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PECULIARITIES OF THE ETIOLOGICAL SPECTRUM OF HOUSEHOLD ALLERGENS

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The aim *of the study was to study the range of substances that cause respiratory sensitization in adults and children living in Dnipro as of 2019.*

Materials and research methods. *Enzyme-linked immunosorbent assay was used to study the serum of venous blood, which determined the specific IgE of up to 9 allergens that are most common in the home. Kits for quantification of allergen-specific IgE from Vitrotest Specific-IgE, Ukraine were used. Conducted allergy diagnosis for 380 people with certain features of allergy history of various types of allergies, who went to the laboratory to specify the etiological root cause of their disease.*

Research results. *As a result of the analysis of the received data the distribution of allergens on their prevalence among the population of Dnipro was established. The degree of hypersensitivity to each specific allergen and their ability to cross-react with each other was determined. Among the allergens of the household panel, the most dangerous were allergens of molds, which caused a sensitization reaction in 292 people, which was 76.8 % of all surveyed. The top three (in prevalence) of household allergens included: cat epithelium, which caused sensitization in 125 people (32.9 %) and Derm mite. Farinae, sensitivity to which was found in 117 patients (30.7 %). The share of inadequately strong allergopathological reactions is one third of all examined and prevails in people with sensitization to allergic agents of the household panel such as cat epithelium, Derm mite. Farinae and Derm. Pteronyssinus. Hyperractivity to fungi of the genus Candida and mold has been found in 9–12 % of people. The lowest severity of sensitization was observed in the epithelium of the dog and house dust, and low sensitivity in the reactivity structure of allergopathological reactions was observed for allergens of the epidermal group (down and feathers of poultry) and cockroaches. The development of cross-reactions took place between allergens of epidermal origin: there was a hypersensitivity to the hair and epithelium of dogs and cats ($r=0.94$, $P<0.01$), poultry feathers and cockroaches ($r=0.99$, $P<0.01$). This association of cross-reactions is possible, given the theory of minor and major proteins, and is due to their similarity: the similarity of the inclusion in the allergen structures of specific forms of molecules inherent in both allergic agents that may have allergy-stimulating effects.*

Conclusions. *Cross-linking between several types of related allergens is the best way to further investigate this issue. It makes sense to include in the laboratory study a molecular method for the determination of major and minor proteins in the case of the greatest relationship to determine not only a specific allergen as an etiological factor, but also a specific sensitizing protein that is part of them. This is of great importance for subsequent immunotherapy when the removal of only one (major) protein agent can reduce the risk of susceptibility reactions to several types of allergens*

Keywords: *house dust mite, molds, sensitization, allergen-specific IgE, cross-reactivity, household allergens, Dnipro*

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1. Introduction

Conditions associated with allergic reactions are one of the most common pathologies in the structure of the disease, not only in Ukraine but also around the world. According to the research, about 35–40 % of the world's population suffer from allergic diseases, and in recent years there has also been a significant increase in the incidence of allergic pathology among children [1, 2]. Regarding Ukraine, real statistics on allergic diseases are not known [3], which is due to seeking medical care mainly from people with the most pronounced clinical manifestations [4]. In addition, due to lack of awareness and generality of the primary manifestations of the disease, patients do not turn to general practitioners, which leads to disregard for several cases of allergic conditions among the population [3].

According to long-term studies on the mechanisms of allergy development [5], with age there is an expansion of the spectrum of sensitization. The development of allergic reactions leads to an increasing number of allergens, and latent sensitization of the body (when the serum contains allergen-specific IgE, and no clinical symptoms) usually precedes the development of allergic disease [6, 7]. This reaction of the body could be

caused by both food and collisions with usual, seemingly ordinary, objects and materials. Dust and pollen are especially common allergies. And each individual allergen could be a prerequisite for a number of symptoms. In addition, most allergy sufferers react simultaneously to a range of allergens. Manifestations of allergies could be different – itchy skin, rash, irritating cough, tearing and runny nose. Indigestion is often observed. In more severe cases, swelling of the skin and mucous membranes may occur. Allergic conditions such as bronchial asthma and anaphylactic shock are especially dangerous – a particularly severe form of pathological allergic reactions.

Mortality from allergic diseases is usually absent or insufficiently covered in official statistics and literature. The mortality rate from bronchial asthma in Ukraine in recent years has ranged between 2.5–2.9 per 100,000 population. Cases of death from anaphylactic shock and drug incompatibility have also been reported. Deaths from exogenous allergic alveolitis, Quincke's edema, and insect allergies have been reported. In Ukraine, the latest data are virtually absent, but according to experts are also quite significant [8].

Studying the scientific literature on the issue of allergic reactions in the Dnipro region, the following was noticed. Most work is based on the clinic and treatment of these conditions, to some extent the main mechanisms for diagnosing this pathology, and especially – the actual allergic diseases (bronchial asthma, allergic rhinitis, atopic and contact dermatitis, etc.) [8, 9]. However, there are practically no works that would primarily shed light on the picture of the etiological root cause of these conditions for this area. However, the leading reason for seeking help is considered to be conditions of allergic origin, caused mainly by the respiratory group of allergens [10].

The aim of this work is to study the etiological spectrum of the main causal respiratory allergens of domestic nature in the inhabitants of Dnipro based on the study of the level of specific IgE.

2. Materials and methods of the research

In vitro allergy diagnostic methods are becoming increasingly popular, one of which is enzyme-linked immunosorbent assay (ELISA), which allows the determination of total IgE and allergen-specific IgE in human serum or plasma. This method is characterized by several advantages: it has no contraindications to examination and age restrictions, does not cause additional sensitization and anaphylactic reactions, is characterized by high sensitivity and specificity.

The work was performed in the department of enzyme-linked immunosorbent assay based on a private laboratory of a wide profile PE "Center for Laboratory Medicine VIS-Medic". Only the most current results of analyses obtained for the period from January 2015 to December 2019 inclusive were taken into account. During this time, a study was conducted to establish sensitization to allergens in the household spectrum for 380 people with certain features of allergy history of various types of allergies, who went to the laboratory to specify the etiological root cause of their disease.

The study was conducted in accordance with the principles of bioethics of the Council of Europe Convention on Human Rights and Biomedicine (04.04.1997), the World Medical Association Helsinki Declaration: Ethical Principles of Human Medical Research (1964–2013), ICH GCP (1996, last revision – ICH VI, 2003), Order of the Ministry of Health of Ukraine No. 690 of 23.09.2009. The results of scientific research were reviewed and approved by the Committee on Bioethics at the Faculty of Medical Technologies of Diagnosis and Rehabilitation of DNU (Minutes No. 1 of January 5, 2022). All participants were informed about the goals, organization, research methods and signed an informed consent to participate in it, and all measures were taken to ensure anonymity of patients.

Determination of the level of specific IgE was performed when necessary to assess the sensitivity to a particular allergen or the inconsistency of the results of skin tests with a history. Detection of specific IgE was also used in the differential diagnosis of IgE-dependent allergic reactions. It was not uncommon for a patient to be hypersensitive to only one allergen, because of which the overall IgE level could be within normal limits, while the skin test and ELISA test for specific IgE were positive.

For the study, panels of household spectrum of allergens were used, which included 9 indicators. The latter characterized the presence of specific hypersensitivity to allergens such as mite Dermatophagoides Pteronyssinus, mite Dermatophagoides Farinae, house dust, feathers (set of antigens to goose, chicken and duck feathers and down), mold (set of 5 species: Penicilli Cladosporium herbarium, Aspergillius fumigatus, Mucor rasemosus, Alternaria alternata (tenius), Candida albicans, cockroach, cat epithelium and dog epithelium).

All analyzes were performed according to the current methodology for the test system "Vitrotest Specific-IgE, Ukraine" [11]. Enzyme-linked immunosorbent assay "Vitrotest Specific-IgE" is designed to quantify the content of specific antibodies of the IgE class in human serum or plasma and is based on the principle of "capture" variant of solid-phase ELISA using biotinylated allergens produced by "IVK Ramintek, Ukraine".

When performing ELISA analysis, antibodies to IgE are adsorbed on a solid support in the wells of a polystyrene plate. The complex formed by the administration of the test serum is detected by the addition of corresponding antibodies conjugated to the enzyme-labelled enzyme (horseradish peroxidase) [12].

After combining the antigen with the enzyme-labelled immune serum, the substrate / chromogen is added to the mixture. The substrate is broken down by the enzyme and changes the colour of the reaction product (the solution in the wells where the immune complexes were formed turns blue, and when the stop reagent is added, the blue colour of the coloured wells changes to yellow); the colour intensity is directly proportional to the number of antigen molecules and labelled antibodies that bind. With a positive result, the colour of the chromogen changes. Each time the next component is added, unbound reagents are removed from the wells by rinsing. The intensity of the reactions of test and control samples is considered on a plate spectrophotometer according to the amount of light absorption with a certain wavelength (450/620 nm).

The methodology of the test system "Vitrotest Specific-IgE" is standardized by the WHO, has a high sensitivity, specificity and reliability (within 98 %), which becomes possible provided full compliance with its recommendations and requirements. However, as an independent technique in the diagnostic process, it cannot act. The final diagnosis is established only based on clinical manifestations, medical history and data from a set of laboratory studies.

Statistical analysis was performed using Microsoft Excel 2016 and Statistica 10 (StatSoft, USA), using methods of clinical, descriptive and mathematical statistics. The choice of statistical procedures took into account the methodological requirements of the International Congress on the Harmonization of Clinical Trials ICH / GGP. Comparisons of groups on a qualitative basis were performed by the method of pairwise comparisons and correlation analysis. The nonparametric Mann-Whitney rank test was used to assess the probability of differences between study groups. Values of $p<0.05$ were considered statistically significant. In order to assess the trends and patterns of changes in the concentration of household allergen specific IgE over time, we used statistical analysis of time series.

The results of the analysis were considered reliable if the optical density (OD) of each of the samples (Table 1) was in the specified range of values and the concentration of control serum was in the range indicated on the label of the microtube (2–3 IU / ml). If the obtained data exceeded the specified values, the results of the analysis were considered inaccurate, and the analysis was repeated.

Table 1

Optical density values for calibrators

Calibrators	OD
CAL 0	not higher than 0.07 OU, i.e., OD CAL 0≤0.07
CAL 0,35	not lower than 0,1 OO, i.e., OD CAL 0,35≥0.1
CAL 1	not lower than 0,2 OO, i.e., OD CAL 1≥0.2
CAL 5	not lower than 0,7 OO, i.e., OD CAL 5≥0.7
CAL 25	not lower than 1,0 OO, i.e., OD CAL 25≥1.0
CAL 100	not lower than 1,7 OO, i.e., OD CAL 100≥1.7

To obtain quantitative results for determining the concentration of specific IgE in IU / ml was built a calibration graph, which determined the concentration (IU / ml) of specific IgE in the samples, which corresponded to the value of the obtained OD. Depending on the concentration of allergen-specific IgE, seven classes were distinguished: from 0 - specific antibodies are absent (<0.35 kIU/l) to class VI with extremely high levels of antibodies (>100 kIU/l). Calibration samples are standardized according to the 2nd WHO International Standard 75/502 for total IgE. As there is no international standardization for both specific IgE units and reference allergen values, the concentrations of specific IgE obtained by different methods may differ (this should be considered when comparing the results of different methods). Levels of specific IgE clearly illustrate the increased pathological sensitization of the patient to the relevant specific allergens, as well as establish the degree of reaction of the body to them. Based on such data, we could conclude about the place of each of the allergens in the structure of hypersensitivity of the population, and thus identify the most common and dangerous of them.

3. Research results

Carrying out a preliminary analysis of the data on the distribution in relation to the identified cases of hypersensitivity to each individual allergen and the number of unreacted (undetected) cases, the following was established (Table 2).

Table 2

Prevalence of household allergens in the Dnipro

No.	Type of household allergens	Obtained results, %	
		Clinically significant	Clinically insignificant
1	Mold allergens	76.8	23.2
2	Cat epithelium	32.9	67.1
3	Mite Derm. Farinae	30.7	69.3
4	House dust	28.4	71.6
5	Mite Derm. Pteronyssinus	23.7	76.3
6	Cockroach allergens	19.7	80.3
7	Fungi Candida alb.	14.7	85.3
8	Dog epithelium	13.9	86.1
9	Feathers of farm animals	12.1	87.9

The top three allergens in the household spectrum are the most common: cat epithelium, which accounts for 32.9 % of patients (125 people), and mite Derm. Farinae, sensitivity to which was shown by 30.7 % of patients (117 people). Feathers had the lowest rates of household allergens, accounting for 12.1 % (46 people) of those diagnosed. As in the case of mold, there is no precise gradation regarding the type of feather sensitization, but the affinity of a certain proportion of protein in these representatives of farm birds is unquestionable.

Further, the analysis of the structure of sensitization of Dnipro residents by the level of reaction was carried out. According to the possibility of quantitative interpretation of the results of the analysis according to the above method, for each case of allergic manifestation the level of specific IgE was calculated, based on which it became possible to identify high, medium and low levels of sensitization for each allergen.

Among the allergens of the household panel, the greatest severity of sensitization was found in relation to the antigen of the epithelium of the cat (Table 3). Excessively high levels of the corresponding IgE fraction (75.1 <IU/ml) were found in 14 people (11.2 %). In contrast, the proportion of very high and high IgE levels was found in three and twenty-two individuals, respectively (2.4 % and 17.6 %), accounting for about one-third of those diagnosed.

The other third, with a rate of 37.6 %, is occupied by people (47 people) who had an average level of reactivity of allergopathological reactions.

Thus, most allergy sufferers have a significant immunological background to the response to this allergen, and therefore have a high risk of severe manifestations and complications of the reaction.

Table 3

Distribution of household allergens by degree of reaction

Distribution by degree of reaction	1	2	3	4	5	6	7	8	9
	Mite Derm. Pteronyssinus	Mite Derm. Farinae	House dust.	Feathers (goose / chicken / duck)	Mildew (5 species)	Candida alb	Cockroach	Cat's epithelium	Dog's epithelium
	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %
Very low level (0.35–0.5 IU/ml / 0–1)	11.11	7.69	15.74	54.34	22.26	32.14	57.33	12.8	18.86
Low (0.51–1.0 IU/ ml / 1)	15.55	10.25	32.40	30.43	42.12	21.42	28	18.4	13.20
Average (1.01–5.0 IU/ ml / 2)	41.11	42.73	37.03	15.21	23.97	37.5	10.66	37.6	50.94
High (5.1–25.0 IU/ ml / 3)	25.55	32.47	13.88	2.17	9.24	7.14	4	17.6	16.98
Very high (25.1–75.0 IU/ ml /4)	4.44	3.41	0.92	0	1.36	0	0	2.4	0
Excessively high (75.1< IU/ ml / 5)	2.22	3.41	0	0	1.02	1.78	0	11.2	0

Excessively high levels of IgE to the products of the mite Derm. Farinae (Table 3) is significantly lower than that of cat epithelium but posed a serious threat to four individuals (3.41 %). Very high and high reactivity of allergopathological reactions occurred in four and thirty-eight people, respectively, 3.41 % and 32.47 %, respectively. In total, high levels of the concentration of the corresponding fraction of IgE to the products of the tick Dermatophagoides Farinae (5.1 <IU / ml) were found in one third of all cases of reactivity to this allergen. Fifty (42.73 %) individuals had a moderate level of sensitivity in the reactivity structure of allergopathological reactions.

The next allergen with a significant share of high reactivity is another mite – Dermatophagoides Pteronyssinus (Table 3), where the share of excessively high levels of the concentration of the corresponding IgE fraction occurred in two (2.22 %), and the share of very high allergy reactions was observed in four people (4.44 %). High manifestation of hypersensitivity to allergic agents Derm. Pteronyssinus was characteristic of twenty-three individuals (25.55 %), and thirty-seven individuals (41.11 %) had moderate hypersensitivity.

High levels of IgE (5.1 <IU/ml) to the fungus Candida alb. Table 3 was less pronounced and occurred in five people (8.92 %), of whom one person (1.78 %) had an excessively high level of sensitivity in the reactivity structure of allergic reactions and in four people (7.14 %) there was a high level of concentration of the corresponding fraction of IgE. Cases of very high levels of hypersensitivity to allergic agents of the fungus Candida alb. was not noticed. The average level of hypersensitivity accounted for 37.5 %, which occurred in twenty-one individuals. In total, the low level of concentration of the corresponding fraction of IgE to the products of the fungus Candida alb. (1.0> IU/ml) was detected in half (30 people) of all cases of reactivity to this allergen.

The share of high sensitivity (5.1 <IU/ml) to mold antigens (Table 3) was about 12 % and occurred in 34 patients who went to the laboratory to specify the etiological root cause of their disease. The average manifestation of hypersensitivity to allergic agents of mold (Penicillium notatum, Cladosporium herbarium, Aspergillius fumigatus, Mucor rasemosus, Alternaria alternata (tenius)) was characteristic of 70 people (23.97 %). Low sensitivity (1.0 IU/ml) in the structure reactivity of allergopathological reactions was observed in 188 people, which accounted for almost 65 % of all cases of sensitivity to this allergen.

The least pronounced sensitization was observed in the hair and epithelium of the dog (Table 3). This group of allergens was characterized by the absence of excessive values in the concentration of IgE (25.1 <IU/ml), and a high level of allergopathological reactions occurred in nine people (16.98 %). In contrast, half (50.94 %) of all cases of hypersensitivity to allergic agents in the hair and epithelium of the dog accounted for the average level of sensitivity (1.01–5.0 IU/ml).

Sensitization to house dust (Table 3) was also devoid of critically high concentrations of the corresponding specific IgE (75.1 IU/ml). However, the proportion of very high and high levels of IgE (5.1–75.0 IU/ml) was found in 16 people, which was about 15 %. The average

degree of hypersensitivity to allergic agents of house dust was typical for 40 people (37.03 %), and 52 people (48.14 %) had low levels of hypersensitivity (1.0 IU/ml).

High and medium levels of sensitization to the products of cockroach life (Tab. 3) were observed in only three (4 %) and eight (10.66 %) people, respectively. In total, a low level of concentration of the corresponding fraction of IgE in the products of cockroach activity (1.0 IU / ml) was found in 64 people (85.33 %) among all cases of reactivity to this allergen.

For the feather group of allergens (Table 3), cases of very high concentrations of specific IgE (25.1 <IU/ml) were not observed at all. The highest proportion of hypersensitivity to allergic agents of the feather group (combination of antigens to goose, chicken, and duck feathers and down) was characteristic of 39 people (84.77 %).

In the further process of research, proceeding from quantitative data concerning intensity of reaction (on value of concentration of the corresponding specific IgE, Table 3), pair correlation between all separate allergens alternately was defined. Analyzing the obtained data, the values with high and very high strength of correlations were the most valuable. As a result, a rather interesting picture was obtained (Table 4).

Table 4

Correlations between different allergens in the household group

Allergens of the household group		1	2	3	4	5	6	7	8	9
		Mite Derm. Pteronyssinus	Mite Derm. Farinae	Household dust	Feathers (goose / chicken / duck)	Mold (5 species)	Candida alb.	Cockroach	Cat's epithelium	Dog's epithelium
1	Mite Derm. Pteronyssinus		0.99	0.78	0.05	0.38	0.68	0.02	0.94	0.95
2	Mite Derm. Farinae	0.99		0.71	-0.09	0.28	0.56	-0.12	0.92	0.90
3	Household dust	0.78	0.71		0.45	0.84	0.88	0.41	0.86	0.87
4	Feathers (goose / chicken / duck)	0.05	-0.09	0.45		0.68	0.72	0.99	0.09	0.26
5	Mold (5 species)	0.38	0.28	0.84	0.68		0.73	0.66	0.49	0.49
6	Candida alb.	0.68	0.56	0.88	0.72	0.73		0.69	0.69	0.85
7	Cockroach	0.02	-0.12	0.41	0.99	0.66	0.69		0.05	0.21
8	Cat's epithelium	0.94	0.92	0.86	0.09	0.49	0.69	0.05		0.94
9	Dog's epithelium	0.95	0.90	0.87	0.26	0.49	0.85	0.21	0.94	

Thus, it was found that cross-links between allergens within the household group (related allergens) are very well traced and in some cases are even unexpected (Table 4). It has been found that people who have hypersensitivity to the mite Derm. Pteronyssinus, are also at risk ($r=0.99$, $P<0.01$) to another group of mites (Derm. Farinae), to the epithelium of cat and dog ($r=0.94–0.95$, $P<0, 01$), and to a lesser extent - to house dust ($r=0.78$, $P<0.05$). Another undoubtedly high correlation is the relationship between allergens of feathers and common cockroaches ($r=0.99$, $P<0.01$), as well as among the species of canine and feline epithelium among themselves ($r=0.94$, $P< 0.01$). Slightly lower correlation is already observed at the level of house dust / mold ($r=0.84$, $P<0.01$) and house dust / Candida alb. ($r=0.88$, $P<0.01$).

Quite a strong correlation is also observed between the representatives of the fungal flora (mold and Candida alb.), where $r=0.73$, $P<0.05$. This is due to their affinity, and above all – the similarity of the inclusion in the structures of specific forms of molecules inherent in both of them, and which in contact with the human body could have an allergy-stimulating effect. Along with family affiliation, Candida also showed a high connection with the epithelium of cat and dog ($r=0.69$-0.85, $P<0.05$), as well as feathers of chickens, geese and ducks ($r=0.72$, $P<0.05$). There are virtually no other correlations in the household group of allergens, and no inverse relationships have been observed.

An analysis was also performed on changes in the concentration of household allergen-specific IgE over time (from 2015 to 2019, Fig. 1). To do this, we calculated the growth rate of changes in the concentration of specific IgE (Table 5), which shows how many times this indicator has changed compared to the baseline (initial), and the growth rate reflects how much this value has changed.

Analysis of the results of the study revealed the following. During 2015–2016, in the structure of hypersensitivity of the population to household allergens, there was an increase in the very high level of concentration of household allergen-specific IgE by 38.2 %. And excessively high levels of antibodies to household allergens indicated stagnation of this indicator.

The dynamics of other levels of concentration of specific IgE during 2016 was negative and ranged from –13.2 % to –42.12 %.

Table 5

The rate of change in the concentrations of household allergen-specific IgE from 2015 to 2019

The level of antibody concentration	Growth rates of concentrations of household allergens, %				
	2015–2016	2016–2017	2017–2018	2018–2019	2015–2019
Very low	–13.2	+112.1	–70.2	+31.9	–24.4444
Low	–42.12	+60.7	+45.3	–74.6	–29.2308
Average	+0.3	–45.6	+37.6	–80.2	–140
High	–30.6	–22.8	+19.8	–71.2	–166.667
Very high	+38.2	–67.8	+51.3	–89.2	–180
Excessively high	0	+100	+8.1	–57.7	+100

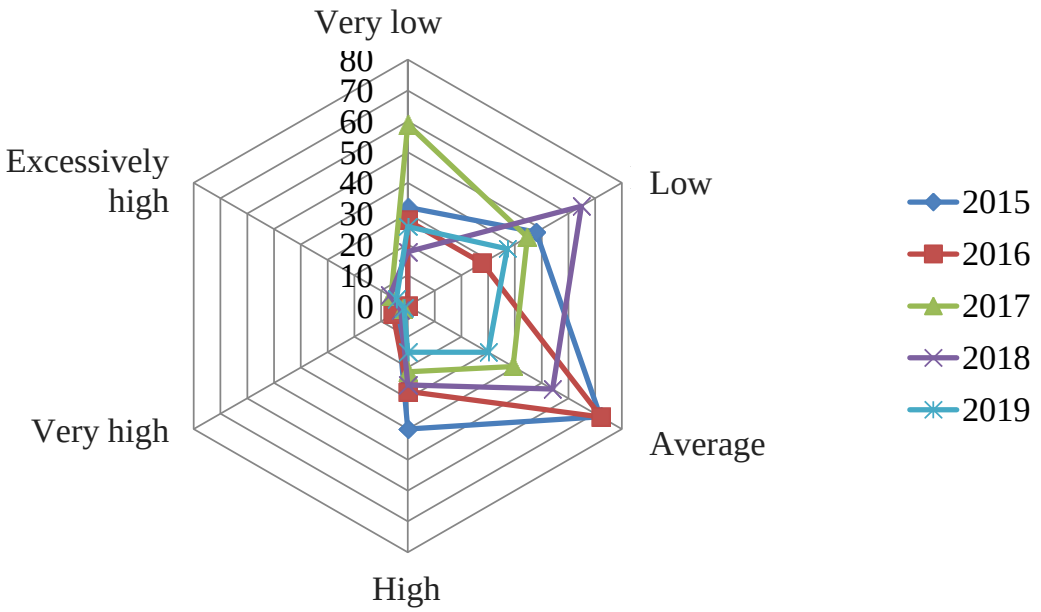

Fig. 1. Dynamics of concentration of household allergen-specific IgE from 2015 to 2019

In the following 2017, the growth rates of concentrations of specific IgE household allergens in the studied samples were positive at low (increase was 60–112 %) and excessively high levels (100 %). During 2018, there was an increase in these indicators of almost all levels of allergen-specific IgE (except very low). In 2019, the growth rate of concentrations of specific IgE household allergens in the studied samples was positive only at a very low level and reached 31.9 %.

The frequency of detection of household allergen-specific IgE, taking into account the age and sex of the subjects showed the following. Household allergens in males who applied to this laboratory accounted for 47.0 % (178 people) and women - 53.0 % (202 people). Depending on the generally accepted periodization of life, the division of males and females was carried out into 6 age groups. Detailed analysis of IgE allowed to identify dominant allergens in each of them (Table 6).

Analyzing the obtained data, it was found that children of both sexes under one year of household allergens are mainly allergic to hair and cat epithelium in boys – 9.7 %, girls – 12.5 %. In women, other respiratory allergens were not detected, and in men the most positive results were up to dog hair – 6.5 %. All other specific IgEs were significantly lower.

Comparing the results of the first age group (up to 1 year) with the second (1–3 years) found the following. Among household allergens, IgE was sharply positive for dog hair and epithelium in boys (9.2 %) and girls (9.0 %). Cat hair and epithelium as the etiological factor in girls took second place (4.5 %), and in boys – third (6.5 %), mold allergens in males was 7.4 %.

At the age of 4–6 years, among household sensitizing agents in the first place mold allergens in boys (10.5 %), and in girls – 10.6 %. Males are more likely to have IgE to the epithelium and hair of cats 5.5 %, while females are 5.8 %. It could be concluded that in this age group there is a uniform distribution of the prevalence of sensitizing factors among boys and girls, but with a predominance in frequency in the latter.

At school age (7–18 years) 9.4 % of positive results for mold allergens were found for males and 11.2 % for females. In second place in girls group, are allergens of cat hair and epithelium – 7.0 %, and in boys they are 6.6 %. They are preceded by allergens to the mite Derm. farinae – 6.7 %.

At the age of 19 and older, household allergens predominate as a cause of allergic diseases, namely mites Derm. Pteronyssinus and Derm. farinae. In addition, IgE to mold allergens dominate in women at this age. At the age of 31 and older, only house dust (6.1 %) is the leading household allergen. Unlike other age groups, IgE to fungi does not occupy a leading place, but is 3.6 %. In women of this age, the first place among allergens occupies mites Derm. pteronyssius – 7.7 %, on the second – mold allergens (7.1 %) and house dust (6.4 %). Next in structure are the mites Derm. farinae.

Table 6

Distribution of positive specific IgE according to age and sex

Allergens	Gender, age, years											
	Male						Female					
	Before 1 year	1–3	4–6	7–18	19–30	31 and older	Before 1 year	1–3	4–6	7–18	19–30	31 and older
Mold allergens, %	0	7.4	10.5	9.4	5.5	3.6	0	8.7	10.6	11.2	10.1	7.1
Cat (epithelium and hair), %	9.7	6.5	5.5	6.6	4.7	2.3	12.5	4.5	5.8	7.0	4.6	3
Dog (epithelium and hair), %	6.5	9.2	6.4	6.2	5.7	2.6	6.3	9.0	6.9	6.4	5.2	0.6
Mite Derm. Farinae, %	0	2.3	4.7	6.7	7.9	4.3	0	1.2	3.9	6.1	6.4	6.1
Household dust, %	0	1.1	2.8	3.6	4.7	6.1	0	0	0.9	2.4	2.6	6.4
Mite Derm. Pteronyssius, %	0	2.7	4.5	6.1	8.7	3.8	0	1.2	3.9	6.3	6.2	7.7
Cockroach allergens, %	0	0.2	0	0.8	0.7	0.5	0	0	0	0.4	0	0.3
Fungi Candida alb., %	0	0.5	1.3	2.1	2.5	0.8	0	0.5	1.3	2	2.6	0.2
Feathers of farm animals, %	0	0	0	0.3	0	0	0	0	0	0	0	0.1

4. Discussion of research results

The most common allergen among all patients in the household spectrum was mold, where the percentage of clinically significant results was 76.8 % (292 people), which is consistent with the results of other researchers [13, 14]. Unfortunately, this indicator was obtained from the reagent complex, which was a reagent from several species of mold, which did not allow to identify the level of sensitization to each component. However, there are assumptions about the presence of 5 species of fungi in common protein structures, which according to the theory of major and minor proteins of allergic antigens are specific in the implementation of hypersensitive effects on the body and may be present in one form among the structural components of various substances. objects. It is possible that the connection in cross-sensitization to each of these types of mold was noticed at the time and led to their combination into one enzyme-linked immunosorbent assay without an exact response at the time.

Detection of correlations between allergic antigens of mites Derm. Pteronyssinus, Derm. Farinae, the epithelium of cat and dog and house dust, which at first glance are diverse, are possible, given the theory of minor and major proteins [15, 16]. This could also happen under these conditions, as well as their constant interconnection, contact in the dust cloud, and so on. This fact is also supported by the fact that both types of mites have almost the same correlation pattern. The leading role in the allergenic activity of house dust belongs to micro-mites of the genus Dermatophagoides pteronyssinus, called “bed” mites. Ticks in house dust feed on epidermal scales, molds, food particles and other organic products [17]. To date, D. pteronyssumus and D. farunae mites have been found to account for up to 90 % of the acarofauna of the premises.

Possible connection of fungi Candida alb. and epithelial scales with dust since dust is a collection of small particles of various substances that diffuse with air particles. It is known that the components of house dust could be distributed according to their importance for the occurrence of household sensitization as follows: 1) house dust mites, 2) pet epidermis, 3) molds and insects [17].

Study limitations. The studies were screening in nature and included a study of the spectrum of substances that cause respiratory sensitization in adults and children by enzyme-linked immunosorbent assay. Therefore, in the future it is advisable to establish cross-links between several types of related allergens, which will help to deepen knowledge on this issue.

Prospects for further research. It makes sense to include in the laboratory study a molecular method for the determination of major and minor proteins in the case of the greatest relationship to determine not only a specific allergen as an etiological factor, but also a specific sensitizing protein that is part of them. This is important for subsequent immunotherapy, when the removal of only one (major) protein agent can reduce the risk of susceptibility reactions to several types of allergens.

5. Conclusions

1. Among the allergens of the household panel, the most dangerous were allergens of molds (sensitization reaction occurred in 76.8 % of respondents), cat epithelium (32.9 %) and mite Derm. Farinae (30.7 %).

2. People who have had hypersensitivity to the mite Derm. Pteronyssinus, were susceptible to another group of mites Derm. Farinae ($r=0.99$, $P<0.01$), cat and dog epithelium ($r=0.94$-0.95, $P<0.01$), and less reactive to house dust ($r=0.78$, $P<0.05$).

3. The development of cross-reactions took place between allergens of epidermal origin: there was a hypersensitivity to the fur and epithelium of dogs and cats ($r=0.94$, $P<0.01$), feathers of poultry and cockroaches ($r=0.99$, $P<0.01$).

4. Cases of inverse correlation (feedback) for allergies are not typical in any of the cases, and only their combinations are possible.

Conflict of interests

The authors declare there is no conflict of interests.

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