

Prevalence of positive skin prick tests, allergic asthma, and rhinoconjunctivitis in teenagers in northern Sweden

Norrman E, Rosenhall L, Nyström L, Jönsson E, Stjernberg N. Prevalence of positive skin prick tests, allergic asthma, and rhinoconjunctivitis in teenagers in northern Sweden.

Allergy 1994; 49: 808–815. © Munksgaard 1994.

The prevalence of positive skin prick tests (SPT) for common allergens and symptoms of allergic rhinoconjunctivitis or asthma was investigated in Umeå in northern Sweden in 1987. Skin prick tests with 10 allergens common in Sweden and a questionnaire were used to examine 1112 teenagers. All subjects with a positive skin prick test or symptoms were interviewed, and they were further investigated by a serum specific IgE test, a ventilatory lung function test, and a physical examination. At least one skin prick test was positive in 43% of the subjects. Ninety-three percent had at least one positive skin prick test to one of the three most common allergens: cat, timothy grass, and birch. The prevalence of current allergic rhinoconjunctivitis was 17%, current allergic asthma 2.8%, and current asthma (both allergic and nonallergic) 6.8%. Multiple logistic regression analysis showed that the most important risk factors for current asthma were sex (being a girl) and atopy. Heredity of asthma or rhinoconjunctivitis and being born in the winter (October–March) also increased the risk. In atopic subjects, having a mother who smoked and heredity of asthma increased the risk. For allergic rhinoconjunctivitis, heredity increased the risk of getting rhinoconjunctivitis.

E. Norrman¹, L. Rosenhall²,
L. Nyström³, E. Jönsson⁴, N. Stjernberg⁴

Departments of ¹ Pulmonary Medicine and Allergology, and ³ Epidemiology and Health Care Research, University Hospital of Northern Sweden, Umeå; ² Department of Allergic and Respiratory Diseases, Huddinge University Hospital, Huddinge, Stockholm; ⁴ National Institute of Occupational Health, Umeå, Sweden

Key words: allergic rhinoconjunctivitis; allergic asthma; epidemiology; skin prick test; teenagers.

Eva Norrman, MD

Department of Pulmonary Medicine and Allergology
University Hospital of Northern Sweden
S-901 85 Umeå
Sweden

Accepted for publication 24 February 1994

In recent years, there has been growing interest in atopy, the liability of a person to develop IgE antibodies against common allergens. The atopic constitution seems to be inherited; it is linked to chromosome 11 (6). Several methods have been used to screen a population to identify atopic subjects. In adolescence, the definition of an atopic subject as one with at least one positive reaction to skin prick tests (SPT) against common allergens has been shown to be useful (6). Skin prick tests are used worldwide to verify the diagnosis of allergic, IgE-mediated disease in symptomatic persons. However, the clinical relevance of a positive SPT in a subject with no allergic symptoms is not clear. Some studies indicate that a positive skin prick test increases the risk of developing symptoms of allergy within 3 years (12). Factors shown to influence the development of allergic disease in different studies are maternal smoking, month of birth, and heredity of allergic disease (1, 5, 8, 17, 18, 21).

The present study examined the prevalence of atopy, allergic rhinoconjunctivitis, and allergic

asthma in eighth grade students (most of them 14 years of age) in Umeå, Sweden, and formed a cohort for prospective studies on the life course of allergic disease. In the present paper, the prevalences of positive skin prick tests, allergic rhinoconjunctivitis, and allergic asthma are reported. The prevalence of asthma has been reported earlier (19).

Material and methods

Population

All students in eighth grade (most of them 14 years old) in the municipality of Umeå in 1987, a total of 1159 students (597 boys, 562 girls), were invited to participate in the study. The municipality of Umeå is situated in northern Sweden near the Gulf of Bothnia, 700 km north of Stockholm and 350 km south of the Arctic Circle. It has about 80 000 inhabitants, most of whom live in the city of Umeå. The city's economy is dominated by the public sector (the university and the university hospital), and there are few industries, unlike other towns in northern

Sweden. The area has 10 secondary schools. Of these, Wasa and Haga are situated in the central part of the city; Ålidhem, Bräntberg, Grubbe, and Teg on the outskirts; and Holmsund, Hörnefors, and Sävar in smaller communities 15–20 km from the city. Some of the schools in the city also have students who live in smaller villages outside the city: in Wasa, 32% (25% boys, 39% girls) of the students; in Grubbe, 33% (34% boys, 32% girls); in Haga, 14% (10% boys, 20% girls); and in Teg, 17% (19% boys, 15% girls). The Waldorf school is an independent private school with 16 students (of whom, two boys and two girls lived out of town) in eighth grade.

Study design

The study design is presented in Fig. 1. During the period September–December 1987 (autumn and early winter), questionnaires were distributed by the school nurses. A few weeks later, skin prick tests were done after written consent from students and parents had been obtained. All students with at least one positive skin prick test or who had reported any symptoms from the airways were invited to a further examination consisting of an interview, a physical examination, a simple lung function test, and blood test for specific IgE. In students reporting any symptoms from the lower airways at the interview, a methacholine provocation test was done. The study was completed in December 1988. In the present study, no grading of the severity of asthma or rhinoconjunctivitis was done.

The study was approved by the ethics committee of the University of Umeå and by the Swedish Data Inspection Board.

Questionnaire

The questionnaire comprised 12 questions on the prevalence of asthma, rhinoconjunctivitis, and symptoms from the airways; allergic heredity; and smoking habits. The students were asked to fill in the questionnaire at home. No advice was given on whether they should get help from their parents to fill in the questionnaire. The questionnaire was designed for this study, and can be acquired from the author on request.

Skin prick test (SPT)

Skin prick tests were done with Phazet (Pharmacia AB, Uppsala, Sweden) (16). Ten common allergen sources in Sweden were tested: birch, timothy grass, mugwort, cat, horse, dog, *Dermatophagoides farinae*, *D. pteronyssinus*, *Cladosporium*, and *Alternaria*. Histamine and blank tests were used as controls. The circumferences of all resulting wheals were drawn

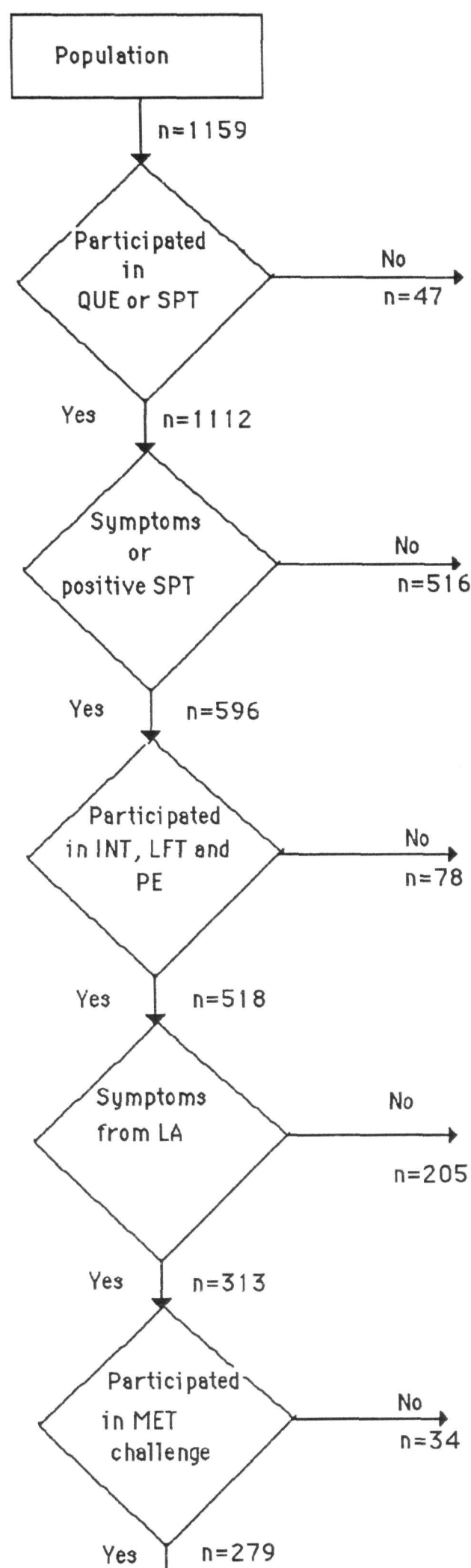


Fig. 1. Flowchart of study design. QUE = questionnaire, SPT = skin prick test, INT = interview, LFT = lung function test, PE = physical examination, LA = lower airways, MET = methacholine.

and transferred to the test protocol. The mean of two perpendicular diameters was taken to be the size of the reaction. A reaction of 3 mm or more was taken to be a positive reaction. In two schools, Teg and Grubbe, *Alternaria* was not included in the SPT.

Interview

The interview was based on a protocol of 172 questions on family history; type of residence; family situation; domestic animals; smoking in the family; and symptoms from eyes (red, itching), nose (itching, watery flow, congestion), and lower airways (dyspnea, wheezing, cough) in contact with different allergens, or during the pollen season, and in contact with nonspecific stimuli such as irritants (perfume, smoke, air pollution, etc.), cold air, and infections. The protocol was made to fit the aims of the study. It had not been validated before use. The questions aimed at evaluating symptoms in contact with dust mites dealt with "symptoms in dusty environment", "symptoms in early mornings", or "symptoms when sleeping on a nonsynthetic pillow". For investigation of symptoms from molds, students were asked whether they had experienced symptoms "in contact with visible or known mold". All questions were answered by the students to the best of their ability, including the questions about their parents' smoking habits and profession. The interviewer was allowed to rephrase the questions if they were not completely understood. All interviews and physical examinations were done by the same physician (EN).

Specific IgE

Specific serum IgE was determined with Phadebas RAST (Pharmacia AB, Uppsala, Sweden). The results were given in Phadebas RAST units (PRU/ml). RAST was considered to be positive when greater than 0.34 PRU/ml. Whenever there was positive SPT, or the subject reported symptoms from a certain allergen, specific serum IgE levels were determined for that particular allergen.

Spirometry

Lung function (FEV₁ and vital capacity) was measured with a dry bellows spirometer (Vitalograph Ltd, Buckingham, UK). The best result of at least three tracings for each subject was used for the analysis. Normal reference values according to Bjure (4) were used.

Methacholine inhalation test

A methacholine inhalation test was done according to the method described by Juniper et al. (14) in all

subjects who reported any symptoms (dyspnea, cough, or wheeze not explained by infection) from the lower airways. The method has been described in detail in an earlier paper (19).

Definitions

Atopy. Subject had at least one positive SPT.

Current asthma. Subjects who within the preceding year had had recurrent attacks of dyspnea with or without wheezing, triggered by known stimuli (not including infections) and at least one of the following: PC₂₀ ≤ 8 mg/ml or signs of obstructive airways at examination. Validation by the definition of asthma used by the Tucson group was done (19).

Current allergic asthma. Subjects who fulfilled the diagnosis of asthma and had attacks of dyspnea or wheezing when they came into contact with a particular allergen and had a positive SPT or RAST for that particular allergen. Subjects with asthma and at least one positive SPT but no dyspnea or wheezing when in contact with this allergen were not classified as suffering from allergic asthma.

Ever having had asthma. Subjects who fulfilled the criteria of current asthma or reported earlier asthma or treatment for asthma in the questionnaire.

Current allergic rhinoconjunctivitis. Subjects who had symptoms of rhinitis or conjunctivitis (i.e., rhinorrhea; sneezing; congestion of the nose; red, itchy, watery eyes) when they came into contact with a particular allergen within the preceding year and positive SPT or positive RAST for that particular allergen.

Ever having had allergic rhinoconjunctivitis. Subjects who fulfilled the diagnosis of current rhinoconjunctivitis or reported earlier allergic rhinoconjunctivitis or treatment for allergic rhinoconjunctivitis in the questionnaire.

Results

Of 1159 students in the population, 1112 (96%) completed the questionnaire or participated in the SPT (Fig. 1). Twelve subjects (six boys, six girls) participated only in SPT, and 985 subjects participated in both questionnaire and SPT (Table 1). More than half of the pupils ($n = 596$; 299 boys, 297 girls) had symptoms or a positive SPT. In this group, 181 subjects (92 boys, 89 girls) had both symptoms and a positive SPT. A positive SPT and no reported symptoms were found in 250 subjects (130 boys, 120 girls). Symptoms and a negative SPT were found in

Table 1. Number of students (*n*) participating in questionnaire or SPT, SPT and interview by sex (partial loss in %)

Participated in:	Boys		Girls		Total	
	<i>n</i>	Partial loss	<i>n</i>	Partial loss	<i>n</i>	Partial loss
Questionnaire or SPT	562	5.9	550	2.1	1112	4.1
SPT	493	17.4	504	10.3	997	14.0
Interview	257	14.0	261	12.1	518	13.1

165 subjects; 77 boys and 88 girls. Of the 596 who were invited to the interview, 87% (*n* = 518) participated. Of those not participating in the interview, 42 were boys and 36 were girls. The prevalence of atopy in this group was 31% (*n* = 13) in boys and 39% (*n* = 14) in girls. Of the atopic subjects, one boy and six girls also reported symptoms.

According to the criteria, 43% of the subjects were atopic, with no significant difference between the sexes. About half of these had one positive SPT; the rest had two or more positive SPT (Table 2). Cat was the most common allergen to give positive reactions, followed by timothy grass and birch. More than 76% of those with positive reactions against birch had a wheal diameter ≥ 5 mm; the corresponding figure for timothy grass was 69% and for cat 29% (Table 3). Of the atopic subjects, 93% had a positive SPT against at least one of the three most common allergens; cat, birch, and timothy grass. There were very few reactions less than 3 mm; most of these subjects had no symptoms against that particular allergen.

Positive SPT in relation to symptoms from the airways (i.e., dyspnea; wheezing; rhinorrhea; sneezing; or red, itching, watery eyes) when in contact with that specific allergen are shown in Fig. 2. Symptoms from the airways in contact with allergens in relation to SPT and RAST are shown in Fig. 3. No difference in the distribution of symptoms between boys and girls was found, except for mite, horse, and cat. More girls than boys reported symptoms against these allergens, but positive RAST and SPT for these allergens did not differ between the sexes.

The prevalence of current asthma (both atopic and nonatopic) was 6.8%; 4.1% in boys and 9.6% in girls. Sixty-three percent (34 subjects) of the asth-

matic girls and 83% (19 subjects) of the asthmatic boys were atopic. A higher proportion of the asthmatic subjects (12%) than the nonasthmatic ones (5.5%) had a positive SPT for mite. Similarly, the asthmatic subjects were more likely to show positive SPT for birch (41%), timothy grass (44%), and cat (59%) than the nonasthmatic subjects (birch 12%, timothy grass 16%, cat 25%).

The prevalence of ever having had asthma was 11% (9.4% in boys and 12.9% in girls). In this group, 66% (71% of the boys and 62% of the girls) were atopic. The prevalence of ever having had allergic rhinoconjunctivitis was 21%; 21% in boys and 20% in girls.

The prevalence of current allergic asthma or allergic rhinoconjunctivitis in the airways was 18% (Table 4). In the group with allergic rhinoconjunctivitis only, 16 subjects were diagnosed as having asthma. They got asthma in association with non-specific stimuli such as exercise, cold air, or irritants but denied getting any asthmatic symptoms in contact with any known allergen. There were 15 subjects (five boys, 10 girls) who had a positive SPT and reported symptoms from the lower airways in contact with that particular allergen, but did not fulfill our criteria of asthma. Of these, three girls needed asthma therapy when exposed to the actual allergen. The others did not need any therapy.

Multiple logistic regression analysis showed that the most important risk factors for current asthma were sex and atopy (Table 5). Girls had a threefold higher odds ratio (OR) for current asthma than boys. Similarly, atopic subjects had a threefold higher OR for current asthma than nonatopic subjects. Having a relative (father, mother, or sibling) with asthma, or being born between October and March (winter) also increased the OR. The risk factor pattern for ever having had asthma was similar, except that the OR for heredity of asthma increased to 3.7, while the OR for being a girl decreased to 1.8. For current allergic rhinoconjunctivitis, only heredity seemed to have any effect – the OR for ever having had allergic rhinoconjunctivitis (OR = 3.3) was higher than for current allergic rhinoconjunctivitis (OR = 2.3) in accordance with the pattern for current asthma and ever having had asthma.

When the analysis was restricted to those who participated in the interview and were atopic (Table 6), the number of observations was reduced from about 1000 to 400, thereby increasing the confidence intervals. The most important risk factor for asthma was having a mother who smoked, with an OR of 2.7 among ex-smokers and 1.6 among smokers. Also heredity for asthma and being a girl doubled the OR for having asthma. When the total heredity (both heredity of asthma and rhinoconjunctivitis) was taken into account, the OR increased from 2.1

Table 2. Prevalence of atopy by sex

Number of positive SPT	Boys	Girls	Total
One	20.5	20.8	20.7
Two	9.1	9.5	9.3
Three or more	14.6	11.9	13.2
One or more	44.2	42.2	43.2

Table 3. Prevalence of reactions to different allergens as measured by wheal diameter by type of allergen and sex (B=boys, G=girls, T=total)

Type of allergen	Wheal diameter											
	2 mm–<3 mm			3 mm–<5 mm			≥5 mm			≥3 mm		
	B	G	T	B	G	T	B	G	T	B	G	T
Birch	0.6	0.2	0.5	3.2	3.2	3.2	12.0	11.7	11.8	15.2	14.9	15.0
Timothy grass	0.8	1.6	1.2	5.9	4.0	5.0	15.0	12.3	13.6	20.9	16.3	18.6
Mugwort	0.8	1.0	0.9	2.5	3.2	2.8	1.6	0.8	1.2	4.1	4.0	4.0
Cat	3.9	3.7	3.8	17.6	22.3	20.0	12.6	6.9	9.7	30.2	29.2	29.7
Horse	0.6	1.2	0.9	1.4	1.2	1.3	4.3	3.4	3.8	5.7	4.6	5.1
Dog	2.7	1.2	2.0	5.5	3.5	4.5	5.5	4.0	4.7	11.0	7.5	9.2
<i>D. pteronyssinus</i>	1.4	0.7	1.1	2.3	2.8	2.5	2.2	2.8	2.5	4.5	5.6	5.0
<i>D. farinae</i>	1.2	1.0	1.1	4.1	3.4	3.7	0.4	2.4	1.4	4.5	5.8	5.1
<i>Cladosporium</i>	1.3	1.0	1.1	1.4	1.4	1.4	1.0	1.4	1.2	2.4	2.8	2.6
<i>Alternaria</i>	0.4	0	0.2	1.0	0	0.5	0.2	0.2	0.2	1.2	0.2	0.7

to 3.0. The risk for allergic rhinoconjunctivitis increased if there was visible mold at home (OR = 4.7 for current allergic rhinoconjunctivitis and 7.4 for ever having had allergic rhinoconjunctivitis). Furthermore, heredity doubled the OR of allergic rhinoconjunctivitis, while having a mother who smoked seemed to have only a marginal effect.

The environmental factors could not be compared between atopic and nonatopic subjects because of

lack of information for the nonatopic group. We plan to investigate this issue in a follow-up study.

Discussion

Our findings on the prevalence of atopy are consistent with studies from other countries (19, 20), but we found a higher prevalence than reported in previous studies from Sweden (2, 3, 15). We found no difference between boys and girls in atopy or allergic rhinoconjunctivitis. In 93% of the atopic subjects, the three most common allergens gave at least one positive SPT. This raises the question of whether time and money could be saved in epidemiologic

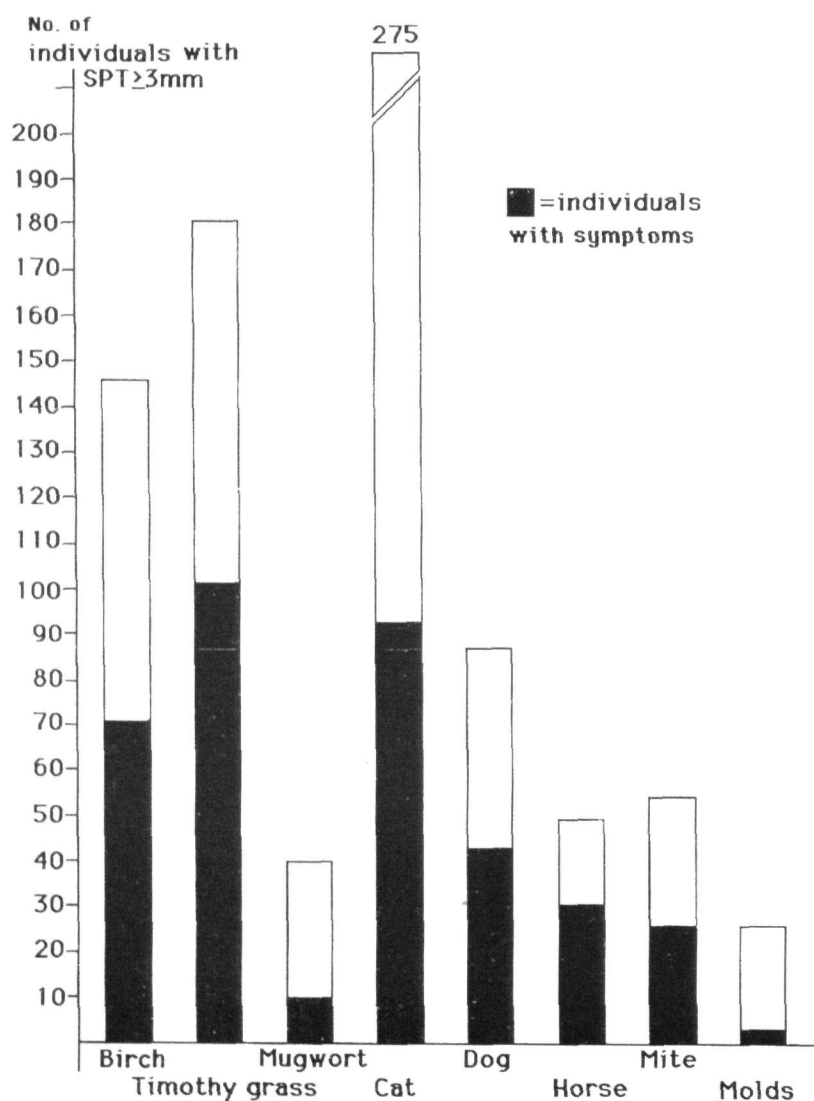


Fig. 2. Subjects (*n*) with positive SPT against different allergens with and without symptoms.

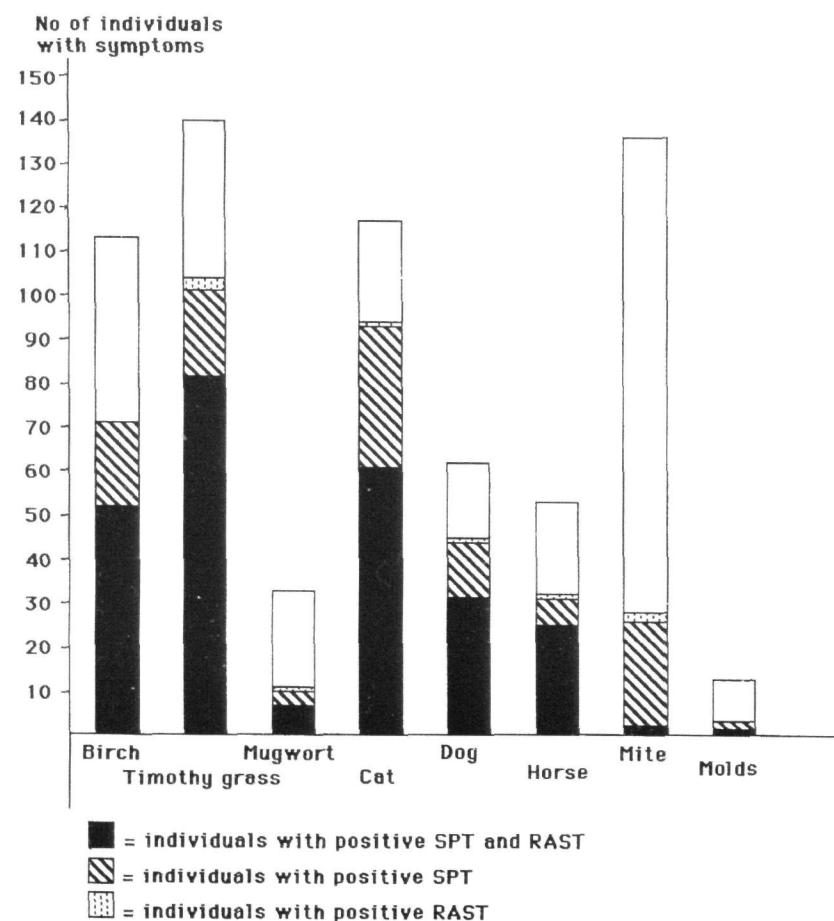


Fig. 3. Number of subjects with symptoms in contact with specific allergens in relation to SPT and RAST.

Table 4. Prevalence of allergic rhinoconjunctivitis and allergic asthma by sex

Allergic disease	Boys		Girls		Total	
	n	%	n	%	n	%
Allergic asthma only	1	0.2	1	0.2	2	0.2
Allergic rhinoconjunctivitis only	90	16.0	75	13.6	165	14.8
Both allergic asthma and allergic rhinoconjunctivitis	9	1.6	20	3.6	29	2.6
Total	100	17.8	96	17.5	196	17.6

research by using fewer test allergens when screening for atopic persons. However, the disadvantage would be that any immunologic change in the population caused by changes in the environment may be missed if fewer allergens are used; for example, the effect of an increasing problem with mite, as shown in studies from Papua New Guinea (7). However, with SPT as a screening method for atopy, a limited number of the most common allergens in the region is sufficient. This has also been shown by a previous Swedish study (9).

In the present study, we found a large proportion of subjects with positive skin prick tests without any symptoms caused by that specific allergen. This may be due partly to the high sensitivity of the method used (16). However, earlier studies have shown that nonsymptomatic subjects with positive SPT reactions are at risk of developing symptoms within 3 years (12). There was a significantly higher prevalence of family history of rhinoconjunctivitis in the symptomatic group than in the nonsymptomatic group, but there were no differences in heredity be-

tween atopic and nonatopic subjects. When changing the definition of atopy to at least two positive SPT, a family history of asthma or rhinoconjunctivitis was significantly higher in the atopic group than in the nonatopic group. These differences might reflect a recall bias in the atopic nonsymptomatic group, since the risk of asthma and rhinoconjunctivitis increases with the increasing number of positive SPT. Another explanation may be that the sensitivity of the method gave rise to false positive reactions. If not, the risk of developing symptoms might be inherited separately from the ability to form antibodies. A third, perhaps more probable explanation is that an interaction between the environment and heredity triggers the development of symptoms. In the present study, probably owing to the cold and dry winters in Umeå, sensitivity to mites was not a major factor in causing asthma, nor were any of the other tested allergens taken alone, although atopy in itself increased the risk of developing asthma threefold. The risk of asthma and allergic rhinoconjunctivitis increased with increasing numbers of positive SPT (OR = 1.2 if one positive SPT; OR = 3.1 if two positive SPT; OR = 9.8 if three or more positive SPT).

The seemingly high prevalence of symptoms caused by mite can be explained by the nonspecific nature of the questions on symptoms caused by mite (see Material and methods). Since mites live in most houses, symptoms can be expected to be perennial and therefore easily overlooked. Since a very wide definition of symptoms caused by mite was used, the specificity was low, and showed that symptoms relating to mite are not easy to define. Another expla-

Table 5. Multiple logistic regression analysis of current asthma, ever having had asthma, current allergic rhinoconjunctivitis, and ever having had allergic rhinoconjunctivitis by atopy, month of birth, sex, heredity of asthma or rhinoconjunctivitis, and location of school in all students participating ($n=1112$). Odds ratio (OR) and 95% confidence intervals (CI)

Independent variables		Categories		Dependent variables							
				Current asthma		Ever having had asthma		Current allergic rhinoconjunctivitis		Ever having had allergic rhinoconjunctivitis	
				OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Atopy	No	1		1							
	Yes	3.12	1.78–5.48	2.50	1.57–3.97						
Month of birth	April–September	1		1		1		1			
	October–March	1.95	1.13–3.35	1.45	0.92–2.28	1.13	0.80–1.59	1.21	0.88–1.68		
Sex	Boys	1		1		1		1			
	Girls	3.24	1.80–5.82	1.81	1.14–2.87	1.05	0.74–1.48	1.10	0.80–1.53		
Heredity of asthma	No	1		1							
	Yes	1.79	0.94–3.40	3.70	2.25–6.06						
Heredity of rhinoconjunctivitis	No					1		1			
	Yes					2.27	1.57–3.26	3.25	2.31–4.57		
Location of school	Rural	1		1		1		1			
	Urban	1.74	0.87–3.47	1.64	0.93–2.92	0.81	0.55–1.20	0.87	0.60–1.27		

Table 6. Multiple logistic regression analysis of current asthma, ever having had asthma, current allergic rhinoconjunctivitis, and ever having had allergic rhinoconjunctivitis by month of birth, sex, heredity of asthma or rhinoconjunctivitis, parental smoking, type of residence, visible mold at home, and location of school among atopic pupils participating in interview (n=404). Odds ratio (OR) and 95% confidence intervals (CI)

		Dependent variables							
Independent variables	Categories	Current asthma		Ever having had asthma		Current allergic rhinoconjunctivitis		Ever having had allergic rhinoconjunctivitis	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Month of birth	April–September	1		1		1		1	
	October–March	1.31	0.69–2.51	1.56	0.86–2.81	0.97	0.63–1.51	1.02	0.66–1.59
Sex	Boys	1		1		1		1	
	Girls	2.67	1.37–5.23	2.10	1.16–3.82	1.10	0.70–1.71	1.22	0.78–1.91
Heredity of asthma	No	1		1					
	Yes	1.60	0.71–3.59	2.12	1.04–4.31				
Heredity of rhinoconjunctivitis	No					1		1	
	Yes					2.49	1.59–3.90	2.42	1.54–3.81
Mother smoking	No	1		1		1		1	
	Yes, ex-smoker	2.68	1.08–6.65	2.68	1.16–6.15	1.08	0.53–2.21	1.17	0.57–2.40
	Yes, smoker	1.63	0.72–3.67	1.55	0.74–3.26	1.30	0.74–2.29	1.31	0.75–2.32
Father smoking	No	1		1		1		1	
	Yes, ex-smoker	0.83	0.35–2.00	0.88	0.40–1.96	0.77	0.41–1.44	0.76	0.41–1.43
	Yes, smoker	0.79	0.34–1.85	0.86	0.40–1.85	0.93	0.52–1.66	0.92	0.52–1.66
Type of residence	House	1		1		1		1	
	Apartment	1.70	0.82–3.52	1.50	0.77–2.94	0.47	0.27–0.84	0.43	0.25–0.78
Visible mold at home	No	1		1		1		1	
	Yes	1.54	0.38–6.15	1.09	0.28–4.32	4.68	1.23–17.89	7.40	1.56–35.19
Location of school	Rural	1		1		1		1	
	Urban	1.46	0.51–4.16	2.05	0.73–5.74	1.09	0.56–2.13	1.19	0.61–2.33

nation is that symptoms arising from dust might be caused by allergens from furred pets, but in the present study, the prevalence of sensitization to furred pets in atopic subjects with and without symptoms caused by mite showed no difference (60% of the subjects with symptoms and 55% of the non-symptomatic subjects had at least one positive SPT for cat, dog, or horse). The significance of reported symptoms caused by the other allergens without any immune response is unclear. It is possible that the allergens might act as irritants, giving rise to symptoms but no immune response. Other possible explanations are that the local production of antibodies in the target organ has not yet overflowed into the circulation or skin, or that our allergens are inappropriate in concentration or composition. Unfortunately, provocation tests in these subjects could not be done for safety reasons in this study.

As in other studies, heredity of asthma or rhinoconjunctivitis increased the risk of getting asthma and allergic rhinoconjunctivitis (2).

The influence of month of birth on development of allergic rhinoconjunctivitis and asthma has been investigated in many studies (1, 8, 18). Our results differ from earlier studies from Australia (8) and the UK (18) showing a higher risk of getting asthma if born in summer. In the present study, children born

in winter were at higher risk of developing asthma. As compared with other countries' inverse pattern, this may reflect the fact that mites are not a great problem in northern Sweden, despite the fact that house-building methods have changed. Children born in winter or autumn are probably outdoors to a lesser extent in their first year of life than children born in summer or spring. Thereby they are more exposed to the indoor environment and viral infections. Both these factors have been discussed as probable causative agents in the development of asthma (1, 3, 5, 10). Cold air may be another important factor. Elite skiers, who are frequently exposed to cold air, seem to have a high prevalence of hyperreactivity and asthma (L. Larsson, personal communication).

In other studies (5, 17, 21), having a mother who smoked seemed to increase the risk of getting asthma, but in the present study the increased risk was significant only in subjects whose mothers had stopped smoking after the child's birth. One explanation for this may be that the mothers stopped smoking when the child got asthma.

Visible mold at home increased the risk of getting allergic rhinoconjunctivitis, but not asthma. This result should be interpreted with care, since the risk of bias is obvious. However, visible mold and the smell

of mold are known to give rise to irritation in upper airways. Irritation and inflammation with damage of the mucosa might facilitate the presentation of allergen to the immune system and thereby initiate the production of antibodies (3, 13).

In conclusion, in the present study, we have found a high prevalence of atopy and allergic rhinoconjunctivitis that is consistent with other studies in Sweden. Cat, birch, and timothy grass were the most common allergens. About half of the atopic subjects were nonsymptomatic. It will be of particular interest to follow up this group in the future. Factors influencing the development of symptoms seemed to be a family history of asthma or rhinoconjunctivitis, month of birth, having a mother who smoked, and visible mold at home.

Acknowledgments

The study was made possible by grants from the Swedish Heart and Lung Foundation and the Swedish Association Against Heart and Lung Diseases.

References

1. ÅBERG N. Birth season variation in asthma and allergic rhinitis. *Clin Exp Allergy* 1989; 19: 643–8.
2. ÅBERG N, ENGSTRÖM I, LINDBERG U. Allergic diseases in Swedish schoolchildren. *Acta Paediatr Scand* 1989; 78: 246–52.
3. ANDRAÉ S, AXELSSON O, BJÖRKSTÉN B, FREDRIKSSON M, KJELLMAN N-IM. Symptoms of bronchial hyper-reactivity and asthma in reaction to environmental factors. *Arch Dis Child* 1988; 77: 826–30.
4. BJURE J. Spirometric studies in normal subjects. IV. Ventilatory capacities in healthy children 7–17 years of age. *Acta Paediatr Scand* 1963; 52: 232–40.
5. COGSWELL JJ, MITCHELL EB, ALEXANDER J. Parental smoking, breast feeding and respiratory infection in development of allergic diseases. *Arch Dis Child* 1987; 62: 338–44.
6. COOKSON WOCM, SHARP PA, FAUX JA, HOPKIN JM. Linkage between immunoglobulin E responses underlying asthma and rhinitis and chromosome 11q. *Lancet* 1989; i: 1292–5.
7. DOWSE GK, TURNER KJ, STEWART GA, ALPERS MP, WOOLCOCK AJ. The association between *Dermatophagoides* mites and the increasing prevalence of asthma in village communities within the Papua New Guinea highlands. *J Allergy Clin Immunol* 1985; 75: 75–83.
8. DUFFY DL, MITCHELL CA. Respiratory symptoms in Queensland schoolchildren: an association between month of birth and respiratory illness. *Clin Exp Allergy* 1991; 21: 231–3.
9. ERIKSSON NE. Allergy screening in asthma and allergic rhinitis. *Allergy* 1987; 42: 189–95.
10. GREGG I. Provocation of airflow limitation by viral infection: implication for treatment. *Eur J Respir Dis* 1983; 64 (Suppl. 128): 369–79.
11. HAAHTELA T, HEISKOLA M, SOUNIEMI I. Allergic disorders and immediate skin test reactivity in Finnish adolescents. *Allergy* 1980; 35: 433–43.
12. HAGY GW, SETTIPANE GA. Prognosis of positive allergy skin tests in an asymptomatic population. A three-year follow up of college students. *J Allergy Clin Immunol* 1971; 48: 200–11.
13. ISHIZAKI T, KOIZUMI K, IKEMORI R, ISHIYAMA Y, KUSHIBIKI E. Studies of prevalence of Japanese cedar pollinosis among the residents in a densely cultivated area. *Ann Allergy* 1987; 58: 265–70.
14. JUNIPER EF, FRITH PA, DUNNETT C, COCKCROFT DW, HARGREAVE FE. Reproducibility and comparison of responses to inhaled histamine and methacholine. *Thorax* 1978; 33: 705–10.
15. KJELLMAN N-IM. Atopic disease in seven-year-old children. *Acta Paediatr Scand* 1977; 66: 465–71.
16. KJELLMAN N-IM, DREBORG S, FÄLTH-MAGNUSSON K. Allergy screening including a comparison of prick test results with allergen-coated lancets (Phazet) and liquid extracts. *Allergy* 1988; 43: 277–83.
17. MAGNUSSON CGM. Maternal smoking influences cord serum IgE and IgD levels and increases the risk for subsequent infant allergy. *J Allergy Clin Immunol* 1986; 78: 898–904.
18. MORRISON-SMITH J, SPRINGETT VH. Atopic disease and month of birth. *Clin Exp Allergy* 1979; 9: 153–7.
19. NORRMAN E, ROSENHALL L, NYSTRÖM L, BERGSTRÖM E, STJERNBERG N. High prevalences of asthma and related symptoms in teenagers in northern Sweden. *Eur Respir J* 1993; 6: 834–9.
20. SOLIGO D, CUGNIO M, BARCELLA M. Prevalence of specific IgE antibodies to mites and pollens in schoolchildren in Milan. *Schweiz Med Wochenschr* 1991; Suppl. 40/1: EAACI Annual Meeting, Zurich, 26–29 May.
21. YOUNG SBS, LESOUF PN, GEELHOED GC, STICK SM, TURNER KJ, LANDAU LI. The influence of a family history of asthma and parental smoking on airway responsiveness in early infancy. *N Engl J Med* 1991; 324: 1168–73.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.