

Micro-regional Hypersensitivity Variations to Inhalant Allergens in the City of Zagreb and Zagreb County

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ABSTRACT

Depending on the geographic and climatic region and vegetation, allergenic plants are characteristic for certain areas and the pollen concentrations of various plant species depend on the phenophase of each single species and most of all on the climatic and meteorological conditions of a certain area. It is precisely because of these specific characteristics that the hypersensitivity of patients to various types of pollen allergens differs according to the geographic regions. The aim of this paper is to determine the frequency of inhalation allergies in adult population (>19 years of age) caused by single types of allergens according to the defined space units (micro-regions) with special emphasis on the rural and urban areas. A number of 2,192 patients have been tested for allergy skin prick tests over a period of four years. Every patient was asked to fill in the questionnaire which contained 29 questions. The results of skin prick testing show that out of a total of 2,192 patients 86.72% were sensitized to pollen, 36.45% to mites, 2.46% to spores of fungi and mould and 5.1% of patients to other allergens which include the allergens of cockroaches, feathers and animal hair ($p < 0.001$). The largest number of poly-sensitized persons allergic to pollen allergens was sensitized to allergens from the pollen of plants that belong to the botanical family of grass. There were 25.36% patients mono-sensitized to individual allergens. In the northern and western parts of the city and the county, the majority of persons were sensitized to the birch pollen allergens, and this is statistically much more than the share of patients with the place of residence in the southern and eastern parts of the city and the county. In the southern and eastern locations prevails the share of sensitized persons to ambrosia which is statistically much more than the share of patients with the place of residence in the northern and western part of the city and the county.

Key words: inhalation allergies, pollen, allergens, hypersensitivity

Introduction

According to a big multi-centric epidemiological study carried out in 1994 on a sample of 100,000 subjects in eight countries of Europe, the incidence of allergic rhinitis was determined ranging from 3.2% in Denmark to 19.6% in Germany¹. The significant characteristic of allergies caused by pollen allergens is the annual periodicity of the onset of symptoms – almost always at the same time during pollination of the plant and/or plants to whose pollen the patient is hypersensitive. Depending on the geographic and climatic region and vegetation, allergenic plants are characteristic for certain areas and the pollen concentrations of various plant species depend on

the phenophase of each single species and most of all on the climatic and meteorological conditions of a certain area. It is precisely because of these specific characteristics that the hypersensitivity of patients to various types of pollen allergens differs according to the geographic regions. Thus, for instance, grass pollen, which is widely spread across the EU countries, causes regionally different percentage of hypersensitive persons. Whereas in Denmark 20% of persons are allergic to grass pollen², in Catalonia (north-eastern Spain) the figure amounts to 35%³, and in the Netherlands and France to as much as 80%⁴. These differences in the numbers of hypersensitive

persons result precisely from the climate diversities and local meteorological conditions. Plant pollen from the Betulaceae family (*Alnus*, *Betula* and *Corylus*) contributes significantly to the incidence of pollen allergies in Northern and Central Europe. Such high hypersensitivity (20% of adult population) represents a big clinical issue in patients in these parts of Europe, and is probably the consequence of a high level of cross reactivity among the pollen allergens representatives of the Betulaceae family⁵. A special problem in the last two decades in Europe has been the hypersensitivity to ambrosia pollen (*Ambrosia* sp.). By its sudden territorial spreading from the East of the continent to the West and by high concentrations of the strong airborne allergenic pollen, it causes high level of hypersensitivity of the European population. The largest number of hypersensitive persons is in Hungary (80% of the total number of patients allergic to pollen)⁶, about 70% in Northern Italy⁷, 30% in France⁸, 35% in the Czech Republic^{9,10}, and 30% in Austria¹¹. Another very interesting datum is the relatively high number of allergic persons to wormwood pollen (*Artemisia* sp.) ranging from 3% to 10%, in spite of low concentrations of this type of pollen in the air (0.5–5% of the annual pollen totals). The wormwood pollen is a significant cause of inhalation allergies in Germany, Italy and France with a tendency of increasing incidence, Poland, Southern Hungary and Switzerland¹². The knowledge on the biology and ecology of allergenic organisms is important for the carrying out of efficient measures regarding the control of allergens in the environment, including the prevention of allergic diseases of the respiratory system. Furthermore, providing information on the movement of allergens, especially pollen, by means of mass media (radio, TV, daily press, web pages) is of great help to persons allergic to this type of allergens. In this way such persons can organise their daily activities in such a way as to avoid as much as possible the contact with allergens, and by planning their holidays at the flowering times of plants to the pollen of which they are allergic may greatly help in the control of their symptoms. The aim of this paper is to determine the frequency of inhalation allergies in adult population (>19 years of age) caused by single types of allergens according to the defined space units (micro-regions) with special emphasis on the rural and urban areas.

Material and methods

Patients

A number of 2,192 patients have been tested, who, over a period of four years attended the University Hospital for Pulmonary Diseases »Jordanovac«, and the Polyclinics for Respiratory System Diseases (Health Centre Črnomerec, Health Centre Novi Zagreb and Health Centre Velika Gorica) for allergy skin prick tests. The patients selected for the research purposes were those who came for the allergy test for the first time. All the patients were sent to tests by the authorised primary-care doctor according to their place of residence, who carried

out the first assessment of the allergy problems. All the persons with more pronounced problems were sent for the allergy treatment, according to the recommendation of the Croatian Society of Allergology and Clinical Immunology that insists on proving and finding the ethyological cause of allergy problems. Prior to allergy testing, the patients were informed about the need to fill in the questionnaire and they signed a consent to the survey. While planning this research, which has been carried out as part of the scientific-research project agreed upon with the Ministry of Science, Education and Sport, a consent was requested and obtained from the Ethics Committee of the Institute for Public Health of the City of Zagreb, and the Ethics Committee of the School of Medicine, University of Zagreb.

Questionnaire

Every patient was asked to fill in the questionnaire which contained 29 questions. The questionnaire served to gather as many data as possible about the patient and the character of the problems as well as the lifestyle which might be related to or have impact on the symptoms and the disease history. The last page of the questionnaire shows the results of allergy tests filled in by the doctor or the nurse in the allergy clinic, immediately upon having read the test results. The filled in questionnaires were collected once a month. During the four years of research the data on 2,192 patients were collected. The survey respected the ethical principles of the medical profession with the obligation of complying with all the international and local laws, regulations and recommendations on the protection of the subjects.

Skin prick test

The skin allergy test was performed by the prick method. A standard inhalation set of allergens of the Institute of Immunology, Zagreb, was used including: negative control (0.9% NaCl solution), positive control (histamine 1 mL/mg), house dust, *Dermatophagoides pteronyssinus*, tree pollen mixture, grass pollen mixture, weeds pollen mixture, ambrosia, moulds mixture, *Alternaria*, animal hair, cockroach allergens (*Blattella germanica*). The persons who had positive skin reaction to tree or weed mixture were additionally tested to individual allergens. For the trees the pollen of hazel (*Corylus*), birch (*Betula*), alder (*Alnus*), oak (*Quercus*), acacia (*Robinia*), willow (*Salix*), poplar (*Populus*), and ash (*Fraxinus*) was used. Individual weeds pollen included: ambrosia (*Ambrosia*), wormwood (*Artemisia*), plantain (*Plantago*), dandelion (*Taraxacum*) and sorrel (*Rumex*).

For the skin prick test a standardized lancet with 1mm long tip was used, which, pricking at an angle of 90°, through a drop of allergen stimulates the mastocytes located in the stratum corneum to reaction, if there is hypersensitivity to the tested allergens. The test started by applying histamine as the positive control and saline solution as the negative control. Allergen preparations were applied to cleaned skin on the volar side of the forearm at distances of at least 3–5 cm. The reaction was

read after 20–30 minutes. In case of positive control by histamine, it amounted to 17 minutes. The characteristics of the positive result of the skin test is the urticaria of a diameter equal or greater than 5mm with erythema and/or equal to histamine reaction. In assessing the skin reaction the maximum reaction diameter was measured, and then the line perpendicular to the largest diameter. The intensity of reaction was obtained by summing up these two values divided by two.

Statistical tests

For the comparison among the groups the variance analysis or Kruskal-Wallis ANOVA was used. To compare the distribution of the category variables among the groups χ^2 -test was used. The category variables are presented as frequency (%).

Results

In the period from 2003–2006 the questionnaires were processed as well as the findings of allergy testing to the standard series of inhalant allergens in the total of 2,192 patients. The basic data on the patients are presented in Table 1. The table shows that according to the gender share the females prevailed in the sample of sensitized persons. The majority of allergic persons belonged to the age group of 31–50 years, followed by the age group of 18–30 years regarding the number of patients. According

TABLE 1
BASIC DATA ON PATIENTS

	Number	%	p (χ^2 -test)	
Patients – total	2192	100.00		
Gender	Male	972	44.34	<0.001
	Female	1220	55.66	
Age group	18–30	807	36.81	<0.001
	31–50	980	44.70	
	51+	405	18.49	
Place of residence (geographic location)	North	379	17.29	<0.001
	South	706	32.21	
	East	493	22.49	
	West	614	28.00	
Place of residence (type of area)	Urban	1704	77.73	<0.001
	Rural	488	22.27	
Age at which first allergy occurs	<5	183	8.34	<0.001
	6 to 15	426	19.44	
	>16	1583	72.22	
Allergies in the family	Yes	1020	46.53	0.008
	No	1172	53.07	
Smoker	Yes	447	20.39	<0.001
	No	1745	79.61	
Pet ownership	Yes	819	37.36	<0.001
	No	1373	62.64	

TABLE 2
RESULTS OF SKIN PRICK TESTS TO INHALANT ALLERGENS

Patients	%		%
Pollen	86.72	<i>Corylus</i> spp.	15.19
		<i>Alnus</i> spp.	4.94
		<i>Betula</i> spp.	25.66
		<i>Quercus</i> spp.	2.10
		<i>Ambrosia</i> spp.	42.07
		<i>Artemisia</i> spp.	4.82
		Urticaceae	2.41
		<i>Rumex</i> spp.	0.44
		<i>Plantago</i> spp.	3.57
		Poaceae	46.91
Mites	36.45		
Spores	2.46		
Other	5.1		

to the place of residence, most of the patients live in the southern parts of the city of Zagreb and the Zagreb County, then in the western locations, and the eastern and northern parts. There are 77.73% of patients living in the urban parts of the Zagreb County. In the majority of the patients the allergy symptoms occurred for the first time after the age of sixteen, followed by a group in which allergy occurred for the first time between 6 and 15 years of age, and the smallest group of patients experienced the first onset of allergy before the age of 5. Table 2 shows that most of the persons, 86.72%, were sensitive to pollen, 36.45% to mites; 2.46% to spores of fungi and mould, and 5.1% of persons to other allergen groups which include allergens of cockroaches, feathers, and animal hair. It should be mentioned here that the majority of persons was sensitive to more than one of the mentioned allergens, and most often to pollen and mites. The majority of patients allergic to pollen allergens were sensitized to allergens from the plant pollen which belong to the botanical family of grass 46.91%, ambrosia 42.07%, birch 25.66%, hazel 15.19%. Fewer than 5% of patients were sensitized to other pollen allergens. It should be mentioned here also that the abovementioned results do not refer to mono-sensitization of the patients, but rather the patients were poly-sensitized. It can be seen from the results of the skin prick testing to inhalant allergens that one fourth of the patients (25.36%) were mono-sensitized to certain allergens. Most of the patients of the total number were mono-sensitized to allergens of mites (12.36%), followed by ambrosia pollen (7.02%), animal hair (3.05%), cockroaches (1.09%), and feathers (0.91%). There were no mono-sensitized patients to the pollen of hazel, alder, oak and sorrel (Figure 1). The sensitization of patients depending on the place of residence (north, south, east and west) to individual allergens is presented in Table 3. Out of the total number of patients, 379 of them have place of residence in the northern part of the city and the county, 706 in the

TABLE 3
MICRO-REGIONAL DIFFERENCES IN SENSITIZATION OF PERSONS TO INDIVIDUAL ALLERGENS

	Number of patients	Trees				Grass
		Corylus	Alnus	Betula	Quercus	
Zagreb North	379	9.37%	3.69%	29.86%	1.31%	47.22%
Zagreb South	706	7.76%	4.95%	16.20%	2.40%	39.84%
Ivanić Grad	493	8.57%	6.89%	11.97%	3.04%	40.97%
Samobor	614	11.17%	1.46%	22.47%	0.16%	45.92%
	Number of patients	Weeds				Plantago
		Ambrosia	Artemisia	Urticaceae	Rumex	
Zagreb North	379	13.10%	3.95%	3.16%	0.79%	2.11%
Zagreb South	706	55.80%	3.37%	1.55%	0.28%	2.54%
Ivanić Grad	493	51.11%	2.99%	2.83%	0.40%	2.83%
Samobor	614	15.60%	6.77%	1.46%	0.16%	4.07%
	Number of patients	Mites	Spores	Other		
Zagreb North	379	35.62%	1.84%	5.01%		
Zagreb South	706	35.55%	2.83%	5.09%		
Ivanić Grad	493	43.20%	3.04%	6.49%		
Samobor	614	24.91%	1.30%	2.93%		

southern part, 493 in the eastern and 614 in the western part. Regardless of the place of residence, the majority of persons were sensitized to grass pollen allergens (Zagreb-north 47.22%; Zagreb-south 39.84%; Ivanić Grad 40.97%; Samobor 45.92%), but without any statistically significant differences in the shares of allergic patients regarding the place of residence (χ^2 -test $p=0.236$). The same situation is with the sensitization to hazel pollen (χ^2 -test $p=0.085$), stinging nettles (χ^2 -test $p=0.146$), sorrel (χ^2 -test $p=0.438$), spores of fungi and mould (χ^2 -test $p=0.173$). In the northern and western parts of the city and the county the majority of persons were sensitive to birch pollen allergens (29.96% and 22.47%), and this is a statistically significantly greater share than the share of patients with the place of residence in the southern and eastern parts of the city and the county 16.20% and 11.97%) (χ^2 -test $p<0.001$). Similar situation is with the sensitized to ambrosia. In the southern and eastern locations the share of the sensitized persons amounts to 55.80% and 51.11%, respectively, and in the northern and western parts 13.10% and 15.60%, respectively (χ^2 -test $p<0.001$). There are statistically significant differences between the share of the patients to the alder, oak and wormwood pollen allergens, and to allergens of mites (χ^2 -test $p<0.001$). According to the type of residence (rural, urban) the share of patients allergic to a certain type of allergen is very uniform. The majority of persons in both environments were allergic to grass pollen allergens (rural 40.51%; urban 50.35%), ambrosia (39.05%; 36.63%), to allergens of mites (36.97%; 36.44%), birch pollen (22.82%; 26.76%) etc. (Figure 2). There are no statisti-

cally significant differences in the shares among patients allergic to individual allergens who live in rural and urban areas.

Discussion

During the four years of research, the questionnaires and findings of a total of 2,192 patients with positive findings of allergy testing to the standard series of inhalant allergens were analysed. According to the gender the sample contained a larger number of allergic females. Similar results were found in the studies from Bilbao (Northern Spain), Austria, Switzerland and Kosovo^{13–16}. In other studies from the available literature a prevalence of allergic male persons was recorded regarding the gender share. For instance, in Northern Greece the results of 15-year research on 1,744 patients have shown that 42.1% females and 57% male persons had positive reaction to skin testing¹⁷. The multi-centric analysis of 1,459 patients from Poznan (Northern Poland) has shown also that the male persons prevailed in the sample of the allergic persons and they were almost double (62.5%) the number of females (37.5%)¹⁸. The age at which the first allergy symptoms appear is also a significant parameter. In our study the patients belonged to a very wide range of age, and they were classified in three age groups (18–30; 31–50 and 51 < years of age). This allowed a good insight into the incidence of allergy and the differences between age groups in our population of patients. In the majority of our patients (72%) the first symptoms of allergy appeared after the age of 16, and the majority of allergic

persons (44.7%) belonged to the age group of 31–50 years. In the papers of authors who, apart from adult population included also children, the majority of allergic persons belonged to the age groups of 20–30 years of age, 16–35, 20, i.e. 2–19^{13,14,16,18}.

Depending on the type of allergen, the majority of patients in our paper were allergic to pollen allergens, followed by mites, spores of fungi and mould, and to other allergens which include the allergens of cockroaches, feathers and animal hair – 5.1% of patients. It should be mentioned here that the majority of persons were sensitized to more than one of the mentioned groups of allergens, and most often to pollen and mites. Similar results were found also in the abovementioned references.

The largest number of persons allergic to pollen allergens in this paper were sensitized to allergens of the pollen of the representatives of the botanical grass family (Poaceae). In the papers by the authors from Greece, it was also grass pollen to which the largest number of persons was sensitized (40.4%)¹⁷, then from Kosovo (52.1%)¹⁶, Northern Spain (97.46%)¹³, 88% in Zaragoza¹⁹, 55.9% in Badajoz²⁰, as well as in other European countries (Germany, Great Britain, Austria, Poland, France)⁴.

In our paper 42.07% of patients out of the total number of those allergic to pollen were sensitized to ambrosia, which is by about 15–20% greater share of patients from France⁸, Austria¹¹ and the Czech Republic^{9,10}. The percentage of sensitized persons in Europe varies regionally, due to the expansion of this weed plant from South-eastern Europe westwards. In the North and far West of Europe no major sensitization to ambrosia pollen was recorded. For the *Ambrosia* genus which includes two allergy significant species *A. artemisiifolia* and *A. trifida* it has been known for a long time already that their pollen is a significant cause of allergy rhinitis, and more recently of asthma as well. Allergy testing on a large number of subjects in the USA yielded results which indicate high share of population allergic to this type of pollen with clinical manifestations of allergy rhinitis and asthma. In Chicago 45% of persons suffering from asthma were sensitized to ambrosia pollen. It has also been concluded that there is greater prevalence of polynosis in rural areas, which was not the case in our study, since no statistically significant differences were found in the rural and urban population²¹. In Canada, out of 3,371 patients with clinical diagnosis of asthma and rhinitis, sensitization to ambrosia pollen was determined in 44.9% patients²². Ambrosia is also widespread in Asia. Ambrosia pollen is the most significant allergen in China with an annual share of 18% in the air and with prevalence of polynosis of 67.7% in persons allergic to pollen²³. A significant share of polinoses to ambrosia pollen was documented on Taiwan (52.3%), Korea (30.81%) and Japan²⁴. Allergy to ambrosia pollen was found also in South America. In Columbia the prevalence in the group of asthmatic patients amounts to 23%, and in the control group 12%²⁵. The allergy to ambrosia pollen was reported in New South Wales, Australia and Egypt²⁶.

The majority of our patients were poly-sensitized, whereas only 7.02% were mono-sensitized to ambrosia pollen, unlike the patients from France, where the majority were mono-sensitized to this type of pollen²⁷. The results of our work show that 4.82% of persons allergic to pollen are allergic to wormwood pollen allergens, like in Germany (4.5%)²³. There is a much greater percentage of patients sensitized in Italy – the region of Chieti Pescara (17%)²⁹. Authors emphasise that this percentage varies significantly regarding the region. In our work as well minimal differences were found in the sensitization of patients to wormwood pollen regarding micro-locations. In Northern France where no ambrosia grows, the wormwood pollen is on the third place as the cause of polynosis following pollen of grass and plantain³⁰, whereas, for instance, sensitization to plantain pollen in our population is minimal.

There were 45.79% patients allergic to the pollen of the representatives of the Betulaceae family, out of which 25.66% are allergic to birch pollen, 15.19% to hazel pollen and 4.94% to alder. Birch pollen in Northern, Central and Eastern Europe represents the most allergenic tree pollen, and there is very high level of allergy cross-reactivity among the pollen of the representatives of the Betulaceae family³¹. In Europe the percentage of sensitized persons to birch pollen ranges from 5% in the Netherlands to 54% in Switzerland. Due to the popularity of birch as ornamental plant, there has come to significant increase of sensitization incidence to birch pollen allergens in the regions where this tree is not autochthonous, and especially in Northern Italy^{32–34}. The results of our work show that sensitization of patients depends on the place of residence. In Northern and Western parts of the city and the county the majority of patients were sensitized to birch pollen allergens, which is statistically significantly more than the share of patients with the place of residence in the southern and eastern parts of the city and the county. It can also be noticed that in our sample of patients there are no mono-sensitized to pollen allergens of hazel and alder, whereas the share of mono-sensitized to birch pollen is below 1%. The cause lies in strong cross-reactivity of pollen allergens from the Betulaceae representatives. In a big study that analyzed cross sensitization between pollen allergens of various taxons in adult population with asthma and rhinitis, Eriksson and Holmen³⁵ found that birch pollen allergens are very often cross reactive with other allergens, and that they induce mainly nasal symptoms in persons at the age of 30. These results confirm fully our results. In our study 36.45% of patients were sensitized to allergens of mites. It should be mentioned that all were poly-sensitized to other inhalant allergens as well. There were 12.36% mono-sensitized patients to allergens of pyroglyphid mites, which is the highest percentage share of mono-sensitized patients. The frequency of allergies to pyroglyphid mites (found on the basis of the positive prick skin test) in general urban population of the continental Croatia in 1995 amounted to 13%³⁶, and in 2000 it increased to 22.4%. In the works of other authors it may be noted that the share

of sensitized population to mites is very different depending on the geographic climate region. In the general population of moderate climatic zone it ranges from 5 to 30%, and in general population of the tropical area it ranges between 30 and 50%. In the population of asthmatic patients the frequency of sensitization to pyroglyphid mites of the moderate climatic zone ranges from 45% to 85%, and in the population of asthmatic patients of the tropic area about 90%^{37,38}. In the work from Turkey, province of Kocaeli out of 1,279 patients 25% were allergic to pyroglyphid mites³⁹.

Conclusions

1. The results of skin prick testing show that out of a total of 2,192 patients 86.72% were sensitized to pollen, 36.45% to mites, 2.46% to spores of fungi and mould and 5.1% of patients to other allergens which include the allergens of cockroaches, feathers and animal hair ($p < 0.001$).

2. The largest number of poly-sensitized persons allergic to pollen allergens was sensitized to allergens from the pollen of plants that belong to the botanical family of grass. Fewer than 5% of patients were sensitized to other pollen allergens: alder, wormwood, plantain, plants from the family of stinging nettles, and docks.

3. There were 25.36% patients mono-sensitized to individual allergens. The majority were mono-sensitized to

allergens of mites, followed by ambrosia pollen, animal hair, allergens of cockroaches, and feathers. There were no mono-sensitized patients to pollen allergens of hazel, alder, oak and docks.

4. Regardless of the place of residence, the majority of persons were sensitized to grass pollen allergies, but with no statistically significant differences in the shares of allergic patients regarding the place of residence as well as for the pollen of hazel, stinging nettles, docks, spores of fungi and mould. In the northern and western parts of the city and the county, the majority of persons were sensitized to the birch pollen allergens, and this is statistically much more than the share of patients with the place of residence in the southern and eastern parts of the city and the county. In the southern and eastern locations prevails the share of sensitized persons to ambrosia which is statistically much more than the share of patients with the place of residence in the northern and western part of the city and the county. There are statistically significant differences between the share of patients to pollen allergens of alder, oak and wormwood, and to allergens of mites.

5. There are no statistically significant differences in the shares between the patients allergic to certain allergens, who live in rural and urban areas.

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MIKROREGIONALNE VARIJACIJE PREOSJETLJIVOSTI NA INHALACIJSKE ALERGENE U GRADU ZAGREBU I ZAGREBAČKOJ ŽUPANIJI

SAŽETAK

Ovisno o geografsko-klimatskom području i vegetaciji, alergogene biljke su karakteristične za pojedina područja, a koncentracije peludi različitih biljnih vrsta ovise o fenofazi svake pojedine vrste i ponajviše o klimatološkim i meteorološkim prilikama određenog područja. Upravo zbog tih osobitosti, preosjetljivost bolesnika na različite vrste peludnih alergena razlikuje se prema geografskim regijama. Svrha ovog rada je utvrditi učestalost inhalacijskih alergija u odrasloj populaciji (>19 godina) uzrokovanih pojedinim vrstama alergena prema definiranim prostornim jedinicama (mikroregijama), s posebnim naglaskom na ruralna i urbana područja. Obrađeno je 2192 bolesnika koji su tijekom 4 godine (2003.–2006. god.) dolazili na alergološko testiranje ubodnom metodom. Svaki bolesnik dobio je na popunjavanje anketni upitnik koji se sastojao od 29 pitanja. Rezultati kožnog testiranja pokazuju da je od ukupno 2192 bolesnika na pelud senzibilizirano 86,72%, na grinje 36,45%, spore gljiva i plijesni 2,46% i na ostale alergene u čiju skupinu spadaju alergeni žohara, perje i životinjske dlake 5,1% pacijenata ($p < 0,001$). Najveći broj polisenzibiliziranih osoba alergičnih na peludne alergene bio je senzibiliziran na alergene iz peluda biljaka koje pripadaju botaničkoj porodici trava. 25,36% bolesnika je monosenzibilizirano na pojedine alergene. U sjevernim i zapadnim dijelovima grada i županije najviše je osoba senzibilizirano na peludne alergene breze, a to je statistički značajno više od udjela pacijenata s mjestom boravka u južnim i istočnim dijelovima grada i županije. Na južnim i istočnim lokacijama prevladava udio senzibiliziranih na ambroziju što je statistički značajno više od udjela pacijenata s mjestom boravka u sjevernim i zapadnim dijelovima grada i županije.