men and 26 % of women<sup>11</sup>. In a study where parent's perceptions were used to examine the prevalence of food intolerance in their children, Rona and Chinn observed a 3 % of children who

were perceived as being food intolerant<sup>12</sup>. Björnsson et al carried out a standardized questionnaire and determined the prevalence of IgE sensitization to egg white, fish, wheat, peanut, soy and milk; they observed a frequency of food intolerance in 25 %<sup>13</sup>. The prevalence of probable IgE-mediated food reactions is rare in young adults (1.3 %), although 12 % of them perceived adverse food reactions<sup>14</sup>. When DBPCFC is used for diagnosis the prevalence in adult population is of 1-2.5 %<sup>6,7</sup>. Our study shows a perceived prevalence of food sensitization in 15.7 % of population, in children: 20.8 % and in adults: 14 %, patients between 15 to 20 years old are the more affected by this disease. Our results are in agreement with the rest of researches when we only deal with perceived prevalence but when we calculate real prevalence based on results of challenges, we get a 9.1 %, this percentage is higher than in other investigations such as Jansen et al who estimated a prevalence of 2.4 %<sup>6</sup>; Young observed by challenges to 8 foods: cow's milk, hen's egg, soy, wheat, citrus fruit, fish/shellfish a real prevalence of 1.4-1.8 %<sup>7</sup>. Kardinaal found out prevalence over 12 % in agreement with us<sup>15</sup>. These results are due to the fact that the population we study are subjects who came to the hospital and the other studies observed general population<sup>10-13</sup>, and on the other hand we didn't

**Table II**  
**Anaphylaxis**

Patients	Age	Sex	Time	Asthma	Foods*	Adrenaline	Anaphylaxis**
1	20-30	M	Immediately	No	Fruits Tree nuts Legumes	No	
2	< 15	F	Immediately	No	Egg	No	
3	< 15	F	Immediately	No	Legumes	No	
4	> 60	F	15-30 min	No	Vegetables: Potato	No	
5	15-20	F	Immediately	No	Fruit	No	
6	40-50	F	Immediately	No	Fish	Yes	
7	20-30	F	Immediately	Yes	Fruits: Melon, kiwi	No	
8	< 15	M	Immediately	Yes	Egg Legumes Fish	Yes	
9	20-30	M	30 min-1h	No	Tree nuts	No	
10	20-30	M	Immediately	Yes	Fruits Tree nuts	No	
11	15-20	F	Immediately	No	Tree nuts	Yes	
12	15-20	F	Immediately	Yes	Fruits: Melon, kiwi Tree nuts: Chestnut Vegetable: Tomato	No	
13	30-40	F	Immediately	No	Tree nut: Pistachio Seed Mushroom	No	Seed: camomile
14	> 60	F	Immediately	Yes	Sellfish: Shrimp Mollusk Clam	Yes	
15	15-20	M	Immediately	No	Tree nuts: Pistachio Sunflower seed	Yes	Pistachio

\*Foods which provoke allergy

\*\*Food which provoke anaphylaxis

choose the group of persons but other investigator's study did select the population<sup>10,12</sup>. We also performed challenges with foods that were harmful for the patients following Kardinaal, in this way, our investigations could get more prevalence of food allergy but the others use specific foods for challenges<sup>7,13,16</sup>, these studies could have lost food allergens and their prevalence is smallest.

We find out more frequency in females (52.8 %) than in males (50 %) according to other reports. Schafer performed a prevalence of 27.5 % in women and 14 % in men<sup>9</sup>. Altman looked after double prevalence in females rather than in males<sup>8</sup> and Emmett et al observed a prevalence of peanut allergy of 0.5 % in adults, more frequent in women, 79 females, 45 males<sup>17</sup>.

**Table III**  
**Predictor variables**

Variable	Value
Sex	1. Male 2. Female
Age	0. 15-20 years 1. 20-30 2. 30-40 3. 40-50 4. 50-60 5. > 60 6. < 15
Foods	0. Fruits 1. Tree-nuts 2. Legumes 3. Egg 4. Milk 5. Shellfish 6. Fish 7. Honey
Symptoms	1. Digestives 2. Anaphylaxis 3. Skin 4. OAS 5. Oculonasal 6. Pulmonary
Prick-pricks	1. Positive 0. Negative
Specific IgE	1. Positive 0. Negative

**Table IV**  
**Number and percentage of cases in the accuracy of food allergy for the prick-prick variable\***

Observed	Predicted		Right cases
	Negative challenge	Positive challenge	
Negative challenge	22	7	75.9 %
Positive challenge	1	21	95.5 %
			84.3 %

\*Cut value is .500.

The severe food reactions got the third place (14.2 %) in our patients clinic, these happened in 15 persons, 12 adults and 3 children, only 5 subjects received correct treatment (adrenaline), the tree nuts were the most frequent cause of anaphylaxis in adults, but the legumes and egg provoked it in chil-

dren. Nobody died, perhaps only 5 people have got asthma as a risk factor, most of them are young adults and there aren't differences between sexes. Our data are in agreement with other ones. Bock studied 32 patients who died from food allergy; the tree nuts and peanuts were the reason in 9.4 %; most with asthma and only 4 persons received treatment with adrenaline<sup>18</sup>. Yunginger also found out that tree nuts were the main cause of death from food allergy and as risk factors he observed asthma and the patients didn't receive adrenaline<sup>19</sup>. The Sampson studies observed tree nuts as the most important cause of anaphylaxis<sup>20</sup>.

### Diagnosis evaluation

We combined the results of the questionnaire with the prick-prick tests in patients whose allergy was confirmed by DBPCFC and observed the following data: sensibility 95,5 %, negative predictive value 96 %, specificity 75 % and positive predictive value 73 %. The accuracy for in vitro test undergoing challenge was worse than prick-prick tests: sensibility 84 %, specificity 43 %, positive predictive value 50 % and negative predictive value 80 %. Moneret-Vautrin in a revision about laboratory tests observed that only when IgE is > 6 kU/l (egg), > 15 kU/l (peanut), > 20kU/l (fish) and > 32 kU/L (milk) the PPV is over 95 %, in the rest the challenges are necessary<sup>21</sup>. A study analyzed in children the laboratory tests (ELISA method) alone or combining them with skin prick test and they didn't observe any advantage from food allergy diagnosis<sup>22</sup>. Norgaard et al found out that commercial extracts of milk and egg from specific IgE (RAST method) didn't have significant concordance with challenges that they performed in 19 adults<sup>23</sup>. Other investigators have studied if the diagnosis methods could predict the severe reactions and they have found out that it isn't possible<sup>24</sup>. We have demonstrated that in vitro tests (CAP system) don't predict allergy food according to the rest of studies, nevertheless in vivo test in combination with questionnaire is a good method, this is in contrast with different observations of other authors who find out high sensibility and NPV (95-100 %) but low specificity and PPV<sup>25</sup>. Ortolani et al in patients with hazelnut allergy, it was observed that skin prick tests have good sensibility (88 %) and PPV (94 %) but lower specificity and NPV<sup>26</sup>, the same happened when the prick tests are performed with carrot and celery<sup>27,28</sup>. Sampson observed that commercial extracts were good to predict of food allergy if they were negative, but the PPV were poor (0-79 %) and better standardization was necessary<sup>29</sup>. It's been demonstrated that



**Table V**  
**Challenges**

Patient	Age	Sex	Food	Symptoms	PPT	IgE	Challenge
1	24	M	Peach	Lips angioedema	—	—	—
2	30	M	Peach	AOS	+	+	AOS
3	49	F	Almond	AOS + Breadless	—	—	—
4	55	F	Sunflower Seed	Urticaria	—	—	—
5	55	F	Shrimp	Urticaria	—	—	—
			Clam	Urticaria	—	—	—
			Chestnut	Rash + angioedema	+	—	Angioedema
			Grape	Rash + angioedema	+	—	Angioedema
6	58	M	Clam	Angioedema + Breadless	+	+	Angioedema
7	50	M	Shrimp	Rash	+	+	Urticaria
8	16	M	Yolk egg	Rash	—	—	—
			White egg	Rash	—	+	—
			Anchovy	Rash	+	+	Urticaria
9	17	M	Yolk egg	Angioedema	—	—	—
			White egg	Angioedema	—	—	—
10	22	F	Tunna	Rash	—	—	—
11	17	F	Honey	Rash	+	+	Erithema
12	34	F	Prawn	Rhinoconjunctivitis + Breadless	—	—	Rhinoconjunctivitis
13	6	F	Shrimp	Rash	—	—	—
14	8	F	Yolk egg	Rash + Breadless	+	+	Vomit
			White egg	Urticaria + Breadless	+	+	Vomit
15	6	F	Yolk egg	Angioedema + Urticaria	—	—	—
			White egg	Angioedema + Urticaria	+	+	—
16	7	M	Yolk egg	Urticaria	+	+	—
			White egg	Urticaria	+	+	—
17	9	F	Yolk egg	Urticaria	—	+	—
			White egg	Urticaria	+	+	Urticaria
18	7	M	Lentil	Urticaria	—	+	—
19	8	M	Lentil	Urticaria	+	+	Urticaria
20	14	F	Lentil	Vomito +	+	+	—
			Pea	Abdominal pain	+	+	—
			Chik pea		+	+	—
21	8	M	Lentil	Urticaria	—	—	—
22	7	M	Lentil	Urticaria	—	+	—
			Tunna	Urticaria	—	+	—
23	12	M	White egg	Urticaria	—	+	—
			White fish	Urticaria	—	+	—
			Hake	Urticaria	+	+	Urticaria
			Codfish	Urticaria	+	+	Erithema
24	2	M	Milk	Angioedema + Vomito	+	+	Urticaria
25	3	F	Yolk egg	Urticaria	+	+	Urticaria
26	3	M	Yolk egg	Urticaria	+	—	Urticaria
27	9	F	Yok egg	Erithema	—	+	—
			White egg	Erithema	+	+	Erithema
28	4	F	yolk egg	Erithema	—	+	—
			White egg	Erithema	+	+	Erithema
29	11	F	Yolk egg	Anaphylaxis	—	—	—
			White egg	Anaphylaxis	+	+	—
30	14	M	Chik-pea	Angioedema	+	+	Angioedema
31	2	M	White egg	Vomito	+	+	Vomit

natural extracts have more sensibility than commercial extracts<sup>26,30</sup>. Pucar et al performed prick-prick tests with peanut in allergic patients who were provoked and observed that the challenges aren't necessary in patients with skin prick negatives<sup>31</sup>. In our study the accuracy of prick-prick test is better than in others, probably it must be because the majority of the observations were about vegetables extracts and we have studied all foods, also someone used commercial extracts and not natural ones, thus not making the results directly comparable. Also it could be interesting to check our results with more persons.

Although this is an unselected population there may be some bias in the estimate of prevalence of food allergy because the participants without history of foods reactions were obviated. Participants who were consulting about allergy pathology were studied and this could overestimate the prevalence of food allergy in this study.

To sum up, this study demonstrates a self-reported prevalence of food allergy in an unselected population of 14 % in adults and 20.8 % in children patients and confirmed food allergy in 9.1 %. The principal foods involved in allergic reactions were fruits and tree nuts. The most common symptoms were the oral allergy syndrome, urticaria and anaphylaxis and this was most frequent in adult patients. We also found out that the procedure consisting in combining our questionnaire with in vivo tests allowed us to diagnose an average of 75-96 % of patients with no food allergy and 95 % of food allergy patients. This method is an excellent alternative for clinical practice, at this moment, to the in vitro tests which are more expensive and time-consuming and can also be an alternative to the challenges that may turn out to be dangerous.

## REFERENCES

- Johansson S, Hurrice J, Bousquet J, Bruijnzeel-Koomen C, Dreborg S, Haahela T, et al. A revised nomenclature for allergy. Position paper. *Allergy*. 2001;56:813-24.
- Breiteneder H, Ebner Ch. Molecular and biochemical classification of plant-derived food allergens. *J Allergy Clin Immunol*. 2000;106:27-36.
- Bindslev-Jensen C, Ballmer-Weber B, Bengtsson U, Blanco C, Ebner C, Hourihane J, et al. Standardization of food challenges in patients with immediate reactions to foods-position paper from the European Academy of Allergology and Clinical Immunology. *Allergy*. 2004;59:690-7.
- The European Academy of Allergology and Clinical Immunology. Position paper. Allergen standardization and skin tests. The European Academy of Allergology and Clinical Immunology. *Allergy*. 1993;48:48-82.
- Noe D, Bartemucci L, Mariani N, Cantari D. Practical aspects of preparation of foods for double-blind, place. *Allergy*. 1998; 53 Suppl 46:75-7.
- Jansen JJ, Kardinaal AF, Huibers G, Vlieg-Boerstra BJ, Martens BP, Ockhuizen T. Prevalence of food allergy and intolerance in the adult Dutch population. *J Allergy Clin Immunol*. 1994;93:446-56.
- Young E, Stoneham MD, Petrukevitch A, Barton J, Rona R. A population study of food intolerance. *Lancet*. 1994;43: 1127-30.
- Altman DR, Chiaramonte LT. Public perception of food allergy. *J Allergy Clin Immunol*. 1996;97:1247-51.
- Schafer T, Bohler E, Ruhdorfer S, et al. Epidemiology of food allergy/food intolerance in adults: associations with other manifestations of atopy. *Allergy*. 2001;56:1172-9.
- Bender AE, Matthews DR. adverse reactions to foods. *Br J Nutr*. 1981;46(3):403-7.
- Burr ML, Merrett TG. Food intolerance. A community survey. *Br J Nutr*. 1983;49(2):217-9.
- Rona RJ, Chinn S. Parents' perceptions of food intolerance in primary school children. *Br Med J (Clin Res Ed)*. 1987;294 (6576):863-6.
- Björnsson E, Janson C, Plaschke P, Norrman E, Sjöberg O. prevalence of sensitization to food allergens in adult Swedes. *Ann Allergy Asthma Immunol*. 1996;77(4):327-32.
- Woods RK, Thien F, Raven J, Walters H, Abramson M. Prevalence of food allergies in young adults and their relationship to asthma, nasal allergies, and eczema. *Ann Allergy Asthma Immunol*. 2002;88:183-9.
- Kardinaal AF. Epidemiology of food allergy and food intolerance. *Bibl Nutr Dieta*. 1991;(48):105-15.
- Woods RK, Thien F, Raven J, Walters EH, Abramson M. Prevalence of food allergies in young adults and their relationship to asthma, nasal allergies, and eczema. *Ann Allergy Asthma Immunol*. 2002;88:183-4.
- Emmett SE, Angus FJ, Fry JS, Lee PN. Perceived prevalence of peanut allergy in Great Britain and its association with other atopic conditions and with peanut allergy in other household members. *Allergy*. 1999;54:380-5.
- Bock SA, Muñoz-Furlong A, Sampson HA. Fatalities due to anaphylactic reactions to foods. *J Allergy Clin Immunol*. 2001;107(1):191-3.
- Yuginger JW, Sweeny KG, Sturmer WQ, et al. Fatal food-induced anaphylaxis. *JAMA*. 1988;260:1450-2.
- Sampson HA, Mendelson L, Rosen JP. Fatal and near-fatal anaphylactic reactions to food in children and adolescents. *N Engl J Med*. 1992;327(6):380-4.
- Moneret-Vautrin DA, Kanny G, Fremont S. Laboratory tests for diagnosis of food allergy: advantages, disadvantages and future perspectives. *Allergy Immunol*. 2003;35(4):113-9.
- Sharnan J, Kumar L, Singh S. Comparison of results of skin prick tests, enzyme-linked immunosorbent assays and food challenges in children with respiratory allergy. *J Trop Pediatr*. 2001;47(6):367-8.
- Norgaard A, Bidslev-Jensen C. Egg and milk allergy in adults. Diagnosis and characterization. *Allergy*. 1992;47:503-9.
- Sicherer SH, Morrow EH, Sampson HA. Dose-response in double-blind, placebo-controlled oral food challenges in children with atopic dermatitis. *J Allergy Clin Immunol*. 2000;105 (3):582-6.
- Poon AW, Goodman CS, Rubin RJ. In vitro and skin testing for allergy: comparable clinical utility and costs. *Am J Managed Care*. 1998;4:969-85.
- Ortolani C, Balmer-Weber BK, Hansen KS, et al. Hazelnut allergy: a double-blind, placebo controlled food challenge multicenter study. *J Allergy Clinical Immunol*. 2000;105:577-81.
- Ballmer-Weber BK, Wüthrich B, Wangorsch A, et al. Carrot allergy: double blinded, placebo- controlled food challenge and identification of allergens. *J Allergy Clin Immunol*. 2001;108: 301-7.
- Ballmer-Weber BK, Vieths S, Luttkopf D, et al. Celery allergy confirmed by double-blind, placebo-controlled food challenge:



- a clinical study in 32 subjects with a history of adverse reactions to celery root. *J Allergy Clin Immunol.* 2000;106:373-8.
29. Sampson HA. Comparative study of commercial food antigen extracts for the diagnosis of food hypersensitivity. *J Allergy Clin Immunol.* 1998;82:718-26.
30. Buczyłko K, Roczen H, Wagner A, Chwala C, Węgrzyniak K, Antoniuk J, et al. Oral allergy syndrome (OAS)-diagnosis values of skin prick test. *Przegl lek.* 2002;59(6):411-6.
31. Pucar E, Kagan R, Lim H, Clarke AE. Peanut challenge: a retrospective study of 140 patients. *Clin Exp Allergy.* 2001;31(1):5-7.