

Sensitization to aeroallergens depends on environmental factors

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Respiratory allergies and subclinical sensitization to aeroallergens were investigated in 129 rural and in 222 urban probands. The incidence of respiratory allergies was not significantly higher in the urban residents. Sensitization to aeroallergens was investigated with Phadezym RAST (house dust mite, *Cladosporium*, orchard grass, birch pollens) and the Phadiatop multi RAST and found to be significantly more frequent in polluted than in unpolluted areas. Allergen-specific IgE was detected in 37.8% of urban probands and in 25.6% of rural probands with Phadezym RAST ($P < 0.025$) and a positive Phadiatop multi RAST was found in 43.7% versus 32.6 ($P < 0.05$).

Key words: aeroallergens; IgE; Phadiatop multi RAST; sensitization.

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The incidence of allergies to aeroallergens varies within a wide range, being influenced by differences in study population, sex, age, and laboratory methods (3, 5-7, 14, 17-20, 25). Some reports describe an increase in the incidence of allergies in recent years (7, 9, 14). In addition, a high incidence appears correlated to air pollution levels (9, 19, 20). Studies based on a questionnaire alone have various drawbacks, being able to detect neither each clinically manifest allergy nor subclinical sensitization. The skin test for example is a method often used to detect allergies and subclinical sensitization, but other test methods which detect allergen-specific IgE in serum seem more sensitive, especially in the early phases of sensitization (1, 8, 10, 13, 21, 27).

This study was designed to detect differences in the incidence of clinically manifest respiratory allergies and subclinical sensitization to aeroallergens between residents of a polluted urban area and an unpolluted rural area.

MATERIAL AND METHODS

The study population consisted of 362 consecutively recruited male subjects (age 15 to 28 years) who underwent routine venipuncture for exclusion of venereal diseases. 222 persons had lived since birth in a major city (Vienna or Linz), known for a high degree of air pollution (2). 129 persons had lived since birth in the country, far from large town or major industries. Persons who moved from town to country ($n = 2$) or vice versa ($n = 9$) were excluded from further investigations.

The study was performed in late autumn at the end of the pollen season. Anamnesis consisted of standardized questions for seasonal or perennial symptoms of conjunctivitis, rhinitis or bronchial asthma, for exogenous causes of these symptoms, and for smoking history.

Total IgE was measured with Phadezym PRIST and allergen-specific IgE with Phadezym RAST (Pharmacia) (15, 26). Allergen-specific IgE was measured against common aero-

allergens, i.e. house dust mite (*Dermatophagoides pteronyssinus*), *Cladosporium herbarum*, orchard grass (*Dactylis glomerata*), and birch pollens (*Betula verrucosa*). Allergen-specific IgE was rated positive above 0.35 PRU/ml. An additional *in vitro* test, the multi RAST (Phadiatop®) was also used (12). Statistical analysis was done using the Student-t-test and the chi-square test (24). $P < 0.1$ was considered indicative of a trend and < 0.05 to be statistically significant.

RESULTS

All probands were free of viral or venereal diseases and the anthropometric data of the urban population ($n = 222$) were comparable with those of the rural population ($n = 129$). Age ranged from 15 to 28 years (mean 19.5) in the urban and from 16 to 26 years (mean 20.7) in the rural population. Recent smoking history was found in 98 town probands (44.1%) and in 61 rural probands (47.3%). Probands from town did not differ from those from the country with respect to duration of nicotine abuse (4 years versus 4.5 years) or by the criterion of overall nicotine abuse (3.8 pack years versus 4 pack years).

Results of allergological investigations are given in Table 1: in the urban group 35 of 222 probands (15.7%) showed clinically manifest allergies of the eyes and respiratory system. In the rural population only 19 of 129 probands (14.7%) showed clinically manifest allergies but

this small difference was not statistically significant.

As far as the total IgE is concerned, there was a slightly higher number of urban as opposed to rural probands who showed increased levels (> 100 kU/l) of total IgE: 93 of 222 (41.9%) versus 45 of 129 (34.9%). Regarding sensitization, specific IgE to each of the investigated allergens were found more often in town than in country residents. This was most obvious in specific IgE to house dust mite and orchard grass pollens. Summarizing overall sensitization to aeroallergens we more often detected specific IgE to one or more investigated aeroallergens in the probands from the town than in those from the country ($P < 0.025$). Town probands also more often showed positive multi RAST (Phadiatop) than country probands ($P < 0.05$). Results of sensitization to aeroallergens were comparable in smokers and non-smokers.

DISCUSSION

Environmental factors, such as allergen load or air pollution, are often held responsible for provoking respiratory diseases and allergies (7, 11, 14, 19, 20, 25). In this study we investigated the different incidences of allergic diseases and of sensitization to aeroallergens, even when the latter was subclinical, by comparing residents from highly polluted areas (Vienna and Linz) with residents from largely unpolluted areas (country far removed from industry and heavy

Table 1
Distribution of allergic diseases and sensitization in probands from town and country

	Town ($n = 222$) (%)	Country ($n = 129$) (%)	
Clinically manifest allergies	35 (15.7)	19 (14.7)	NS
Total IgE (> 100 kU/l)	93 (41.9)	45 (34.9)	NS
Spec. IgE to one or more aeroallergens	84 (37.8)	33 (25.6)	$P < 0.025$
Phadiatop® pos	97 (43.7)	42 (32.6)	$P < 0.05$
Spec. IgE to house dust mite	38 (17.1)	12 (9.3)	$P < 0.05$
Spec. IgE to <i>Cladosporium</i>	6 (2.7)	2 (1.6)	NS
Spec. IgE to orchard grass pollens	59 (26.6)	24 (18.6)	$P < 0.1$
Spec. IgE to birch pollens	22 (9.9)	10 (7.8)	NS

traffic). We found no significantly higher incidence of clinically manifest allergies in the town population than in the rural.

Even total IgE can be influenced by various other factors, a slightly higher number of town probands showed increased values of total IgE (> 100 kU/l). The most marked differences were seen with respect to sensitization to aeroallergens. In the town we found higher numbers of probands who developed allergen-specific IgE than in the country, the difference being most striking for house dust mite but also well marked for orchard grass pollens. Seasonal and indoor climate changes can influence the levels of house dust mite but important differences of environmental conditions can be excluded in our study population. A similar tendency to a higher incidence of sensitization was seen to *Cladosporium* and birch pollens. Total sensitization to common inhalant allergens investigated with multi RAST (Phadiatop) was also shown to be higher in residents in the town than in the country. Even if we could not reveal a significant difference in sensitization to aeroallergens in smokers and non-smokers, we cannot exclude a harmful effect of this important air pollutant in some of our probands. The relatively high incidence of sensitization to aeroallergens can be ascribed to the time of year of the investigation, and a seasonal rhythm of allergies (4, 22).

The presence of specific IgE against aeroallergens without manifest allergic diseases can be explained as subclinical sensitization, which can precede the onset of allergic diseases (21). Further, the sensitization to aeroallergens shown by investigation of specific IgE appears to be one of the most sensitive parameters for assessing the influence of air pollution. Finally, we believe that increasing levels of air pollution can undermine local defence barriers and increase bronchial hyperreactivity. The increased absorption of antigens across mucosal surface and the more efficient contact between antigens and antigen-presenting cells can lead to an increased sensitization to aeroallergens (16). A further adverse mechanism might be the increased antigenicity of pollens by exposure to air pollutants (SO_2 , NO_2 and CO) (23). Such reactions may

be the underlying mechanisms of increased sensitization observed in polluted areas.

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REFERENCES

- Ahlstedt, S., Eriksson, N., Lindgren, S. & Roth, A.: Specific IgE determination by RAST compared with skin and provocation tests in allergy diagnosis with birch pollen, timothy pollen and dog epithelium allergens. *Clin. Allergy* 4, 131-140, 1974.
- Aigner, K. & Schindl, R.: Bronchitis und Umwelt-Infrastruktur. *Wien. Med. Wschr.* 23, 617-620, 1986.
- Barbee, R. A., Lebowitz, M. D., Thompson, H. C. & Burrows, B.: Immediate skin-test reactivity in a general population sample. *Ann. Intern. Med.* 84, 129-133, 1976.
- Berg, T. & Johansson, S. G. O.: In vitro diagnosis of atopic allergy. IV. Seasonal variations of IgE antibodies in children allergic to pollens. *Int. Arch. Allergy Appl. Immunol.* 41, 451-462, 1971.
- Bericano, F. A., Crespo, M., Bao, C. G. & Alvarez, F. V.: Serum levels of total IgE in non-allergic children. Influence of genetic and environmental factors. *Allergy* 42, 267-283, 1987.
- Dupal, H. D., Horak, F. & Türk, R.: Häufigkeit der Inhalationsallergie bei Schulkindern im ländlichen Raum im Vergleich zum Großstadtgebiet. *Laryngol. Rhinol. Otol. (Stuttg.)* 67, 648-650, 1982.
- Eaton, K. K.: The incidence of allergy - has it changed? *Clin. Allergy* 12, 107-110, 1982.
- Eichler, I., Götz, M., Jarisch, R., Eichler, H. G. & Moss, R.: Reproducibility of skin prick testing with allergen extracts from different manufactures. *Allergy* 43, 458-463, 1988.
- Gassner, M., Peeters, A. G. & Primault, B.: Relation von meteorologischen Gegebenheiten mit Pollen- und Luftschadstoffmissionen, insbesondere Ozon, im Rheintal. *Schweiz. Ärztezeitung* 68, 1079-1082, 1987.
- Gleich, G. J., Averböck, A. J. & Swedlund, H. A.: Measurement of IgE in normal and allergic serum by radioimmunoassay. *J. Lab. Clin. Med.* 77, 690-698, 1971.
- Goldstein, I. F. & Cuzick, J.: Daily patterns of asthma in New York City and New Orleans: An epidemiologic investigation. *Environ. Research* 30, 211-223, 1983.
- Gustafsson, D. & Danielsson, D.: In vitro diagnosis of atopic allergy in children. A comparison between total IgE, conventional RAST and a new multi RAST (Phadiatop). *Allergy* 43, 105-108, 1988.
- Hagy, G. W. & Settapan, G. A.: Risk factors for developing asthma and allergic rhinitis. A 7-year follow-up study of college students. *J. Allergy Clin. Immunol.* 58, 330-336, 1976.

14. Jarisch, R.: Atopie-syndrom: Familiäre Faktoren, Allergie- und andere Umweltfaktoren. *Allergologie* 10, 487-489, 1987.
15. Johansson, S. G. O., Bennich, H. & Berg, T.: In vitro diagnosis of atopic allergy. III. Quantitative estimation of circulating IgE antibodies by the radioallergosorbent test. *Int. Arch. Allergy Appl. Immunol.* 41, 443-451, 1971.
16. Leskowitz, S., Salvaggio, J. E. & Schwartz, H. J.: An hypothesis for the development of atopic allergy in man. *Clin. Allergy* 2, 237-246, 1972.
17. Lu, M. C., Smolensky, M. H., Hsi, B. & McGovern, J. P.: Seasonal changes in immunoglobulin and complement levels in atopic and nonatopic persons. In Smolensky, M. H., Reinberg, A. & McGovern, J. P. (eds.): Recent advances in the chronobiology of allergy and immunology, pp. 275-286. Pergamon Press, Oxford, 1980.
18. Mosbech, H.: House dust mite allergy. *Allergy* 40, 81-91, 1985.
19. Peat, J. K., Britton, W. J., Salome, C. M. & Woolcock, A. J.: Bronchial hyperresponsiveness in two populations of Australian schoolchildren. II. Relative importance of associated factors. *Clin. Allergy* 17, 283-290, 1987.
20. Peat, J. K., Britton, W. J., Salome, C. M. & Woolcock, A. J.: Bronchial hyperresponsiveness in two populations of Australian schoolchildren. III. Effect of exposure to environmental allergens. *Clin. Allergy* 17, 291-300, 1987.
21. Popp, W. & Zwick, H.: Befunde bei der Entstehung einer Mehlallergie am Beispiel einer Querschnittsuntersuchung von Bäckerlehrlingen. *Allergologie* 11, 498-502, 1988.
22. Reinberg, A., Gervais, P., Levi, F., Smolensky, M., Del Cerro, L. & Ugolini, C.: Circadian and circannual rhythm of allergic rhinitis: An epidemiologic study involving chronobiologic methods. *J. Allergy Clin. Immunol.* 81, 51-62, 1988.
23. Ruffin, J., Liu, M. Y. G., Sessoms, R., Banerjee, S. & Banerjee, U. C.: Effects of certain atmospheric pollutants (SO_2 , NO_2 and CO) on the soluble amino acids, molecular weight and antigenicity of some airborne pollen grains. *Cytobios* 46, 119-129, 1986.
24. Sachs, L.: *Angewandte Statistik*. 6th ed. Springer, Berlin, 1984.
25. Salome, C. M., Peat, J. K., Britton, W. J. & Woolcock, A. J.: Bronchial hyperresponsiveness in two populations of Australian schoolchildren. I. Relation to respiratory symptoms and diagnosed asthma. *Clin. Allergy* 17, 271-281, 1987.
26. Wide, L., Bennich, H. & Johansson, S. G. O.: Diagnosis of allergy by an in vitro test for allergen antibodies. *Lancet* 2, 1105-1107, 1967.
27. Zetterstrom, I. & Johansson, S. G. O.: IgE concentration measured by PRIST in serum of healthy adults and in patients with respiratory allergy: A diagnostic approach. *Allergy* 36, 537-547, 1981.

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