

# IgE-dependent sensitization to tropho- and aeroallergens with regard to age, sex and birth season of children and adolescents living in the north-eastern region of Poland

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## Abstract

**Introduction:** A small number of studies concern trophoallergens and aeroallergens sensitization in the developmental age population in Poland. Only a few studies describe the role of selected factors determining the frequency and type of IgE-dependent sensitization in this population.

**Aim:** To assess the rate of sensitization to chosen tropho- and aeroallergens in the group of sensitized patients living in the north-eastern region of Poland with regard to age, sex and birth season.

**Material and methods:** Skin prick testing (SPT) with selected food allergens (trophoallergens) and airborne allergens was used to evaluate the sensitization process of patients recruited to this study between 1998 and 2012. A positive result of sensitization was defined when the patient had at least one positive skin prick test with the allergen studied. The skin prick tests were done after written consent had been obtained from the parents.

**Results:** Significant results were as follows: sensitization was more common in boys (41.9%) than in girls (35.7%); the highest percentage of sensitized patients was observed in the group of children aged 13–18 years (45.0%) as compared to the group of children up to 3 years old (the lowest 33.1%). The highest percentage of sensitized patients was observed among children born during winter (41.3%), the lowest among children born in autumn (36.8%).

**Conclusions:** The assessment of sensitization to chosen trophoallergens and airborne allergens should include the role of age, sex and birth season of the diagnosed patient.

**Key words:** IgE-sensitization, tropho/airborne allergens, age, sex, birth season.

## Introduction

Epidemiological studies on allergic diseases in the human population, conducted in the last decades of the 20<sup>th</sup> century, recorded an increasing trend in their prevalence in various regions of the world. Recent data suggest that this increase may now be levelling off. This trend includes both developmental age populations as well as adults [1–5].

Some studies have described the pattern of allergic sensitization during the first years of life, either in whole populations or in hospital-referred patients. They emphasize that sensitization to food allergens is prevalent in young children and is a factor that predicts the development of different allergic diseases [6–8]. In Poland, long-term data analysis concerning the sensitization process

to trophoallergens and airborne allergens in the population of children and adolescents is not available. Therefore, we decided to perform a retrospective analysis of the scores of skin tests conducted in 1998–2012 in the population of children and adolescents in our region [9].

In the group of patients who underwent SPT as part of the current study, the percentage of those sensitized to at least one allergen was 39.0%. Over the 14-year period, this percentage increased from 35.3% (1998) to 40.4% (2012). The analysis of the sensitization rate by allergen showed that the proportion of patients sensitized to trophoallergens increased two-fold from 10.5 % in 1998 to 20.1% in 2012, whereas the proportion of those sensitized to airborne allergens did not essentially change, accounting for 28.2% in 1998 and 27.2% in 2012 [9].

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## Aim

The analysis takes into consideration the effect of age, sex and birth season on sensitization of the patients studied.

## Material and methods

Of 6,577 children and adolescents who in 1998–2012 underwent SPT with tropho- and airborne allergens, 2,565 were sensitized to at least one allergen (irrespective of its type), which accounts for 39.0%. In this group the sensitization process was analysed with regard to age, sex and sensitization season.

The characteristics of the study group and statistical analysis were described in detail in the first part of this publication [9].

### Study objective

In the group of children and adolescents sensitized to chosen tropho- and aeroallergens, the effect of age, sex and birth season on the sensitization rate was assessed.

### Ethics

The Bioethics Committee of the Medical University of Bialystok, Poland granted its approval for this study. Approval No. R-I-002/233/2009.

## Results

### Sensitization depending on sex, age, and season of birth in the children studied

The prevalence of sensitization, depending on sex, age and season at birth of the patient is presented in Table 1.

**Table 1.** Prevalence of sensitization in the period of 1998–2012 depending on sex, age and season at birth

Characteristics	Number of sensitized patients	%	P-value*	
Sex	Girls	1110	35.75	< 0.0001
	Boys	1455	41.91	
Age	Up to 3 years	651	33.05	< 0.0001
	4–7 years	958	38.99	
	8–12 years	548	44.02	
	13–18 years	390	44.98	
Season at birth	Spring	693	40.08	0.0377
	Summer	639	37.74	
	Autumn	585	36.84	
	Winter	626	41.29	
Total	2565	39.00		

\* $\chi^2$  test of independence.

Sensitization was more common in boys (41.9%) than in girls (35.7%) ( $p < 0.0001$ ). A statistically significant relationship was found between the occurrence of sensitization and the age group ( $p < 0.0001$ ). The highest percentage of sensitized individuals was observed in the group of children aged 13–18 years (45.0%), the lowest in the group of children up to 3 years old (33.1%). There was a statistically significant relationship between the occurrence of sensitization and birth season of the study participants ( $p < 0.038$ ).

The percentage of sensitized patients was the highest among children born in winter (41.3%), the lowest among children born in autumn (36.8%).

### Sensitization to food and airborne allergens depending on sex, age, and season at birth

There was a significant relationship between the occurrence of sensitization to food allergens and the age group ( $p < 0.0001$ ) (Table 2).

The highest percentage of children sensitized to a food allergen was observed in the youngest group of

**Table 2.** Prevalence of sensitization to food and airborne allergens in the years 1998–2012 depending on sex, age and season at birth

Parameter		N	%	P-value*
Food allergen sensitization:				
Sex	Girls	442	14.24	0.0519
	Boys	554	15.96	
Age	Up to 3 years	426	21.62	< 0.0001
	4–7 years	274	11.15	
	8–12 years	170	13.65	
	13–18 years	119	13.73	
Season at birth	Spring	253	14.63	0.0685
	Summer	250	14.77	
	Autumn	223	14.04	
	Winter	261	17.22	
Airborne allergen sensitization:				
Sex	Girls	860	27.70	< 0.0001
	Boys	1170	33.70	
Age	Up to 3 years	314	15.94	< 0.0001
	4–7 years	852	34.68	
	8–12 years	498	40.00	
	13–18 years	354	40.83	
Season at birth	Spring	567	32.79	0.0255
	Summer	500	29.53	
	Autumn	457	28.78	
	Winter	491	32.00	

\* $\chi^2$  test of independence.

children aged up to 3 years (21.6%). No significant relationship was noted between the occurrence of sensitization to a food allergen and sex and the season at birth. Boys were significantly more often sensitized to an airborne allergen (33.7%) than girls (27.7%) ( $p < 0.0001$ ).

There was a significant relationship between the occurrence of sensitization to airborne allergens and the age group ( $p < 0.0001$ ). The oldest children – from 13 to 18 years (40.8%) – were most often sensitized to airborne allergens and the youngest children aged up to 3 years (15.9%) – the least often. There was a significant relationship between the occurrence of hypersensitivity to an airborne allergen and the season at birth ( $p < 0.03$ ). The lowest percentage of patients with a hypersensitivity to an airborne allergen was observed in the group of children born in autumn (28.8%), the highest in the group of children born in spring (32.8%) and in winter (32.0%).

#### Sensitization to both food and airborne allergens

After isolating the group of children who were sensitized to both food and airborne allergens, a significantly higher percentage of hypersensitivity to airborne allergens was observed among boys (7.7%) than in girls (6.2%) ( $p < 0.017$ ) (Table 3).

There was a significant relationship between the occurrence of sensitization simultaneously to airborne allergens and age group ( $p < 0.0001$ ). The highest percentage of children sensitized to both food and airborne allergens was observed in the groups of children aged from 8 to 12 years (9.6%) and from 13 to 18 years (9.6%), whereas the lowest in the group of children aged up to 3 years (4.5%). No significant relationship was noted between the occurrence of sensitization simultaneously to food and airborne allergens and sex and the season at birth.

A significant relationship was found between the occurrence of sensitization only to food allergens and the age group ( $p < 0.0001$ ). The highest percentage of sensitization to food allergens only was observed in the group of youngest children aged up to 3 years (17.2%).

In the remaining age groups this percentage was at a level of approximately 4.0%. There was no relationship between the occurrence of hypersensitivity only to food allergens and sex and the season at birth.

The rate of sensitization only to airborne allergens was significantly higher among boys (26.0%) than girls (21.5%) ( $p < 0.0001$ ). A significant relationship was found between sensitization to airborne allergens and the age group ( $p < 0.0001$ ). The highest percentage of sensitization only to airborne allergens was observed in the group of the oldest children aged 13 to 18 years (31.3%) and the lowest in the youngest children up to 3 years of age (11.5%). There was no relationship between the occurrence of sensitization only to airborne allergens and the season at birth.

## Discussion

Epidemiological data of the last three to four decades indicate that the prevalence of allergic diseases among residents of countries with high economic and hygienic

**Table 3.** Occurrence of sensitizations to food and airborne allergens in the period from 1998 to 2012 depending on sex, age, and season at birth of the study participants, with isolation of the group of children who were sensitized to both food and airborne allergens

Parameter		N	%	P-value*
Sensitizations to food allergens only:				
Sex	Girls	250	8.05	0.7510
	Boys	287	8.27	
Age	Up to 3 years	338	17.16	< 0.0001
	4–7 years	107	4.35	
	8–12 years	50	4.02	
	13–18 years	36	4.15	
Season at birth	Spring	126	7.29	0.3712
	Summer	140	8.27	
	Autumn	128	8.06	
	Winter	136	8.97	
Sensitizations to airborne allergens only:				
Sex	Girls	668	21.51	< 0.0001
	Boys	903	26.01	
Age	Up to 3 years	226	11.47	< 0.0001
	4–7 years	685	27.88	
	8–12 years	378	30.36	
	13–18 years	271	31.26	
Season at birth	Spring	440	25.45	0.2522
	Summer	390	23.04	
	Autumn	362	22.80	
	Winter	366	24.14	
Sensitization to both food and airborne allergens:				
Sex	Girls	192	6.18	0.0167
	Boys	267	7.69	
Age	Up to 3 years	88	4.47	< 0.0001
	4–7 years	167	6.80	
	8–12 years	120	9.64	
	13–18 years	83	9.57	
Season at birth	Spring	127	7.34	0.0685
	Summer	110	6.49	
	Autumn	95	5.98	
	Winter	125	8.24	

\* $\chi^2$  test of independence.

standards has been systematically increasing. This trend includes both developmental age populations as well as adults [1–5]. According to the available data, the number of people with allergic hypersensitivity in some regions of the USA doubles every 10 years. Sensitization to selected environmental allergens affects about 40% of the population. The analysis contained in the White Book of Allergy suggests that with such a growth rate, the number of people sensitized in 2020 will be higher than that of healthy people [10, 11].

Our retrospective research involving 2,565 patients showed interesting relationships of sensitizations with age, sex and season at birth. Sensitizations were more common in boys (41.9%) than in girls (35.7%), the difference being statistically significant. A statistically significant relationship was also found between the occurrence of sensitization and the age group. The highest percentage of sensitized individuals was observed in the group of children aged 13–18 years (45.0%), the lowest in the group of children up to 3 years old (33.1%). This research showed that the birth season of the children surveyed had a significant impact on the sensitizing process. The highest percentage of sensitized patients was noted among children born during winter (41.3%), the lowest among those born in autumn (36.8%).

Previous epidemiological studies considering the effects of age, sex and season at birth on the allergic sensitization process in children are rather scarce [5, 11–13].

Govaere *et al.* investigated the prevalence of allergic symptoms and their associations with sensitization in an unselected population of Flemish children, with the mean age of 9.3 years, living in the city and the surrounding area. Skin prick testing with the most common aeroallergens was performed. Among 2,021 children included in that study, 1,538 (76.1%) had negative skin prick tests and 483 (23.9%) had at least one positive skin prick test. In that group, 60.6% of those sensitized were boys, and 39.4% girls. The percentage of allergic patients depending on age was as follows: 3.4 to 6 years – 11.8%; 6 to 8 years – 8.1%; 8 to 10 years – 12.8%; 10 to 12 years – 41.0%; 12 to 14.8 years – 26.3% [14].

Norrman and Falth-Magnusson, who analysed the SPT results of 5,908 children (mean age: 6.4 years) showed that 46.0% of them had a positive test at least to one allergen. There were slightly more boys (55.0%) than girls (45.0%) in the study group. The total percentage of positive skin prick tests to various food, pollen and animal allergens was 18.0%, and was identical to that in the age group of 0–2 years. The highest percentage of sensitizations (22.0%) was noted in the age group of 13–18 years [15].

The season at birth was reported to be a risk factor for food allergy but the mechanisms by which it acts are unknown [14].

The relationship between birth season and food allergy was studied by Keet *et al.* in two large groups: 5,862

children from the National Health and Nutrition Examination Survey (NHANES) and 1,514 children with food allergy from Johns Hopkins Pediatric Allergy Clinic (JHPAC). Autumn birth was more common among food allergic subjects in both NHANES (OR = 1.91) and JHPAC (OR = 1.31) groups.

Ethnicity of the studied children (Caucasian, OR = 2.34 vs. non-Caucasian, OR = 1.19) and skin barrier dysfunction (subjects with a history of eczema) constituted a group of increased risk of sensitization to food allergens. In the Caucasian ethnic group, the highest percentage of allergic patients was recorded in September and November. The authors observed greater predisposition to sensitization in relation to the season of birth (autumn) or skin condition (damaged), associating it with a seasonal variation in the vitamin D level [15, 16].

Among 86.2% of sensitized patients to at least one allergen, Quoix *et al.* found a significant difference in the month of birth distribution for patients (especially among women) with positive skin tests to grass pollen, with a high rate of birth from January to May [17]. For the whole sensitized population, the birth rate tended to be low in December, except for the cat and dog sensitized. According to these authors, their study confirmed the well-known seasonal peak of births in the first 5 months of the year for grass pollen sensitized patients. The same comparison by sex showed no significant difference between patients sensitized and the reference population.

Garcia *et al.* studied 44 infants of both sexes, aged less than 12 months, who attended the dermatology department with symptoms suggesting atopic dermatitis. The aim of analysis was the clinical relevance of the IgE-dependent sensitizations in this disease. The relationship was studied using SPT and measurement of specific serum IgE (s-IgE). Of the 44 patients studied, sensitization to foods was detected in 27 (61.0%), and the most frequent sensitization observed was to egg [6].

De Benedictis *et al.* analysed study results concerning IgE-dependent sensitization of infants with atopic dermatitis from 12 countries [7]. A total of 2,222 children were screened, of which 2,096 (mean age: 17.6 months; 57.1% male; 92.0% Caucasian) were included in data analysis. Atopy was defined as a presence of at least one specific IgE measurement  $> 0.35 \text{ kU}_A/\text{l}$  and/or total IgE measurement  $> 30.0 \text{ kU}/\text{l}$ . The analysis showed that 44.5% were not sensitized; 18.7% were monosensitized and 36.8% were polysensitized with specific IgE  $\geq$  class 1. There was a wide variation in the sensitization rate to food between countries. Sensitization to egg white predominated in each country and was particularly common in Australia (54.0%), Italy and the UK (53.0%). The highest sensitization rate to cow milk was found in Italy (48%). The prevalence of sensitization to food allergens was particularly low in Belgium (egg 23.0, milk 14.0%) and Poland (egg 27.0%, cow milk 18.0%). A large varia-

tion in the sensitization rate to airborne allergens was also observed between the countries studied [7].

Of the 501 children from the DARC cohort, who had at least one s-IgE test performed between 3 and 72 months of age – 146 (29.1%) had more than one positive IgE, to egg, milk, peanut or fish [8].

## Conclusions

The retrospective research concerning the prevalence of sensitization in the population of children and adolescents in north-eastern Poland in 1998–2012, extends the knowledge of the process of IgE-dependent sensitization in this age population in our country. Our study results may serve as reference to that type of research conducted in other countries. They also indicate an essential effect of such factors as age, sex and birth season on the rate of sensitization to chosen tropho- and airborne allergens in the population studied.

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Maciej Kaczmarski is professor emeritus, head of the department in the years 1990–2014.

## Conflict of interest

The authors declare no conflict of interest.

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