

Onset and Remission of Allergic Rhinitis and Asthma and the Relationship with Atopic Sensitization and Smoking

PETER P. PLASCHKE, CHRISTER JANSON, EVA NORRMAN, EYTHOR BJÖRNSSON, SUSANNE ELLBJÄR, and BENGT JÄRVHOLM

Amager Hospital, Copenhagen University Hospitals, Denmark, and Department of Respiratory Medicine and Allergology, Sahlgrenska University Hospital, Göteborg, Sweden; Department of Medical Sciences, Respiratory Medicine and Allergology and Asthma Research Center, Akademiska Sjukhuset, Uppsala, Sweden; Department of Pulmonary Medicine and Allergology, University Hospital of Northern Sweden, Umeå, Sweden; and Occupational Medicine, Department of Public Health and Clinical Medicine, Umeå University, Umeå, Sweden

The aim of this study was to assess the influence of some risk factors for onset and remission of allergic rhinitis and asthma in Swedish adults. A random sample of 1,370 subjects, age 20 to 44 yr was investigated by means of postal questionnaires in 1990 and 1993. Skin prick tests were conducted in 1991–1992. The association between risk factors and onset or remission of allergic rhinitis and asthma was estimated using multivariate logistic regression analysis. Onset of allergic rhinitis was associated with sensitization to birch (odds ratio [OR] = 6.5), *Parietaria* (OR = 7.4); and pets (OR = 3.0) and with female sex (OR = 1.9). Onset of asthma was associated with allergic rhinitis (OR = 4.9), sensitization to pets (OR = 2.4); and with smoking (OR = 3.0). Onset of asthma was strongly associated with allergic rhinitis among atopics (OR = 5.7), but onset of asthma and rhinitis also tended to be related among nonatopics (OR = 3.5). A strong association between smoking and onset of asthma was found among nonatopics (OR = 5.7). In conclusion, sensitization to pollens and pets were risk factors for onset of allergic rhinitis, whereas allergic rhinitis, sensitization to pets, and smoking were risk factors for onset of asthma.

The prevalence of allergic rhinitis (AR) and asthma has increased during the last 30 years in many countries including Sweden (1, 2). Cross-sectional studies have revealed that adult asthma is associated with sensitization to inhaled allergens (3–5). However, prevalence studies have some limitations considering the identification of risk factors. The association between atopic sensitization and asthma in adults could be caused by asthma that started in childhood. Other possible risk factors could be obscured by change in exposure or lifestyle after the onset of the disease (e.g., change of smoking habits after the onset of asthma). The aims of this study were to investigate the influence of some risk factors for onset or relapse and remission of AR and asthma.

METHODS

Study Design and Population

The first two parts of this study were performed in accordance with the European Community Respiratory Health Survey (ECRHS) protocol (6), i.e., a cross-sectional investigation of a random sample of the general population. A random sample of 1,800 men and 1,800

women age 20 to 44 was selected from each of the three Swedish study areas using the national, computerized population register, which contains continuously updated information about age, sex, and address for the total population of Sweden. The computerized selection of the random population samples was done directly from the register and independent of the study investigators. A postal questionnaire (Stage I) was sent to all subjects in the beginning of December 1990 (7). With the aim of obtaining approximately 600 participating subjects from each area, random subsamples of individuals (950, 800, and 672 subjects from Göteborg, Uppsala, and Västerbotten, respectively) were selected for participation in Stage II of the study. The subjects were selected from the original Stage I sample using computerized randomization. The different numbers of subjects were chosen owing to differences in estimated participation rates between the areas. Only those who had previously answered the screening questionnaire were invited to participate. In all, 89.2% of the invited subjects agreed to participate. Stage II was conducted between February 1991 and June 1992 and included a large questionnaire, skin prick tests, total and specific immunoglobulin E (IgE), lung function and methacholine challenge tests (5, 8). In the third stage of the study, we used a postal questionnaire, identical to the initial screening questionnaire. It was sent to all subjects who had participated in the second stage of the study, in the beginning of December 1993, exactly 3 yr after the initial questionnaire. In total, 1,358 subjects (86% of those invited) participated in this third stage of the study.

The study was approved by the ethics committees at the universities in the three areas and by the Swedish Data Protection Board.

Areas of Residence

The study areas are described in our previous publications (7, 8). Göteborg is the second largest city in Sweden, located at the sea in the southwestern part of the country. Uppsala is a university city, 60 km northwest of Stockholm in the interior of the country. Västerbotten is a large county in northern Sweden with a subarctic climate.

In all three areas, the birch pollen season in May 1993 was the most powerful ever recorded (9).

Questionnaires

The screening questionnaire was the ECRHS modified version of the International Union Against Tuberculosis and Lung Disease (IUATLD) questionnaire (10, 11).

Definitions

AR was defined as a positive answer to the question “Do you have hay fever or any other nasal allergy?” The criterion for asthma was a positive answer to at least one of the questions: “Have you had any asthma attacks during the last 12 months?” or “Are you currently using any form of medication (aerosols, powder inhalers, or tablets) against asthma?” The criteria for AR and asthma were the same as in the Stage I study (7). Onset of AR was defined as no AR at Stage I (1990) and AR at Stage III (1993). Similarly, onset of asthma was defined as no asthma at Stage I and asthma at Stage III. Thus, onsets of AR and asthma included both primary onsets of these conditions and relapses of previous disease.

Remission of AR was defined as AR at Stage I and no AR at Stage III. Similarly, remission of asthma was defined as asthma at

(Received in original form December 7, 1999 and in revised form March 1, 2000)

Supported by grants from the Swedish Heart and Lung Foundation, the Swedish Association against Asthma and Allergy, the Swedish Medical Research Council, the Associations against Asthma and Allergy in Göteborg and Uppsala, the Herman Krefting Foundation, the Bror Hjerpstedt Foundation, and the County Councils of Göteborg and Uppsala.

Correspondence and reprint requests should be addressed to Peter P. Plaschke, Department of Medicine, Amager Hospital, Copenhagen University Hospital, Italiensvej 1, DK-2300 Copenhagen S, Denmark. E-mail: pp@email.dk

Am J Respir Crit Care Med Vol 162, pp 920–924, 2000

Internet address: www.atsjournals.org

TABLE 1

BASIC CHARACTERISTICS OF RESPONDERS AND NONRESPONDERS		
	Responders (n = 1,358)	Nonresponders (n = 501)
Females, %	51.5	50.6
Age, yr, mean $\pm$ SD	33.2 $\pm$ 7.3	32.3 $\pm$ 7.2*
Smokers, %	27.3	31.9
AR in 1990, %	23.6	23.0
Asthma in 1990, %	6.1	8.4

* p < 0.05.

Stage I and no asthma at Stage III. Atopy was defined as one or more positive skin prick tests (SPT).

Skin Prick Tests

Skin prick testing was carried out using Phazets (Pharmacia Diagnostics, Uppsala, Sweden), stainless-steel lancets precoated with lyophilized standardized allergen extracts (12). SPT was performed as a single test and in accordance with the European Academy of Allergy and Clinical Immunology (EAACI) position paper (13). All the fieldworkers were trained to perform the SPT in a standardized manner (6). The common ECRHS panel of allergens was used: cat, house-dust mite (HDM) (*Dermatophagoides pteronyssinus*), timothy grass, birch, *Cladosporium herbarum*, *Alternaria alternata*, olive, common ragweed, and *Parietaria judaica*. In addition, two common Swedish allergens, dog and mugwort, were added. A histamine-coated Phazet was used as the positive control and an uncoated one as the negative control. A mean weal diameter of 3 mm or more was regarded as positive (13). SPT to olive and common ragweed was not included in this presentation because of the low occurrence of sensitization to these allergens.

SPT to pets was defined as a positive SPT to cats, to dogs, or to both. SPT to pets was used in the multivariate logistic regression analysis to avoid collinearity because of the close association between sensitization to cats and dogs (14). SPT to molds was defined as a positive SPT to *C. herbarum*, to *A. alternata*, or to both. SPT to molds was used in the multivariate logistic regression analysis because of the few cases of sensitization to the separate allergens.

Statistics

The chi-square test was used when analyzing differences between groups. Fisher exact test was used, when small numbers were compared ($n < 100$). Unpaired *t* test was used to compare continuous variables. Multivariate logistic regression analysis was performed to estimate the adjusted odds ratios (OR) when taking several independent variables into account. When nothing else is specified, age (an increase of 10 yr), sex, area of residence, cat or dog at home, smoking, and positive SPT to the various allergens were included as independent variables. The statistical analyses were performed with the StatView 4.0 (Abacus Concepts, Inc., Berkeley, CA) and Statistica 4.0 (StatSoft Inc., Tulsa, OK) software packages. Values of $p < 0.05$ (two-tailed test) and OR with the 95% confidence intervals (CI) excluding 1.0 were regarded as statistically significant.

RESULTS

Subjects who fulfilled all stages of the study were compared with nonresponders to SPT at Stage II or to the Stage III questionnaire (Table 1). The nonresponders were younger than the responders. In addition, there tended to be more smokers and more asthmatics among nonresponders than among those who participated. The prevalence of AR and asthma in 1990 and 1993 and the number of onsets and remissions in 1993 are shown in Table 2.

Allergic Rhinitis

Subjects with or without onset of AR and with or without remission of AR are described in Table 3. Onset of AR occurred

TABLE 2

PREVALENCE OF AR AND ASTHMA IN 1990 AND IN 1993 AND THE NUMBER OF ONSETS AND REMISSIONS IN 1993				
	Prevalence in 1990 (%)	Prevalence in 1993 (%)	Onsets n (%)	Remissions n (%)
AR	24.0	25.8	86 (8.4)	64 (19.8)
Asthma	6.2	7.8	51 (4)	30 (36.1)

more frequently among women than among men. There was a tendency toward more nonsmokers among those who had onset of AR than among those without onset of AR. Sensitization to all allergens was more common among subjects with onset of AR than among subjects without onset of AR. In the multivariate logistic regression analysis, onset of AR was associated with SPT to birch, *Parietaria*, and pets and to female sex. All new cases of AR sensitized to *Parietaria* were residents in Göteborg.

Subjects with remission of AR were more often smokers than subjects without remission, but the difference was not statistically significant. In addition, sensitization to all allergens was less frequent in the remission group compared with subjects without remission. In the multivariate logistic regression analysis, remission of AR was still negatively associated with atopic sensitization, whereas smoking was not associated with remission.

Subjects with onset of AR were compared with subjects reporting these conditions in both 1990 and 1993. Among subjects who reported onset of AR, 64.0% were women compared with 49.2% of those with AR in both 1990 and 1993 ($p < 0.05$). Among subjects with onset of AR, 64.0% were sensitized to one or more allergens, whereas 84.2% of subjects with AR in both 1990 and 1993 were sensitized ($p < 0.001$).

Asthma

Subjects with or without onset of asthma and with or without remission of asthma are described in Table 4. Individuals with onset of asthma were younger than subjects without asthmatic onset. More smokers had onset of asthma than nonsmokers had, though the difference was not statistically significant in this unadjusted analysis ($p = 0.07$). However, the association between smoking and onset of asthma was statistically significant in the adjusted analysis. Preexisting AR and sensitization to major allergens, in particular to pets, were more common in subjects with onset of asthma than in subjects without. No subjects sensitized to *Parietaria* had onset of asthma. Of subjects with AR, 13.1% had onset of asthma compared with 1.6% of persons without AR. Among subjects sensitized to pets, 13.4% had onset of asthma compared with 2% of those who were not pet-sensitized. In the multivariate logistic regression analysis, onset of asthma was independently associated with AR, SPT to pets, and smoking. AR itself was associated with sensitization to specific allergens. Therefore, a multivariate analysis was made without inclusion of AR as an independent variable. SPT to pets was then even more strongly associated with onset of asthma (OR = 4.0; CI = 1.9 to 8.5), and SPT to grass tended to be associated with onset of asthma (OR = 2.1; CI = 1.0 to 4.6), whereas SPT to birch and HDM was still not associated with onset of asthma. In a multivariate logistic regression analysis, atopy was included instead of sensitization to the individual allergens. Both AR (OR = 6.0; CI = 3.0 to 12.2) and atopy (OR = 2.7; CI = 1.3 to 5.7) were independently associated with onset of asthma.

Onset of asthma was studied separately in atopics and non-atopics (Table 5). In atopics, those with onset of asthma were

TABLE 3
ONSET AND REMISSION OF AR IN RELATION TO POTENTIAL RISK FACTORS

	No Onset (n = 941)	Onset (n = 86)	OR* (95% CI) Onset	No Remission (n = 260)	Remission (n = 64)	OR* (95% CI) Remission
Age, yr, mean $\pm$ SD	33.5 $\pm$ 7.3	32.3 $\pm$ 7.3	0.9 (0.7–1.3) [†]	32.4 $\pm$ 7.2	34.1 $\pm$ 7.5	1.0 (0.6–1.5) [†]
Females, %	50.8	64.0 [§]	1.9 (1.2–3.2)	49.2	50.0	1.7 (0.3–1.2)
Smokers, %	29.7	22.1	0.6 (0.4–1.2)	20.0	29.7	1.2 (0.6–2.6)
Pets at home, %	28.6	24.4	1.0 (0.6–1.7)	22.3	28.1	0.9 (0.4–1.8)
SPT to						
cat, %	5.4	24.4 [¶]	—	45.8	20.3 [¶]	—
dog, %	3.9	22.1 [¶]	—	47.7	12.5 [¶]	—
pets, %	7.0	31.4 [¶]	3.0 (1.6–5.8)	61.2	25.0 [¶]	0.4 (0.2–0.9)
mite, %	6.1	19.8 [¶]	1.5 (0.7–3.3)	20.0	3.1 [¶]	0.2 (0.03–0.7)
grass, %	5.4	17.4 [¶]	1.3 (0.6–2.9)	52.7	18.8 [¶]	0.4 (0.2–0.9)
birch, %	5.1	34.9 [¶]	6.5 (3.6–12.0)	49.2	10.9 [¶]	0.2 (0.1–0.4)
mugwort, %	2.4	10.5 [¶]	2.0 (0.7–5.2)	14.6	3.1 [§]	0.5 (0.1–2.3)
Parietaria, %	0.9	3.5 [§]	7.4 (1.7–33)	4.6	1.6	0.5 (0.1–5.0)
molds, %	1.4	5.8 [¶]	2.1 (0.5–7.9)	8.9	1.6 [§]	0.4 (0–3.8)
Atopy, %	18.7	64.0 [¶]	8.0 (4.9–12.8) [‡]	84.2	42.2 [¶]	0.1 (0.1–0.2) [‡]

* Adjusted for age, sex, area of residence, smoking, pets at home, and sensitization to specific allergens.

[†] 10 years' difference.

[‡] Adjusted for atopy instead of specific allergens.

[§] p < 0.05, [¶] p < 0.01, [‡] p < 0.001, univariate analysis.

younger, more often sensitized to pets, and had more often AR compared with those without onset of asthma. In the multivariate analysis, AR was associated with onset of asthma. In addition, onset of asthma tended to be associated with low age, sensitization to pets, and more weakly with smoking.

Among nonatopics, smoking and AR were more common among those with onset of asthma than among those without onset of asthma. Of 246 smokers, nine (3.7%) had onset of asthma, whereas four out of 606 nonsmokers had onset of asthma (0.7%). In a multivariate analysis, which included age, sex, area of residence, smoking, and self-reported AR as independent variables, onset of asthma was associated with smoking, and there was a tendency toward an association between self-reported AR and onset of asthma.

Subjects with onset of asthma (n = 51) were compared with subjects who reported asthma in both 1990 and 1993 (n = 53).

Among new cases of asthma, 39.2% were smokers, whereas 15.1% of those who already had asthma were smokers (p < 0.01). Cat at home was reported in 18.0% of those with asthmatic onset and in 3.8% of those who already had asthma (p < 0.05).

Subjects with remission of asthma were slightly younger and more often pet owners compared with subjects without remission, but these differences were not statistically significant. In addition, sensitization to pets and HDM tended to be less frequent among those with remission compared with subjects without remission. A multivariate logistic regression analysis including multiple independent variables was not feasible because of the small numbers. An analysis that included age, sex, smoking, pets at home, and sensitization to pets as independent variables did not show any statistically significant associations with remission of asthma.

TABLE 4
ONSET AND REMISSION OF ASTHMA IN RELATION TO POTENTIAL RISK FACTORS

	No Onset (n = 1,224)	Onset (n = 51)	OR* (95% CI) Onset	No Remission (n = 53)	Remission (n = 30)	OR [†] (95% CI) Remission
Age, yr, mean $\pm$ SD	33.3 $\pm$ 7.3	31.1 $\pm$ 6.2 [¶]	0.7 (0.4–1.1) [‡]	33.7 $\pm$ 7.4	31.9 $\pm$ 7.2	0.6 (0.3–1.2) [‡]
Females, %	50.7	49.0	1.0 (0.6–1.9)	64.2	63.3	0.9 (0.3–2.4)
Smokers, %	27.5	39.2	3.0 (1.5–5.8)	15.1	20.0	1.6 (0.5–5.3)
Pets at home, %	27.8	26.0	1.0 (0.5–2.1)	11.3	26.7	2.8 (0.8–9.8)
AR in 1990, %	18.6	68.0 ^{**}	4.9 (2.3–10.4)	—	—	—
SPT to						
cat, %	11.4	49.0 ^{**}	—	49.1	46.7	—
dog, %	10.5	52.9 ^{**}	—	52.8	20.0 [¶]	—
pets, %	15.9	58.8 ^{**}	2.4 (1.1–5.2)	58.5	46.7	0.6 (0.2–1.7)
mite, %	8.7	21.6 [¶]	1.5 (0.7–3.4)	15.1	6.7	—
grass, %	13.3	47.1 ^{**}	1.4 (0.6–3.2)	32.1	33.3	—
birch, %	14.0	43.1 ^{**}	1.3 (0.6–2.7)	30.2	33.3	—
mugwort, %	4.3	15.7 ^{**}	1.6 (0.6–3.9)	13.2	6.7	—
Parietaria, %	1.6	0	—	7.6	0	—
molds, %	2.7	5.9	0.6 (0.1–2.2)	7.6	6.7	—
Atopy, %	31.5	74.5 ^{**}	2.7 (1.3–5.8) [§]	67.9	60.0	0.8 (0.3–2.2) [§]

* Adjusted for age, sex, area of residence, smoking, pets at home, allergic rhinitis, and sensitization to specific allergens.

[†] Adjusted for age, sex, smoking, pets at home, and sensitization to pets.

[‡] 10 years' difference.

[§] Adjusted for atopy instead of specific allergens.

[¶] p < 0.05, [¶] p < 0.01, ^{**} p < 0.001, univariate analysis.

TABLE 5
ONSET OF ASTHMA IN ATOPICS AND NONATOPICS IN
RELATION TO POTENTIAL RISK FACTORS

	Atopics (n = 423)			Nonatopics (n = 852)		
	No Onset (n = 385)	Onset (n = 38)	OR* (95% CI) Onset	No Onset (n = 839)	Onset (n = 13)	OR† (95% CI) Onset
Age, yr, mean ± SD	32.5 ± 7.3	29.7 ± 5.7 [§]	0.6 (0.3–1.0) [‡]	33.7 ± 7.3	35.1 (5.9)	1.1 (0.5–2.4) [‡]
Females, %	47.3	44.7	1.0 (0.5–2.1)	52.3	61.5	1.2 (0.4–3.9)
Smokers, %	26.0	29.0	1.8 (0.8–4.2)	28.3	69.2 [‡]	5.7 (1.7–19.2)
Pets at home, %	23.6	21.6	0.9 (0.4–2.2)	19.6	15.4	—
SPT to pets, %	50.0	79.0 [‡]	2.2 (0.9–5.1)	—	—	—
AR in 1990, %	43.8	83.8 [‡]	5.7 (2.2–14.6)	7.0	23.1 [§]	3.5 (0.9–13.5)

* Adjusted for age, sex, area of residence, smoking, pets at home, AR, and sensitization to pets.

† Adjusted for age, sex, area of residence, smoking, and AR.

‡ 10 years' difference.

§ p < 0.05, [‡]p < 0.01, [§]p < 0.001, univariate analysis.

DISCUSSION

Sensitization to birch, *Parietaria*, and pets, and female sex were risk factors for onset of AR, whereas AR, smoking, and sensitization to pets were risk factors for onset of asthma. Remission of AR was more common in persons without sensitization. We found no other statistically significant predictors of remission, but numbers were small.

Asthma in Relation to Rhinitis

AR was a strong risk factor for onset of asthma in accordance with the previous findings of Settupane and coworkers (15). AR was strongly associated with sensitization as expected, as in principle all persons with AR should have atopy. Not only the sensitization, but also the AR itself, was a risk factor for asthma. Several pathophysiological mechanisms could explain the association between rhinitis and asthma: nasal obstruction leading to mouth breathing, causing impaired warming and humidification of the inspired air and increased deposition of inhaled allergens in lower airways; a nasal-bronchial reflex; aspiration of nasal secretions; and an increased bronchial hyperresponsiveness (BHR) in subjects with AR (16). Rhinitis also tended to be a risk factor for asthma among nonatopics in accordance with the results of another ECRHS publication (17).

Allergic Rhinitis and Asthma in Relation to Sensitization

In the cross-sectional study, sensitization to pets and not to HDM was most strongly associated with asthma and BHR (5). Two previous studies also indicated a particular importance of sensitization to pets as a cause of adult asthma (18, 19). In this study, pets were the sensitizing allergens most strongly associated with onset of asthma. Sensitization to pets was also related to onset of AR, underlining the importance of these allergens. Pet owners did not have an increased risk for onset of AR or asthma, but subjects with onset of asthma were more often cat owners than those with asthma both in 1990 and in 1993. Persons with a long duration of asthma could be less prone to have pets, and some asthmatics have probably removed their pets after the onset of the disease. Subjects with remission of asthma tended to have pets more often than subjects without remission. However, only one pet-sensitized pet owner had remission of asthma. Pet allergens are easily transported and can be found in public places, and in homes without pets, where allergen levels might be sufficient to cause symptoms (20–22).

Our finding that sensitization to birch and not to grass was associated with onset of AR is most likely explained by the powerful birch pollen season in 1993. Presumably, the high

pollen levels caused symptoms in sensitized subjects who had no previous symptoms or who had had remission during years of lower pollen counts. In spite of this powerful birch season, sensitization to birch was not associated with onset of asthma. Similarly, there was no association between birch-sensitization and asthma in the cross-sectional analysis (5). It appears that sensitization to birch is not an independent risk factor for asthma in Swedish adults.

Parietaria is an important allergen in southern Europe (23). Our finding of an association between sensitization and AR suggests that *Parietaria* also has clinical importance in local areas in northern Europe. A rather large group of people reported AR without being sensitized to the tested allergens. Many of these subjects were probably misclassified as AR, while they were suffering from nonallergic rhinitis.

Although AR was strongly related to onset of asthma, atopy was also independently associated with asthmatic onset, indicating that even asymptomatic atopy is a risk factor. Of the atopic asthmatics, 33% had remission compared with 41% of those with nonatopic asthma (p = 0.5). Thus, atopy itself does not seem to have a prognostic value in asthma.

Asthma in Relation to Smoking

Exposure to environmental tobacco smoke is a risk factor for pediatric asthma (24). Many studies have not found any clear association between smoking and asthma (4, 5, 25–28). However, in some longitudinal studies of teenagers or young adults (29–32) and in a case-control study (33), smoking was found to be a risk factor for onset of asthma. Similarly, our study revealed an association between smoking and onset of asthma, in particular among nonatopics. Furthermore, we found more smokers among subjects with onset of asthma than among asthmatics who had the disease already in 1990. This could be explained by a possible reluctance to start smoking or by a stronger tendency to quit smoking among those who have a long history of asthma. In questionnaire-based studies it is difficult to separate asthmatics from subjects with chronic obstructive pulmonary disease (COPD). However, in the cited studies and in our study of young adults, the occurrence of COPD should be low. Furthermore, we used the same criteria for asthma in this study as in the cross-sectional study which did not reveal any association between smoking and asthma (7). Therefore, it is not probable that the relationship between onset of asthma and smoking could be explained by misclassification. Cross-sectional studies could miss a possible relationship between smoking and asthma because they are biased by asthmatics who never started smoking or who stopped because of their disease. Together with the cited studies, our

study indicates that smoking is an important risk factor for asthma in young adults.

Nonresponse and Methodological Problems

The slightly higher proportions of smokers and asthmatics among nonresponders compared with participants could have biased the prevalence data of 1993 toward lower values, and the higher proportion of smokers among nonresponders could have biased the number of onsets of asthma toward lower values. However, the response rates were relatively high, so the possible bias should not influence the results.

The results of this study come from a national analysis of data collected for the ECRHS. A final international comparison might use a different form of analysis. Our definition of onset includes both new cases and relapses of disease in subjects with previous remission. The very high proportions of onsets and remissions indicate substantial fluctuations in reporting current AR and asthma. Whereas AR and asthma are defined as chronic disorders, it is possible that patients with a mild disease only report they have AR or asthma if they have recently had symptoms. Thus, the risk factors that we have found are risk factors for a mixture of onset and relapse of disease.

In conclusion, sensitization to pollens and pets and female sex were associated with onset of AR, whereas AR and two, in principle, preventable risk factors—smoking and sensitization to pets—were associated with onset of asthma.

Acknowledgment: The authors thank N. B. Lindholm, E. Berglund, B. Lundbäck, L. Rosenhall, and G. Boman for their participation in this study.

References

- Krzyzanowski, M., and M. D. Lebowitz. 1992. Changes in chronic respiratory symptoms in two populations of adults studied longitudinally over 13 years. *Eur Respir J* 5:1–20.
- Åberg, N., B. Hesselmar, B. Åberg, and B. Eriksson. 1995. Increase of asthma, allergic rhinitis and eczema in Swedish schoolchildren between 1979 and 1991. *Clin. Exp. Allergy* 25:815–819.
- Burrows, B., F. D. Martinez, M. Halonen, and R. A. Barbee. 1989. Association of asthma with serum IgE levels and skin test reactivity to allergens. *N. Engl. J. Med.* 320:271–277.
- Sunyer, J., J. M. Anto, M. Kogevinas, M. A. Barcelo, J. B. Soriano, A. Tobias, N. Munozguren, J. Martinez-Moratalla, F. Payo, J. A. Maldonado and the Spanish Group of the European Community Respiratory Health Survey. 1997. Risk factors for asthma in young adults. *Eur. Respir. J.* 10:2490–2494.
- Plaschke, P., C. Janson, E. Norrman, E. Björnsson, and B. Järholm. 1999. Association of skin test reactivity, specific IgE and total IgE with asthma and bronchial hyper-responsiveness in Swedish adults: pets and not mites are the most important allergens. *J. Allergy Clin. Immunol.* 103:58–65.
- European Community Respiratory Health Survey. European Commission, Directorate—General XIII, Office for Official Publications, L-2920 Luxembourg 1993.
- Björnsson, E., P. Plaschke, E. Norrman, C. Janson, B. Lundbäck, A. Rosenhall, N. Lindholm, L. Rosenhall, E. Berglund, and G. Boman. 1994. Symptoms related to asthma and chronic bronchitis in three areas of Sweden. *Eur. Respir. J.* 7:2146–2153.
- Plaschke, P., C. Janson, E. Norrman, E. Björnsson, B. Lundbäck, N. Lindholm, L. Rosenhall, B. Järholm, and G. Boman. 1996. Skin prick test and specific IgE in adults from three different areas of Sweden. *Allergy* 51:461–472.
- Berggren, B., S. Nilsson, Å. Dahl, and S.-O. Strandhede. 1993. Pollensåsongen 1993 (in Swedish). The Palynological Laboratory, Stockholm and The Institution of Botany, University of Göteborg, Göteborg, Sweden.
- Burney, P. G. J., and S. Chinn. 1987. Developing a new questionnaire for measuring the prevalence and distribution of asthma. *Chest* 91 (Suppl.):79–83.
- Burney, P. G. J., L. A. Laitinen, S. Perdrizet, H. Huckauf, A. E. Tattersfield, S. Chinn, N. Poisson, A. Heeren, J. R. Britton, and T. Jones. 1989. Validity and repeatability of the IUATLD (1984) bronchial symptoms questionnaire: an international comparison. *Eur. Respir. J.* 2:940–945.
- Belin, L., S. Dreborg, R. Einarsson, I. Halvorsen, M. Holgersson, B. Lund, T. Löfkvist, A. Moxnes, G. Stålenheim, Å. Wihl, and I.-J. Våla. 1985. Phazet—a new type of skin prick test. Calibration and stability. *Allergy* 40(Suppl. 4):60–63.
- Dreborg, S., A. Backman, A. Basomba, J. Bousquet, P. Dieges, and H.-J. Mallig. 1989. Skin tests used in type I allergy testing. Position Paper. Subcommittee on Skin Tests of the European Academy of Allergy and Clinical Immunology. *Allergy* 44(Suppl. 10):1–59.
- Spitzauer, S., B. Pandjaitan, S. Mühl, C. Ebner, D. Kraft, R. Valenta, and H. Rumpold. 1997. Major cat and dog allergens share IgE epitopes. *J. Allergy Clin. Immunol.* 99:100–106.
- Settipane, R. J., G. W. Hagy, and G. A. Settipane. 1994. Long term risk factors for developing asthma and allergic rhinitis: a 23 year follow-up study of college students. *Allergy Proc.* 15:21–25.
- Corren, J. 1997. Allergic rhinitis and asthma: how important is the link? *J. Allergy Clin. Immunol.* 99:781–786.
- Leynaert, B., J. Bousquet, C. Neukirch, R. Liard, and F. Neukirch on behalf of the European Community Respiratory Health Survey. 1999. Perennial rhinitis: an independent risk factor for asthma in nonatopic subjects. Results from the European Community Respiratory Health Survey. *J. Allergy Clin. Immunol.* 104:301–304.
- Lin, R. Y., J. LaFrance, and D. Sauter. 1993. Hypersensitivity to common indoor aeroallergens in asthmatic patients. *Ann. Allergy* 71:33–39.
- Augusto, A., A. Litonjua, D. Sparrow, S. T. Weiss, G. T. O'Connor, A. A. Long, and J. L. Ohman, Jr. 1997. Sensitization to cat allergen is associated with asthma in older men and predicts new-onset airway hyperresponsiveness. *Am. J. Respir. Crit. Care Med.* 156:23–27.
- Berge, M., A. K. Munir, and S. Dreborg. 1998. Concentrations of cat (Fel d1), dog (Can f1) and mite (Der f1 and Der p1) allergens in the clothing and school environment of Swedish schoolchildren with and without pets at home. *Pediatr. Allergy Immunol.* 9:25–30.
- Egmar, A. C., G. Emenius, C. Almqvist, and M. Wickman. 1998. Cat and dog allergen in mattresses and textile covered floors of homes which do or do not have pets, either in the past or currently. *Pediatr. Allergy Immunol.* 9:31–35.
- Bollinger, M. E., P. A. Eggleston, E. Flanagan, and R. A. Wood. 1996. Cat antigen in homes with and without cats may induce allergic symptoms. *J. Allergy Clin. Immunol.* 97:907–914.
- D'Amato, G., A. Ruffili, and C. Ortolani. 1991. Allergenic significance of *Parietaria* (pellitory-of-the-wall) pollen. In G. D'Amato, F. T. M. Spiekma, and S. Bonini, editors. *Allergenic Pollens and Pollinosis in Europe*. Blackwell Scientific Publications, Oxford. 113–118.
- Cogswell, J. J., E. B. Mitchell, and J. Alexander. 1987. Parental smoking, breast feeding and respiratory infections in development of allergic diseases. *Arch. Dis. Child.* 62:338–344.
- Burney, P. G. J. 1992. Epidemiology. In T. J. H. Clark, S. Godfrey, and T. H. Lee, editors. *Asthma*, 3rd ed. London. 254–307.
- Higgins, M. W., J. B. Keller, and H. L. Metzner. 1977. Smoking, socioeconomic status, and chronic respiratory disease. *Am. Rev. Respir. Dis.* 116:403–410.
- Vesterinen, E., J. Kaprio, and M. Koskenvuo. 1988. Prospective study of asthma in relation to smoking habits among 14,729 adults. *Thorax* 43:534–539.
- Troisi, R. J., F. E. Speizer, B. Rosner, D. Trichopoulos, and W. C. Willett. 1995. Cigarette smoking and incidence of chronic bronchitis and asthma in women. *Chest* 108:1557–1561.
- Larsson, L. 1994. Incidence of asthma in Swedish teenagers—relation to gender and smoking habits. *Thorax* 50:260–264.
- Norrman, E., L. Nystrom, E. Jonsson, and N. Stjernberg. 1998. Prevalence and incidence of asthma and rhinoconjunctivitis in Swedish teenagers. *Allergy* 53:28–35.
- Strachan, D. P., B. Butland, and H. Ross Anderson. 1996. Incidence and prognosis of asthma and wheezing illness from early childhood to age 33 in a national British cohort. *B.M.J.* 312:1195–1199.
- Kaplan, B. A., and C. G. Mascie-Taylor. 1997. Smoking and asthma among 23-year-olds. *J. Asthma* 34:219–226.
- Flodin, U., P. Jonsson, J. Ziegler, and O. Axelsson. 1995. An epidemiologic study of bronchial asthma and smoking. *Epidemiology* 6:503–505.