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INCREASED SENSITIZATION PREVALENCE TO COMMON INHALANT AND FOOD ALLERGENS IN YOUNG ADULT POLISH MALES

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Abstract: Numerous epidemiological studies concluded recently have suggested that the prevalence of allergic diseases has increased, which mainly results from an increase in the prevalence of atopic diseases. The problem is even more difficult because the number of people sensitized, who are prone to fall ill, exceeds the number of people presently ill. The prevalence of sensitization to atopic allergens and its time dynamicity is still unknown. The aim of the study was to determine the prevalence of atopic sensitization in the population of young Polish males and to compare these findings with those obtained 16 years before. The present study was performed on a group of 156 randomized healthy men, voluntary blood donors, aged 18–27 years. Having filled out a questionnaire, they underwent skin prick tests (SPTs) to common inhalant allergens. They also had a blood sample taken to have serum total IgE concentration and allergen-specific IgE (asIgE) determined to inhalant and food allergens. Positive SPT findings to at least one allergen were found in 50 (32%) subjects, and in equivocal 12 (8%). In 54 (35%) subjects asIgE to inhalant allergens was found, including 11 (7%) who had been tested for food allergens. The most common sensitizing allergen was house dust mite (20%), followed by grass/rye pollen (17%), while mould spore was the least common (4%). In town dwellers, positive SPTs were found in 41%, and were positive in 19% of people living in rural areas. While comparing the present findings with those of a similar study carried out in 1986, we found that in the last 16 years there had been a 52% increase in the prevalence of asIgE to atopic allergens. This means that the percentage of sensitized people can be estimated to have increased at a rate of approximately 3.25%/year.

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INTRODUCTION

The importance of the problem of allergy and atopy prevalence can be illustrated by the findings of numerous multicentre studies covering from one to dozens of countries. These include: ISAAC (International Study of Asthma and Allergies in Childhood), ECRHS (European Community Respiratory Health Survey) and regional projects such as SAPALDIA (The Swiss Study on Air Pollution and Lung Diseases in Adults) and CESAR (Central European Study on Air pollution and Respiratory health). Based on epidemiological data from the last decades of the 20th century, 'The Allergy White Paper' [11] estimates that in some countries allergic diseases may affect 50% of the population by 2020. At present 10–30% of the population are believed to complain of manifestations of allergic diseases. The group most often affected is young people aged 15–30 years, and the most common disease is one type of allergic diseases, namely atopic diseases [19, 24, 39]. Another 20–30% of the population, especially in the developed countries, are believed to develop positive skin prick test (SPT) reaction or have serum allergen-specific IgE (asIgE), although they are symptoms free [29]. Such individuals are in the group of high risk of developing an atopic disease. Epidemiological analyses have so far been based mainly on the morbidity rate. They rarely include the underlying

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cause – the frequency of sensitization, which characterizes a population better in terms of atopy incidence and the risk of developing atopy. Such sensitizations can be diagnosed with SPTs to appropriately selected allergens or by determining serum asIgE.

The aim of the study was: (1) to determine the prevalence of positive skin reactions and serum asIgE to a standard group of inhalant and food allergens in a precisely defined population of young, healthy males; and (2) compare these findings with those obtained from a sex- and age-matched population from 16 years before.

MATERIAL AND METHODS

Having gained acceptance from the Bioethical Committee, we performed a study on a group of 156 healthy men aged 18–27 years (mean 21 ± 7), who had volunteered to donate blood and expressed their informed consent to participate in the study (to answer questions and to have blood samples taken). For at least 3 previous months all the subjects had been living in similar conditions and had been exposed to environmental agents which were comparable.

Before giving blood, the subjects completed a questionnaire under the direction of a physician, and then they were examined by a physician and underwent SPTs. The questionnaire had been prepared according to the guidelines of the ISAAC study and supplemented with assumptions of the present study. Apart from demographic information, the questions covered present and past manifestations of asthma (A), allergic rhinitis (AR) and atopic dermatitis (AD). A general physical examination focused on signs and symptoms which might inform of contraindications to donate blood and manifestations typical of A, AR and AD.

Table 1 shows the characteristic features of the group studied including age, origin, cigarette smoking, manifestations of a present or past allergic disease.

Table 1. Characteristics of the population studied.

Group features	No. of subjects
Age: 18–27 years	156
Has been smoking cigarettes for at least a year	93
Manifestations suggesting a present or past allergic disease	20
Living in the country	64
Living in a town below 100,000 inhabitants	76
Living in a town over 100,000 inhabitants	16

SPTs were performed on the healthy skin of forearms with the use of an allergen kit (Allergopharma, Germany) following the recommendations published in the Polish edition of Standards in Allergology, Part I [37]. They included positive and negative controls, and 9 following allergenic extracts: house dust mite – *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*, dog and cat allergens, allergens of grass/rye pollen, and those of tree and weed pollen, as well as mould spores – *Alternaria alternaria* and *Cladosporium herbarum*. The blood serum was analyzed for IgE concentration and presence of asIgE to inhalant allergens using a Phadiotop (Pharmacia, Sweden) test. Tests for selected food allergens – cow milk protein, proteins of egg, wheat, soya, fish, peanuts – were performed using an Fx-5E (Pharmacia Sweden) test. Positive results of either of the tests, which are qualitative methods, meant that there was specific IgE present in the serum to at least one of the allergens included in the panel; negative results meant there were none. A serum IgE concentration higher than 135 IU/ml was classified as elevated. Serum IgE concentration and asIgE presence were compared with the findings of the 1986 study on a group of 144 men aged 18–27 years (mean 21 ± 7), who had undergone a physical examination but had not filled out a questionnaire [17].

Table 2. Data from history, SPT, asIgE and IgE in the group studied (N = 156).

Parameters			History				SPT				asIgE				IgE			
			+		–		+		–		+		–		+		–	
			n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
History	+	20					13	8	7	5	17	11	3	2	10	6	10	7
	–	136					37	24	99	63	37	24	99	63	45	29	91	58
SPT	+	50	13	8	37	24					39	25	11	7	28	18	22	14
	–	106	7	5	99	63					15	10	91	58	27	17	79	51
asIgE	+	54	17	11	37	24	39	25	15	10					32	21	22	14
	–	102	3	2	99	63	11	7	91	58					23	14	79	51
IgE	+	55	10	6	45	29	28	18	27	17	32	21	23	14				
	–	101	10	7	91	58	22	14	79	51	22	14	79	51				
Total		156	20	13	136	87	50	32	106	68	54	35	102	65	55	35	101	65

Table 3. Simultaneous or separate incidence of positive SPT and asIgE in the group studied – in positive and negative history subgroups.

	No. of subjects N = 156		Negative history N = 136		Positive history N = 20	
	n	%	n	%	n	%
SPT(+)	11	7	10	7.5	1	5
SPT(+) and asIgE	39	25	27	20	12	60
asIgE	15	9	10	7.5	5	25
Total	65	41	47	35	18	90

The characteristic features of the population studied have been analysed statistically using descriptive statistics (mean percentages and standard deviation), and the chi-square test was used to compare the asIgE prevalence in the subjects studied in 1986 and those in 2002. $P<0.05$ was considered statistically significant.

RESULTS

Table 2 shows that in the group of 156 subjects, 50 (32%) had positive SPTs to at least one allergen, asIgE was present in 54 subjects (35%), and serum IgE concentration was elevated in 55 (35%).

In a subgroup of 136 subjects with negative history and physical examination findings, both positive SPT and asIgE present to at least one allergen were found in 37, and serum IgE concentration increased in 45.

In a subgroup of 20 (13%) subjects with positive history but negative physical examination findings, the possibility of an atopic disease was suspected. Asked about manifestations (AR), (AD) and (A), they gave a positive response although initially they had considered themselves totally healthy. In 13 (8%) subjects in this subgroup, SPT to at least one allergen was found to be positive, asIgE was present in 17 (11%), and serum IgE concentration increased in 10 (6%).

Table 3 shows that out of 156 subjects 39 (25%) had simultaneously both positive SPTs and asIgE presence. Either positive SPT or asIgE present was found in 11 (7%) and 15 (9%) subjects, respectively. In 27 of 136 negative history subjects (20%) both positive SPT and asIgE were present simultaneously. Either positive SPT or asIgE present were found in 10 (7.5%) subjects each. In 12 out of 20 positive history subjects (60%) both positive SPT and asIgE were found simultaneously. Either positive SPT or asIgE present were found in one (5%) and 5 (25%) subjects, respectively.

Analysis of the data presented in Table 5 shows that SPT and asIgE findings were consistent in 57% in the negative history subgroup, in 60% in the whole group studied, and in 67% in the positive history subgroup. While comparing the percentage of positive SPTs, the highest values were found in the positive history subgroup (65%), followed by 32% in the whole group studied, and 27% in the negative history subgroup.

Table 4 shows that there was no significant difference in the sequence of sensitizing agents when the incidence of positive SPT to particular allergens in the whole group and in the negative history subgroup were analyzed. The most sensitizing allergen was that of house dust mite at 20% in the whole group and 19% in the negative history subgroup. Considering the both groups respectively, further allergens were: grass/rye pollen at 17% and 14%, followed by cat allergen at 10% in both groups, weed at 10% and 8%, and tree allergen at 8% and 7%. The least sensitizing were dog allergen at 6% and 5%, and mould spores at 4% and 3%, respectively.

Positive SPT to one allergen was found in 19 (12%) subjects, whereas in the remaining 31 (20%) SPTs were positive to 2 or more allergens.

There were no statistically significant differences found in the mean IgE concentrations between the 1986 group of 144 subjects (mean 126 ± 204 IU/ml) and those from the 2002 group of 156 subjects (mean 182 ± 297 IU/ml). In 1986, the mean serum IgE concentration in those with

Table 4. Positive SPT incidence for individual allergens in the whole group and in the negative history subgroup.

	Number of subjects n=156 (whole group)			Number of subjects n=136 (negative history)		
	No. of subjects with SPT (+)	%	SPT (+)%	No. of subjects with SPT (+)	%	SPT (+)%
Mite	31	20	62	26	19	70
grass/corn	27	17	54	19	14	51
Cat's allergen	15	10	30	13	10	35
Weeds	15	10	30	11	8	29
Trees	13	8	26	10	7	27
Dog's allergen	9	6	18	7	5	18
Mould	7	4	14	5	3	8

Table 5. Mean IgE concentration and standard deviation in the groups studied in 2002 with elevated and normal IgE concentrations and positive and negative SPTs.

	Group studied		Positive history		Negative history		Group studied	
	IgE>135	IgE<135	IgE>135	IgE<135	IgE>135	IgE<135	SPT (+)	SPT (–)
Mean concentration	427	49	752	69.5	354	47	287	132
Standard deviation	±397	±36	±365	±40.7	±369	±35	±323	±272

Table 6. PTS, asIgE and IgE mean concentration (±SD) in subjects living in towns and the country.

	SPT				asIgE				IgE IU/ml	
	positive		negative		present		absent		mean concentration	Standard deviation
	n	%	n	%	n	%	n	%		
country	12*	19	52	81	10*	16	54	84	142.2	±110
towns	38*	41	54	59	44*	47	48	53	186.1	±310

* $p<0.05$

asIgE present was found in 33 (23%) subjects (mean 258 ± 327 IU/ml), and in 111 of those in whom asIgE was absent (mean 78 ± 113 IU/ml), which made it statistically significantly different ($p<0.05$). In 2002, in the positive SPT group, the mean serum IgE concentration was 287 ± 323 IU/ml, and was therefore similar to that in the group with asIgE present where it was 296 ± 311 IU/ml. In both groups mentioned above, mean IgE concentrations were significantly statistically higher ($p<0.05$) when compared with those with negative SPTs and asIgE absent, where they were 132 ± 272 IU/ml and 121 ± 272 U/ml, respectively.

Tables 2 and 5 show that in 2002 an increased serum IgE concentration to at least one allergen was found in 55 subjects (35%) (mean 427 ± 397 IU/ml). IgE concentration was normal in 101 (65%) subjects (mean 49 ± 36 IU/ml), which made it statistically significantly different ($p<0.05$). In a subgroup of 20 positive history subjects, an increased serum IgE concentration was found in 10 subjects (mean 752 ± 365 IU/ml). It was normal also in 10 (mean 69.5 ± 40.7 IU/ml), which was significantly statistically different ($p<0.05$) between the 2 groups. In a subgroup of 136 negative history subjects, an increased serum IgE concentration was found in 45 subjects (mean 354 ± 369 IU/ml). It was normal in 91 (mean 47 ± 35 IU/ml), which was significantly statistically different ($p<0.05$) between the 2 groups. Positive SPT to at least one allergen was found in 50 (32%) subjects (mean IgE 287 ± 323 IU/ml). It was normal in 106 (68%) (mean IgE 132 ± 272 IU/ml), which made it statistically significantly different ($p<0.05$).

Table 6 shows that among people living in the rural environment SPTs were positive in 12 (19%) and asIgE present in 10 (16%), whereas among city dwellers they were found in 38 (41%) and 44 (47%), respectively. There was no statistically significant difference found between the 2 groups in terms of IgE concentrations, which were 142.2 ±110 IU/ml and 186.1 ±310 IU/ml. The chi-square test revealed there was a significant statistical difference in the prevalence of SPTs and asIgE between the subjects living in towns and those living in the country.

Table 7. Comparison of serum IgE concentration and asIgE presence in the groups studied in 1986 vs. 2002.

Number of subjects (n)		1986 N = 144		2002 N = 156	
		n	%	n	%
asIgE	Present	33*	23	54*	35
	Absent	111	77	102	65

* $p<0.05$

Table 7 illustrates that findings of the 1986 study compared with those of the present study; it was found there had been a statistically significant ($p<0.05$) 52% increase in the percentage of individuals with asIgE present. This means a 3.25%/year increase of individuals sensitised.

DISCUSSION

The present study has shown that in 2002, in young men in Poland, positive SPT and asIgE for at least one atopic allergen could be found in a similar percentage of subjects – 32% and 35%, respectively. Considering the findings of the epidemiological studies in Poland which had been the basis for the estimation of allergic diseases incidence – approx. 16% in the adult population [27], it might be suggested that those currently suffering from an atopic disease in Poland are about 45% of the whole risk group prone to having an allergic disease. Comparing the present findings with those obtained in 1986, it can be said that in the 16 years in the Polish population the number of people with serum asIgE increased by 52%, which translates into a mean annual

increase of 3.25%. If 1986 is taken as a reference point, an absolute increase of atopics percentage in the whole population was 12% (an increase from 23% to 35%), which translates into a mean absolute annual increase by 0.75 percentage point. The findings obtained have also confirmed an increase in the number of sensitized people (positive SPT and/or serum asIgE present) who may fall ill with an atopic disease in the future, proving a general increasing trend similar to that of allergic diseases.

It has also been shown that 13% of young men, in some period of their lifetimes, might develop intermittent manifestations suggesting an atopic disease (AR, AD, A), which these men did not realize. In 65% of young men, serum IgE concentration was normal, but in as many as 35% it was elevated. This, however, did not allow for a satisfactory foreseeing of the presence or absence of atopy because an elevated IgE concentration was found only in 56% of the subjects with positive SPTs, and in 59% of those with asIgE present. This fact proves that the quality of this parameter is limited, and it does not seem to be suitable for epidemiological studies, which has also been pointed out by other authors [10].

In the subgroup with positive history, positive SPT was observed less frequently than the presence of serum asIgE. Yet in the negative history subgroup no such significant differences were noted. In 38% of positive SPT subjects, sensitization to one allergen was found; in the remaining 62% – to more than one allergen. The most common allergen sensitizing the subjects studied was house dust mite (20%), followed by grass/rye pollen (17%), cat allergen and weed pollen (both 10%). Dog allergen was less common (6%), and the least common was that to mould (4%). Interestingly, all subjects allergic to food allergens were allergic to inhalant allergens.

The risk of suffering from an atopic disease stems from active allergy, which can be diagnosed with an SPT and/or the presence of asIgE in the serum. The present study has shown that only in 39 subjects (25%) both parameters could inform about such a risk, whereas in another 26 subjects (16%) it was either one of them. Among these subjects, in 11 (7%) it was SPT; in 15 (9%) asIgE present in the serum.

The results of the present study concerning the presence of serum asIgE and serum IgE concentration were compared with those of the similar studies carried out in 1986. It must be pointed out that in 1986 the basic method of diagnosing atopic allergy was a direct test to find if in the serum there was IgE specific to a particular types of food and inhalant allergens. In 2002, more modern screening tests were employed for this purpose (Phadiatop and Fx-5E), which simplified the examinations but does not seem to have had any significant influence on the detectability of antibodies. Many authors believe that the diagnostic value of asIgE determining in food allergy largely depends on the type of allergen [13, 40]. Determining asIgE to allergens of plant origin and fish allergen is considered reliable. Yet, in as many as 50% of patients allergic to animal protein the diagnostic quality of the test is doubtful [2, 8]. In the present study the percentage of subjects who had asIgE to food allergens was not high, i.e. 11%.

In the SAPALDIA study, the incidence of allergy among adults aged 18–60 years diagnosed with SPTs was 32.3%, it was therefore similar to that in the present study. The existing differences were in the incidence of allergy to particular allergens. The most sensitizing allergen was grass pollen (12.7%), followed by mite (8.9%), birch (7.9%), and cat's and dog's fur allergens (3.8% and 2.8%, respectively) [34]. The studies performed by Burney *et al.* [7] as part of the ESRHC research study covering the population aged 20–44 years from numerous countries, showed the incidence of asIgE to atopic allergens ranged between 22–44%. The highest values were found in the UK (44%) and Germany (35%), the lowest in Greece (25%) and Iceland (22%). That study showed that in the region of Wrocław, Poland, positive SPT was found in 34.5% of the group studied [28]. Such a result is similar to that obtained in the present study.

In separate studies, attempts have been undertaken to assess the prevalence of atopy among athletes. Lapucci *et al.* (20) carried out a study on Italian athletes training for the Sydney Olympic Games in 2000. They found SPTs to have been positive in 32.6%. Lumme *et al.* [23], who studied the allergy incidence in athletes in 2003, found positive SPTs in as many as 57% of professional ice hokey players. In another study in 2002, Leung *et al.* [21] diagnosed students from 3 Asian towns: Hong Kong, Kota Kanibalu in Malaysia and San Bu in China, and found positive SPTs in as many as 49.0–63.9% of them. The literature proves that the prevalence of atopic allergies at present is relatively high in populations living in different countries throughout the world. All age groups are affected, although the prevalence in children and young people is substantially higher than in the elderly.

High prevalence indices of allergy diagnosed with SPTs presented in the study are connected with a consistent increase of allergy prevalence confirmed in all the studies focused on this problem [5, 12, 15, 20].

The data concerning the prevalence of allergy to particular allergens are ambiguous. Some studies, similarly to the present one, argue the allergy to house dust mite is more prevalent than that to grass pollen [6, 12, 16, 25, 30]. In others, allergy to grass pollen prevails [5, 22, 34]. Among allergic clinics patients, i.e. patients suffering from atopic diseases, allergy to grass pollen is usually encountered more frequently [18, 38].

The so-called civilisation theory of allergic diseases claims that an early contact with various allergens (plant and domestic animals allergens), which is so common in the country, makes the sensitisation and allergic disease prevalence much lower in the rural population in comparison with town dwellers. The present study has found that the percentage of positive SPTs in town dwellers was 41%,

and was more than double than that observed in people living in the country, where it was 19%.

The results of various studies published so far which have assessed the temporal dynamicity of atopic allergy in different age groups and periods are also equivocal [3, 6, 16, 31, 32]. In some of them, the atopic allergy prevalence increases faster, in others more slowly, which confirms the trends observed in the analyses of allergic diseases morbidity. It is worth noticing that none of the studies has found the prevalence of allergy to have decreased.

The dynamicity of allergy prevalence increase, similar to that observed in the present study, was reported in the US in the 1980s. Barbee *et al.* [3] within 9 years found an increase of allergy prevalence by 28% in the age group of 15–24 years; and by 25% in subjects aged 25–34 years. Thus, the annual increase in their study was 3%/year, which is very similar to the increase reported in the present work.

Broadfield *et al.* [6] obtained much lower results in a recent study performed in the UK. Their 9-year-long study revealed an increase in allergy by 11% in subjects aged 27–35 years, which translates into only 1.2% per year. In the 1990s in Australia, Peat *et al.* [31] in a similar period found an allergy increase in subjects aged 15–55 years to have been 5%, i.e. only around 0.5/year. Linneberg *et al.* [22] reported higher prevalence findings, since in a similar period of time they noted an increase in the allergy incidence in Denmark by 28% in subjects aged 15–41 years, i.e. by 3.5%/year. Also Krause *et al.* [16] studied the inhabitants of Greenland aged 15–80 years and during 11 years found the increase of allergy prevalence to have been very high, namely 90%, i.e. 8.2%/year. These latter results clearly differed from those of the former studies.

The data from the literature on the dynamicity of temporal trends in atopic allergy in children are also equivocal, just like those referring to adults. In Australia, Peat et al. [32] estimated the prevalence increase of allergy of this type in children in the period of 10 years at 15%, i.e. 1.5%/year. In Germany, though, von Mutius *et al.* [42] observed an increase by 42% in 5 years, that is 8.2%/year. Pisiewicz *et al.* [33], in a study carried out during 12 years in Poland, found no significant increase of atopy prevalence in children, which seems hardly reliable.

The above-mentioned differences in the allergy prevalence increase reported from studies on adults and children might have been due to numerous factors. The studies comprised subjects in different age groups; and in the case of young individuals the allergy prevalence may be higher. Also the length of the periods studied differed between studies. Even as short a period as 5-years was evaluated; on average 8–9 years, but never has it been as long as the presented one. A significant parameter might have been also the number of subjects with allergy included in the initial phase of a study. The smaller the cohort, the bigger was the dynamicity, which was particularly visible in older and longer studies. The geographic differences between the regions where the studies were carried out also contributed to different risk factors of atopy appearance and development. The methodology of atopic allergy diagnosis was different, as were the criteria of a positive finding.

Nor is it clear what the dynamicity of allergy prevalence increase will look like in the future [12, 25, 26, 30]. Part of the recent studies analyzing asthma (A) morbidity prevalence in various age groups suggest that it is now constant [4, 9, 35, 36] or even diminishing [1, 14, 43]. It is also worth noting that more than 10% of healthy individuals who have positive SPTs never develop an atopic disease, as pointed out by other authors. Thus, predispositions (atopy) seem to depend rather on genetic factors, whereas developing an atopic disease is firstly stimulated by such environmental factors as: allergens; air, food and water pollution; viral and bacterial infections; and commonly used chemical substances. For example, in the Gambian adult population coming from both industrial and rural regions, atopy prevalence was 35.3%, whereas (A) was diagnosed only in 3.6% [41]. In China, atopy was prevalent in 49% but (A) diagnosed in 1.9% [21]. Among Nigerian children aged 8–11 years, atopy was found in 28.2%, and (A) in 6%. Australian children were diagnosed with atopy in 32.5%, and (A) in 28% [12]. It seems that this variability may refer to the allergy to particular allergens. Until recently, a common allergen was birds feathers. At present, this type of allergy is so rarely diagnosed that it is not even included in a screening allergen kit [37]. Unfortunately, reliable studies on temporal changes in the prevalence of allergy to particular allergens are lacking.

Summing up, basied on the studies performed in 1986 and 2002, the increase of the dynamicity of the number of people in Poland prone to be ill with an allergic disease can be estimated at approximately 3.25%/year, which is still less than in other countries. Just as in the case of allergy morbidity, it is difficult to find one cause responsible for the existent increase in the atopic allergy prevalence. Genetic preferences seem a rather unlikely candidate. Many authors believe that, similarly to the morbidity of atopic diseases, the main contributing factors are connected with environmental changes (including allergens), abandoning traditional dietary habits, and adopting the so-called 'western style of living'. It is not clear, though, if this trend in the increasing dynamicity of allergy prevalence in the population will continue in the coming years.

CONCLUSIONS

- At present, 27% of young men in Poland whose history finding for an allergic disease is negative, are diagnosed with allergy to atopic allergens.
- The most common allergen, sensitizing 20% of the population, is that to house dust mite.
- The comparison of the present incidence of serum asIgE with that from 16 years ago in a similarly selected group of young men shows an increase of this parameter by 52%, on average 3.25%/year.

• Epidemiological studies on the incidence of allergic diseases should include the prevalence of allergy as the most important factor to which the development of allergic diseases is due.

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