

Allergic Disorders and Immediate Skin Test Reactivity in Finnish Adolescents

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We studied the prevalence of allergic disorders in an unselected group of 708 adolescents aged 15-17 years. All subjects were physically examined and interviewed by the authors. The prevalence of past or present asthma was 5.7% in boys and 3.1% in girls. The figures for hay fever were 14% and 8%, and for atopic dermatitis (including allergic urticaria) 25% and 30%, respectively. In 24% of all symptomatic subjects, the condition had not been active during the year preceding the study. The sex difference in the prevalence of hay fever was significant. It is associated with higher immediate skin test reactivity in boys. A progressive increase in the frequency of allergic disorders was observed with increasing number of positive skin reactions in both boys and girls. Respiratory allergy was closely related to a positive skin test: 87% of the asthmatics and 83% of all those with allergic rhinitis exhibited at least one positive skin reaction. For atopic dermatitis the association was less pronounced. Nineteen per cent of the population studied had a positive symptom history and a positive skin test to pollens, animal epithelia or dusts indicating a clinically significant relationship. However, 39% of the 346 subjects with a positive skin test, including some with a large number of positive reactions, were completely asymptomatic.

Key words: allergic disorders; epidemiology of allergy; immediate skin test reactivity

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Few studies have dealt with the relationship between asthma, other allergic disorders and immediate skin test reactivity in unselected subjects. On the other hand, there are numerous clinical reports in which the prevalence of skin test reactions and their correlations with allergic symptoms have been established in selected patient groups. Previously, we surveyed a small group of adolescents and observed much higher frequency of symptomatic and asymptomatic allergy than presented earlier in Finland (9). This extended study was taken to elucidate further the epidemiology of allergy in young people.

We report the prevalence of asthma, bronchial wheezing, allergic rhinitis and

atopic dermatitis in a population of adolescents aged 15-17 years, and the correlations of the symptoms with immediate skin test reactions to common allergens.

SUBJECTS AND METHODS

Subjects, 9th grade students from the town of Imatra have been described in the preceding paper (11). A questionnaire was given beforehand to the subjects by the school nurses. It consisted of questions about any disorders indicating allergy, including symptoms of allergy observed by the subject, his parents or his doctor, the occurrence of asthma, allergic rhinitis and atopic dermatitis in the parents or siblings and information on

any pets at home. The questionnaire was the same as that used in a previous study (10). The subjects were asked to answer the questions with the help of their parents. The health records, containing most of the important information on the subjects' health since childhood, were also available and were surveyed by the school nurses in order to make the study as comprehensive as possible.

After skin prick testing with 16 extracts of 12 common allergens (11) the authors (T. H. and M. H.) carried out the physical examination. Special attention was paid to symptoms and manifestations indicative of allergy and the histories of allergic conditions were again ascertained. The lungs were auscultated during normal breathing and forced expiration. The peak expiratory flow rate was measured using Wright's peak flow meter.

Asthma was defined as an episodic disorder associated with shortness of breath, wheezing and difficulty in expiration. Asthma had to be diagnosed by a physician upon examination of the patient. As bronchial wheezing we accepted symptoms reported on the questionnaire. Allergic rhinitis (seasonal or perennial) was defined as an episodic rhinorrhea usually

associated with nasal stuffiness and sneezing in response to a known or strongly suspected allergen(s), often accompanied by lacrimation. If there was no known or suspected allergen, the rhinitis had to be associated with asthmatic symptoms, wheezing or atopic dermatitis in order to be accepted as "allergic". Atopic dermatitis was defined as a pruritic dermatitis often accompanied by dry skin and white dermographism, whether the offending allergen was known or not. The infantile and childhood phases were included. Allergic urticaria was defined as a periodic, localized, pruritic oedema associated with a known or strongly suspected allergen. Those with contact dermatitis were excluded. The authors used the criteria mentioned. Diagnoses made by other physicians who had seen the subjects previously were also accepted, although definitions may have varied.

The significance of differences between various groups was examined with the χ^2 -test.

RESULTS

Past or present allergic disorders including bronchial wheezing had occurred in 41% of

Table 1
The prevalence of past or present allergic disorders including bronchial wheezing in adolescents

Symptom	Boys		Girls		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Bronchial wheezing including asthma	42	13.3	41	10.5	83	11.7
— asthma	18	5.7	12	3.1	30	4.2
		(4.1) ^a		(2.0)		(3.0)
Allergic rhinoconjunctivitis	76	24.0	97	24.7	173	24.4
		(17.7)		(16.4)		(17.1)
— hay fever ^b	45	14.2 ^c	32	8.2	77	10.9
— perennial	31	9.8 ^c	65	16.5	96	13.6
Atopic dermatitis including allergic urticaria	78	24.6	117	29.8	195	27.5
		(20.6)		(22.4)		(21.6)
— urticaria	23	7.3	30	7.6	53	7.5
Any symptom(s)	131	41.4	161	41.1	292	41.2

^a The figures in parentheses indicate the prevalence of diagnoses made by physicians before this study.
^b The figures for hay fever are for subjects who had a positive history and positive skin test(s) to pollens; some subjects also had perennial rhinitis.
^c $P < 0.01$ for sex difference.

the subjects (Table 1). Seventeen per cent had more than one type of manifestation (Table 2).

Asthma was more common in boys than in girls, but the difference was not significant (Table 1). Altogether 35 boys (11.4%) and 33 girls (8.4%) had wheezed during the past year. Nine boys (2.8%) and five girls (1.3%) wheezed when auscultated at the physical examination. Bronchial wheezing was stated to have been provoked during the past year under the conditions listed in Table 3.

Boys had hay fever significantly more often than girls. On the other hand, perennial rhinitis (excluding the subjects with pollen allergy) was significantly more common in girls (Table 1).

At the time of the physical examination, 20 boys (6.3%) and 34 girls (8.7%) were observed to have lesions typical of atopic dermatitis.

In 24% of all the symptomatic subjects the condition had not been active for at least 1

year, in 13% the symptoms had become clearly worse (in 7% new manifestations of allergy had evolved in addition to the old ones), and in 9% one symptom had been replaced by another. In the remaining group (54%) the condition was more or less unchanged. Fig. 2 shows that the difference between the prevalence of active disease (=symptoms present during the preceding year) and cumulative diseases (=symptoms present at any time of life) is most marked with dermatitis and less obvious with respiratory allergy.

As shown in Fig. 1, there was a progressive increase in the frequency of allergic disorders with increasing skin test reactivity. There were, however, a few subjects (6 boys and 2 girls) in the highest skin test reactivity group without any symptoms whatsoever.

Respiratory disorders, considered to be allergic in origin, were closely connected with positive skin reactivity, while atopic dermatitis

Table 2
The prevalence and co-occurrence of past or present allergic disorders including bronchial wheezing in adolescents

Symptom	Prevalence of second symptom %			Total
	Allergic rhinitis	Atopic dermatitis	No second symptom	
Bronchial wheezing including asthma	7.6 ^a	6.5 ^a	2.7	11.7
Allergic rhinitis		13.4 ^a	8.5	24.4
Atopic dermatitis			12.7	27.5

^a Subjects with all three symptoms (5.1%) are included

Table 3
Factors reported to have provoked wheezing during the year preceding the study

Factor(s)	Boys <i>n</i>	Girls <i>n</i>	Total <i>n</i>
Respiratory infections	11	12	23
Physical exertion	10	6	16
Respiratory infections, physical exertion	1	6	7
Allergen exposure	4	1	5
Respiratory infections and/or physical exertion and allergen exposure	5	5	10
No obvious cause	4	3	7
Total	35	33	68

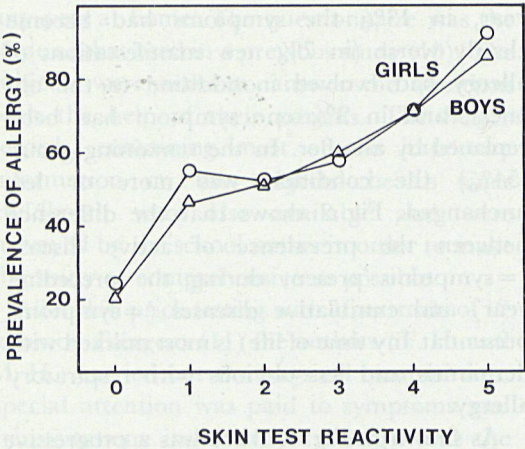


Fig. 1. Prevalences of past or present asthma, wheezing, allergic rhinitis and atopic dermatitis alone or in combinations in relation with the grades for skin test reactivity in adolescents. The reactivity to the test panel of 16 allergen extracts was graded according to following criteria: 0 = no reaction, 1 = one positive reaction, 2 = 2–4 reactions, 3 = 5–8 reactions, 4 = 9–12 reactions, 5 = > 12 reactions. If large weals with pseudopodia were detected, the grade was raised by one step.

was somewhat less clearly related (Fig. 2). In subjects with asthma, a skin test was positive in 87% (72% for all the wheezy subjects), with allergic rhinitis in 83% and with atopic dermatitis in 69%. If atopic dermatitis was the only manifestation, the skin test was positive in no more than 57%. Sixty-one per cent of the

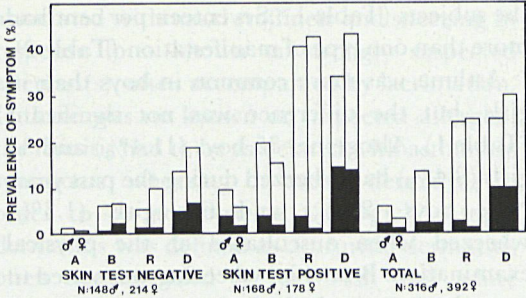


Fig. 2. The prevalence of active and cumulated allergic disorders as a function of sex and skin test result. Active disease was present during the past year and is indicated by open bars. Filled bars indicate previous disorders. A = Asthma
B = Bronchial wheezing
R = Allergic rhinitis
D = Atopic dermatitis

skin test positive subjects and 23% of the negative subjects had at least one clinical manifestation. On the other hand, 72% of the symptomatic and 33% of the asymptomatic subjects exhibited at least one positive skin test reaction.

Pollens appeared to be the most frequent cause of allergic symptoms (Table 4). Nineteen percent of the studied population had a positive skin reaction as well as a positive history to the allergen(s) in question. Subjects with a positive skin test or symptoms, or both,

Table 4
Different allergen groups as causes of allergic disorders as judged by the presence of both a positive history and a positive skin test

Allergens	Boys %	Girls %	Total %	P ^a
Pollens	14.2	8.2	10.9	0.01
Animal epithelia	5.7	8.9	7.5	ns.
House dust	5.1	4.8	4.9	ns.
Foods ^b	4.7	9.4	7.3	0.02
More than one group of allergens ^c	4.7	3.8	4.2	ns.
Any allergen(s)	25.0	27.5	26.4	ns.

^a χ^2 -test for sex difference.
^b The figures indicate that a positive history to various foods was obtained, only fish-extract was included in the skin test panel.
^c Included also in the above numbers.

had a positive family history more often than those without (Table 5).

Twenty-two per cent of the boys and 15% of the girls were regular smokers; 3.4% had been smoking for at least 5 years. The symptoms of 11 subjects (1.5%) fulfilled the criteria of chronic bronchitis (2). Seven of these were smokers and the condition was significantly ($P < 10^{-4}$) more prevalent in smokers.

The susceptibility to respiratory infections and prolonged coughs was investigated in the questionnaire. The susceptibility increased with smoking, symptoms of allergy and positive skin tests (Table 6).

The mean PEF value was 520 l/min

(s.d. = 63 l/min) for boys and 449 l/min (s.d. = 41 l/min) for girls.

DISCUSSION

We obtained a considerable body of medical history data from the subjects, their parents and medical records. Every subject was physically examined and interviewed by the authors, and this made it possible to evaluate recent signs of allergy and to exclude symptoms too vague to be considered as allergic. However, it is likely that some of the allergic conditions not active for years were forgotten or never diagnosed. A wheezy chest

Table 5
Prevalence of allergic disorders in parents or siblings as a function of skin reactivity and symptoms in the subjects of the study

Prevalence of respiratory or dermal allergy in parents or siblings %								
Skin test positive			Skin test negative			All		
Sympt.	Asympt.	Total	Sympt.	Asympt.	Total	Sympt.	Asympt.	Total
51	35	45 ^a	49	25	31 ^a	51 ^b	28 ^b	38

^a $P < 0.001$ for difference between skin test positive and negative subjects.

^b $P < 0.001$ for difference between symptomatic and asymptomatic subjects.

Table 6
Susceptibility to respiratory infections and prolonged coughs in relation to skin reactivity, smoking habit and allergic symptoms

Variable	Prevalence of susceptibility					
	Boys		Girls		Total	
	%	<i>P</i>	%	<i>P</i>	%	<i>P</i>
Skin test result						
negative	20	ns.	28	ns.	25	0.02
positive	27		37		32	
Smoking habit						
non-smokers	21	0.04	29	0.02	26	0.004
regular smokers	33		46		39	
Allergic symptoms						
asymptomatic	13	10^{-5}	18	10^{-5}	16	10^{-5}
wheezing, rhinitis and/or dermatitis	39		52		46	
Total group	24		32 ^a		28	

^a Significant sex difference for total group, $P < 0.01$.

during childhood may frequently have been ignored if not diagnosed as asthma. It has been established that wheezy chest has an excellent outcome and disappears usually before adolescence (8, 19). Smith (25) reported active wheezing in 5.3% of boys and in 2.9% of girls aged 15–16 years and stated that these figures were smaller than in those aged 5–6 years.

Asthma and/or allergic rhinitis, past or present, was observed in 25% of the subjects. This is close to the figures obtained by Freeman & Johnson (7) (24% in the age-group of 14–18 years) and Hagy & Settipleane (12) (25% in the age-group of 16–20 years). Our cumulative prevalence for asthma, 4.2%, is rather similar to the figures obtained in

young people in the United States and U.K. (7, 12, 23, 24), but much higher than those reported earlier from Finland, with the exception of our recent observations (Table 7). We also found that, at the age of 15–17, not more than one out of three asthmatics had been totally symptom-free during the past year; the asthmatic condition had, however, ameliorated in many cases.

The difference between various types of allergic rhinitis, vasomotoric rhinitis and infectious rhinitis is rather arbitrary if based only on a symptom history (4). Hay fever is the purest manifestation of atopic allergy and it is therefore interesting that our figures are close to those obtained by Hagy & Settipleane (12)

Table 7
The prevalence of respiratory allergy in schoolchildren and young people in Finland and other Scandinavian countries according to selected studies

Country and study	Age range (mean age)	Cumulative prevalence %				Source of information
		Asthma		Allergic rhinitis		
		Boys	Girls	Boys	Girls	
<i>Finland</i>						
Peltonen et al. (20)	7–14	0.85		0.62 ^a		Health nurses, parents
Eriksson-Lihr (6)	7–14	0.4	0.3			School nurses, health surveys for military service
	18–19	0.96				
Alanko (1)	10–19	0.5	0.5	2.7	2.7	Interview by a nurse, diagnosis made earlier by physicians
Malmberg (18)	6–11			13		Questionnaire, parents
		3.9		(4.7) ^a		
	19–49 (23.5)			8 28 (9.2) ^a		
Haahtela (9)	14–16	3.6	2.8	15	13	Questionnaire, parents, medical records, physical examination, skin prick test
Haahtela & Jokela (10)	18–19	2.7		20 (12) ^a		
This study	15–17	5.7	3.1	24	25	
				(14) ^a	(8) ^a	
<i>Sweden</i>						
Kjellman (16)	7	3.9	1.4	5.9	1.5	Questionnaire, parents, partly medical records
Kraepelien (17)	7–15	3.0	2.1			Medical records in schools
<i>Denmark</i>						
Johnsen & Mygind (14)	21–35 (25.8)			18 ^a	10 ^a	Questionnaire, skin prick test

^a Prevalence of hay fever

(13.5%) and Johnsen & Mygind (14) (14.9%) based on the same definition (see also Table 7).

Prevalence rates for atopic dermatitis in adolescent populations are difficult to obtain from the literature. Salo & Hannuksela (22) examined 823 Finnish conscripts and found active atopic dermatitis in 5.6%. The figures for infantile eczema reported in Finnish studies are quite low—usually less than 4% (20). The cumulative frequency of 27% for atopic dermatitis in the present study is surprisingly high, and it seems that the dermal manifestation is the most common allergic disorder up to adolescence. Fifty-four per cent of the subjects with dermatitis had respiratory symptoms as well. On the other hand, 52% of the subjects with respiratory symptoms had experienced dermatitis.

Boys were significantly more atopic than girls as judged by the skin reactivity (11). This seemed to be reflected in the higher prevalence for asthma, wheezing and especially hay fever in boys (Table 1). The higher prevalence of asthma and wheezing in boys had been established in numerous studies. While it is known that atopy is a frequently observed characteristic in wheezy subjects, it has been suggested that it may not be the main determinant of the susceptibility to wheeze and the explanation of the sex difference (5). However, we found that the wheezy subjects had positive skin reactions more than twice as often as the asymptomatic subjects, thus revealing this as an underlying feature disposing them to wheezing and asthma at this age. Horn & Gregg (13) reported that 60% of wheezing children showed a positive skin test. McNicol & Williams (19) have emphasized that almost all the asthmatics they surveyed showed several features (including immediate skin reactions) of the allergic state at 14 years of age. However, the relationship between atopic constitution and bronchial hyperreactivity is not altogether clear (27). It should be also noted that in the present study only 53% of those 19 subjects with wheezing as the only symptom had a positive skin test.

The predominance of the boys with hay

fever was very significant. This tendency for boys and young men has been observed by Freeman & Johnson (7), Arbeiter (3) and Johnsen & Mygind (14). Kjellman (16) found the difference in 7-year-olds. In many studies, however, it has either not been confirmed, or obscured by grouping all the subjects with allergic nasal symptoms under the heading "allergic rhinitis", which, as such, seems to be as prevalent in girls as in boys (Table 1). For non-seasonal allergic rhinitis, the sex difference was reversed. This could perhaps be related to the fact that the girls had a pet at home in 56% of the cases and the boys in 45%. In addition the girls seemed to report milder symptoms than the boys, which, of course, should affect all prevalences.

When the number of positive skin test reactions increases, the probability of manifest allergy increases in a progressive way (Fig. 1). Respiratory disorders were closely related to immediate skin test reactivity (Fig. 2). Even 87% of the asthmatics showed positive reactions, although the diagnostic definition of asthma did not, *a priori*, rely on a history of causative allergen(s); in fact only nine boys and six girls reported wheezing on exposure to allergens (Table 3).

Immediate skin test reactions have been reported to occur in 43–72% of patients with atopic dermatitis (26). According to Jones et al. (15) skin test positivity is no more frequent among patients with dermatitis than in a "normal population" when there is no respiratory allergy. Our observations on subjects with dermatitis as the only manifestation are rather similar; we found positive skin reactions in 57% of those subjects.

Our study revealed a significant association of immediate skin reactivity with hereditary allergy (Table 5) and susceptibility to respiratory infections and coughs (Table 6). Chronic bronchitis and respiratory infections were also related to smoking (Table 6).

In clinical practice, positive skin test results are commonly thought to implicate the aetiological factor(s) responsible for the complaint concerned. This is justified when a clear-cut

symptom history, e.g. pollen allergy, is given by the patient (Table 4). Frequently such clear evidence is not obtained, and skin test results should then be interpreted with caution. Although multiple positive skin reactions indicate an "atopic" predisposition (21), and frequently correlate with a history of respiratory allergy, individual reactions do so to a much lesser degree. We found that 98 boys and 84 girls reacted to one or more of the six pollen extracts used, but only 45 boys and 32 girls had a history of pollinosis. The correlations between reactions to animal epithelia and dusts and clinical history were even less significant. While 49% of the population studied experienced at least one positive skin reaction to pollens, epithelia or dusts (11), not more than 19% had also a positive history to the allergen(s) in question. Active treatment should be undertaken cautiously, without undue reliance on skin tests.

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Comparison of Different Diagnostic Materials

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Extracts of five common atmospheric pollen allergens (Corydalis, Alnus and Potentilla) obtained from different manufacturers were compared by means of skin prick testing and, partly, with the radioallergen sorbent test. Considerable differences were found between the extracts with regard to potency and found to mould allergic individuals and species. A purified allergen preparation of Corydalis allergen was inferior to the crude allergen extracts. The results suggest that the allergen content of the extract differed both with regard to total allergen potency and to allergen composition.

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The diagnosis of respiratory allergy is usually a hard task because the history may be equivocal and the allergen extract available for objective diagnosis may be far from satisfactory, as pointed out more than 30 years ago by Boorman (12) and by Nilsson & Aal (1). Studies in our laboratory and elsewhere have demonstrated a marked heterogeneity of pollen extracts and that the quality and composition of the extracts depend on many variables (6, 12, 24).

This led us to investigate in more detail to what degree various commercial allergen extracts of five of the most common species—*Corydalis*, *Alnus*, *Potentilla*, *Urtica* and *Phlomis*—differ with respect to total allergen activity in diagnostic skin prick test (SPT) and radioallergen sorbent test (RAST). Since it has been shown that the purified allergen preparation of Timothy grass pollen is representative of and superior to the crude aqueous pollen extract, both in diagnostic and therapeutic (13, 14), a similar type of purified preparation of *Corydalis* allergen was included in the study in comparison with conventional aqueous and glycerinated crude extracts. Similar high quality allergen preparations were not available for the other moulds.

PATIENTS

The study included a total of 30 patients aged 8-15 years referred with asthma, rhinitis and/or hives suggestive of allergy to moulds and with an informed consent to participate given by the patient and parents. Twelve patients with allergic asthma without any history suggesting mould-allergy were selected as controls. The latter had no previous SPT or

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