

Increase of asthma, allergic rhinitis and eczema in Swedish schoolchildren between 1979 and 1991

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Summary

Background A previous study has shown a twofold increase in prevalence of asthma and allergic rhinitis (AR) in Swedish recruits during the 1970s. The increase was higher in more northerly colder regions.

Objectives To follow up the previously found trend to increasing prevalences with time as well as the climatic variations within the country.

Methods The prevalences of asthma, allergic rhinitis and eczema were assessed using two questionnaire studies, 12 years apart (1979 and 1991) with identical questions about the diseases. The study comprised representative samples of children from the Göteborg area on the south-western coast (in 1979: 7-year-olds, $n = 4255$, in 1991: 7-year-olds, $n = 1649$) and in Kiruna, a mining town in the northernmost inland mountains (in 1979: 7-year-olds, $n = 427$, in 1991: 7–9-year-olds, $n = 832$). In 1991 there was also a personal interview and a skin-prick test (SPT) on subsamples.

Results The prevalence of all these diseases present over the last year had roughly doubled over the 12-year period. On both occasions, most symptoms were more prevalent in the northern area. In 1991, the prevalence of one or more symptoms in Göteborg was 23.8% and 32.5% and in Kiruna 29.9% and 44.8% in the questionnaire and the interview, respectively.

Conclusion Asthma, AR and eczema increase continuously in prevalence in Sweden and the climatic distribution of the prevalences suggests possible major risk factors to be found in a closed indoor climate.

Keywords: epidemiology, asthma, allergic rhinitis, eczema, childhood, indoor climate

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Introduction

Increasing prevalence of asthma, allergic rhinitis (AR), and eczema are reported from different parts of the world in recent decades [1–6]. Regarding a twofold increase in prevalence of asthma and AR in Swedish recruits during the 1970s [7], the increase was higher in more northerly colder regions and in subjects dwelling in a closed indoor environment during their first months of life [8]. This relation to environmental factors has been interpreted as evidence for a real increase, and not only increased awareness of symptoms [3]. To follow up this trend, we

studied the prevalence of the diseases in children during the 1980s in two parts of Sweden representing a wide climate span.

Population and methods

In 1979, a questionnaire study of allergic diseases was conducted in schoolchildren, 7, 10 and 14 years of age in three areas [9]. One of them was Göteborg, a city on the south-western coast, and one was Kiruna, a mining town in the northernmost inland mountains. There were 4255 complete answers in Göteborg (response rate 95%) and 427 in Kiruna (response rate 97%) from the 7-year-olds. Two years later 82 children could be identified of the 99 children in Gothenburg who reported asthma during

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the last year. Five of these 82 had moved before the investigation. The remaining 77 all had a history of asthma according to the interview criteria below, and severity scoring was performed.

In 1991, a second questionnaire study was conducted. In Göteborg, a sample of schools with 7-year-olds representing all parts of the city, comparable from social and environmental pollution points of view with the classes included in 1979. There were 1115 complete answers (response rate 83%). In Kiruna, to get a sufficient number for geographical comparisons, all 7–9-year-olds were included. There were 832 complete answers (response rate 91%). In addition, all 7-year-olds in Mölndal, a town adjacent to Göteborg were included, 534 complete answers (response rate 93%).

The questions about disease were identical in 1979 and 1991: has your child ever had asthma/wheezy bronchitis, AR/conjunctivitis, eczema or urticaria/allergic congestion? Have there been any symptoms in the last year? The same questions about disease ever were also asked for the parents. For the children, new questions were added in the questionnaire in 1991 about severity of asthma symptoms comparable with the questions used in the follow-up sample from the study in 1979.

In spring 1992, representative samples of children in Mölndal and Kiruna were invited to have a validation interview and a skin-prick test (SPT) for the most common airborne allergens in Sweden. In Mölndal, 203 children were invited but 11 refused SPT and these parents were interviewed by telephone. In Kiruna 209 children were interviewed and four refused SPT. No one refused the interview. The samples were stratified into four groups, one for each of the reported chronic diseases and one healthy control for each child with a disease. The goal was to have as equal numbers of the three disease groups as possible, but the practical accessibility of the patients gave the following distribution: asthma 13%, AR 16%, eczema 21% and healthy controls 49%. Consecutive cases were invited by telephone from class lists from schools distributed to represent the different parts of the areas, if they had suitable premises for SPT. Trained nurse/research assistants carried out the SPT, according to the standards from the sub-committee on skin tests of the European Academy of Allergology and Clinical Immunology [10]. Forty-nine skin-prick tests on the same seven patients simultaneously did not reveal any difference in number of positive tests between the two investigators. The allergen extracts used were all of ALK make; Soluprick SQ 10 HEP: birch, timothy-grass, *Dermatophagoides pteronyssinus*, dog, cat and horse. The most common airborne mould spore in Sweden, *Cladosporium herbarum*, was represented by Soluprick in dilution 1 : 20. Positive control was Histamine 10 mg/mL

Soluprick. A positive SPT in this paper corresponds to at least one weal with a diameter exceeding the negative control by at least three millimetres. The results of the interview and SPT were applied to the total population in a weighted manner, in relation to the proportions of children in the populations that filled the criteria used for selection of the test strata. The relative risks were estimated as ratios of the proportions for the two areas. These were weighted using the proportions in the different strata as weights. The confidence intervals were constructed using the technique for test based confidence intervals [11].

In the interview, past and present symptoms were asked for and affirmative answers labelled with the diagnosis: asthma: wheezing/whistling breathing or heavy breathing/breathing difficulties that could not be ascribed other disease (e.g. pseudocroup). Asthma was considered to be severe if the children over the last year had more than 10 asthma periods with free intervals, or more than two periods of at least 6 weeks duration, or was on regular medication for more than half the year. Allergic rhinitis/conjunctivitis (AR): recurrent sneezing/thin nasal discharge, congested and red/itching eyes or low grade nasal discharge for at least 6 months. Possible infectious origin of the nasal/ocular symptoms was considered and disqualified for the AR label. Eczema (symptoms must have been present or recurrent for at least 6 months): itching erythema, scaling, leather-like coarse skin eruptions or pimples/blisters/fissures/sores on typical positions, mainly joint flexures. A history of pimples/blisters/fissures/sores or more than three locations was labelled as severe eczema.

The statistical analyses were made using the statistical package PC-SAS. Statistical significance of group differences were assessed using the *t*-test and chi-square-test. The study was approved by Ethics Committee of Gothenburg University.

Results

The proportion of severe asthma was on the same level in Göteborg in 1979 (20%) as in 1991 (24%) and as in Mölndal in 1991 (28%). In Kiruna the proportion of severe asthma in 1991 (49%) was twice as high ($P < 0.05$) as in the southern areas. Most results in Göteborg and Mölndal were very similar, and in the tables and below both these municipalities are included in the Göteborg area.

There were significant increases in prevalence of all diseases as well as the total (each $P < 0.001$) between 1979 and 1991 (Table 1). The increase was roughly the same in both areas, with higher frequencies in Kiruna on both occasions.

Table 1. Prevalence of disease present during the last year according to the questionnaires in 1979 and 1981

	Total <i>n</i> = 4682 <i>n</i> = 2481	Göteborg <i>n</i> = 4255 <i>n</i> = 1649	Kiruna <i>n</i> = 427 <i>n</i> = 832	Relative risk (95% confidence interval)
<i>Asthma</i>				
1979	116 (2.48%)	99 (2.33%)	17 (3.98%)	1.71 (1.03–2.83)
1991	142 (5.71%)	85 (5.14%)	57 (6.82%)	1.3 (0.96–1.84)
<i>AR</i>				
1979	255 (5.45%)	232 (5.46%)	23 (5.39%)	0.99 (0.65–1.50)
1991	201 (8.08%)	129 (7.80%)	72 (8.61%)	1.10 (0.84–1.45)
<i>Eczema</i>				
1979	330 (7.05%)	287 (6.75%)	43 (10.07%)	1.49 (1.10–2.02)
1991	455 (18.28%)	270 (16.33%)	185 (22.13%)	1.36 (1.15–1.60)
<i>Total (One or more)</i>				
1979	597 (12.75%)	526 (12.36%)	71 (16.63%)	1.35 (1.07–1.69)
1991	641 (25.84%)	392 (23.77%)	249 (29.93%)	1.26 (1.10–1.44)

In the interview in 1991, 93% of the questionnaire diagnoses in both areas were verified according to the criteria mentioned. Asthma was verified in all cases but one and the lowest frequency of verification of questionnaire reports, 85%, was seen for AR in the southern area. Less than 10% (15 children of whom three had positive SPT) of all children with symptoms of AR in the interview were considered to have infectious induced rhinitis and were consequently not counted as AR. The prevalence of symptoms in the last year were, on the average, 1.4 times higher in the interview than in the questionnaire (Table 2). The geographical differences were greater in the interview than in the questionnaire in terms of absolute frequencies, but the trends to higher prevalence in the north measured as relative risks were similar to those found in the questionnaire.

A still stronger geographical trend was seen for the prevalence of one or more positive SPTs for any of the major allergen groups as well as the total (Table 3). Present keeping of furry pets (dogs or cats) was reported by 23% of the children in Göteborg and 34% in Kiruna, respectively.

Discussion

The most apparent finding of the present study is the substantial increase over time of both asthma, AR and eczema over the 12-year period studied. Another prominent feature is the remaining geographical difference over the interval, with higher frequencies in the northernmost area of Sweden.

Table 2. Prevalence of symptoms during the last year according to the interview in 1991. The frequencies obtained in the test strata are applied to the total populations in a weighted manner, in relation to the proportions of the interview strata in the populations. At least one positive SPT is required for the diagnosis of AR

	Göteborg <i>n</i> = 202	Kiruna <i>n</i> = 207	Relative risk (95% confidence interval)
Asthma	7.71%	12.68%	1.65 (1.17–2.33)
AR	6.46%	19.14%	2.98 (2.26–3.93)
Eczema			
total	27.32%	30.86%	1.13 (0.93–1.38)
severe	14.87%	21.72%	1.45 (1.17–1.81)
One or more above	32.51%	44.81%	1.38 (1.18–1.63)

Table 3. Percentages of positive skin-prick tests in 1991. The frequencies obtained in the test strata are applied to the total populations in a weighted manner, in relation to the proportions of the interview strata in the populations

Allergen	Göteborg <i>n</i> = 192	Kiruna <i>n</i> = 204	Relative risk (95% confidence interval)
Animals (any of dog, cat or horse)	6.46%	20.71%	3.23 (2.44–4.28)
Pollen (any of birch grass pollen)	9.94%	16.14%	1.62 (1.22–2.16)
Any of house dust mite or <i>Cladosporium herbarum</i>	3.66%	4.55%	1.22 (0.71–2.08)
Total of at least one above	13.65%	27.20%	2.00 (1.57–2.54)

One of the limitations of figures obtained from questionnaires like this one that involve labels like asthma, AR or eczema is the varying awareness and possible underreporting in the populations studied, in the present study made visible by the difference between the frequencies based on questionnaire reports and the interview. Still, the use of the same questionnaire twice, with a 12-year interval, provided a good opportunity to study trends in prevalences over time. Symptoms should be less affected by recollection losses the more recently they occurred, and therefore we focus only on symptoms during the last year. Furthermore, the fact that the children in Kiruna were on an average 1 year older than those in Göteborg should bias present frequencies less than cumulative figures. In 1979, AR was the only recent symptom that increased in prevalence during school age [9], with an increment of less than 1%/year of age.

Asthma

The total prevalence of present asthma symptoms was about 5% in 1991, making a doubled prevalence since 1979. The prevalence on both occasions was on the same level as in other Swedish studies from the respective periods [12–15]. This congruence in increasing figures from many investigations supports the idea of a true increase. Another fact further contradicting the notion of increased awareness underlying the increasing figures in the present study was the increase in the prevalence of severe asthma, corresponding to findings reported from UK [6]. In the UK, the USA, Australia and New Zealand, higher figures than in Sweden are reported [1–4]. In the interview however, the prevalence of asthma/wheezing symptoms, particularly in the northernmost area, reached the same level as in the UK [1,2,4].

Allergic rhinitis and positive SPT

The prevalence of AR in the questionnaire in 1991 was about 8%, the same level as described in 7-year-old children in a recent cohort study from southern Sweden [15].

As a positive SPT was required for the label of present AR in the interview, the difference in SPT-positivity was also reflected in the geographical difference in AR between the areas. The high level of both allergic rhinitis and SPT-positivity in the northern area, however, is comparable with results from another town in northern Sweden [16].

Eczema

Eczema was the most common disease and the one that increased most rapidly over time. The questionnaire in 1991 revealed a prevalence of almost 20%, which is high compared with another recent Swedish study [17]. In the interview, the prevalence of severe eczema corresponded to roughly the same levels as the total prevalence of eczema in the questionnaire reports. This finding may support a notion that the questionnaire reports in 1991 represented clinically significant disease and, consequently, that the increase in prevalence of eczema between 1979 and 1991 is a real increase rather than an increased awareness of mild disease.

Increase over time and geographical trend

The total of one or more symptoms of asthma/wheeze, AR or eczema doubled in prevalence over the period, resulting in apparently high levels in 1991, although no figures for direct comparison are available from other studies. In the interview, almost half of the children in the northern area had had any of the symptoms during the last year. Various awareness, particularly of mild disease may always bias questionnaire reports as they often, as was obvious in the present study, represent substantial underreporting. Still, the congruence in increase between total and severe asthma in the questionnaire as well as the similarity between severe eczema in the interview and the questionnaire reports in 1991 make us believe that the questionnaire reports represent clinically significant disease fairly well and that the increase is basically real and not only a reflection of increasing awareness.

In other parts of the world, increasing frequencies of these diseases have been related to exposure and to allergy to house dust mite [2,18]. In Sweden, allergy to house dust mite is so far not very common in childhood to date [12,16], a fact that was confirmed in the present study. No other major allergens like animal danders and pollens have increased correspondingly. The explanations of the remaining geographical trend over the period may, however, also partly explain the increase over time as well. The difference in absolute percentage of affected children between the areas tended to increase over the period, and the trend in 1991 was further enhanced when considering more significant disease: severe asthma in the questionnaire, SPT-verified AR and severe eczema in the interview. Allergies to animals and pollens were both more common in the northern area, despite the fact that pollens are much less common in the area (Nilsson S. Palynological Laboratory, Stockholm, pers. comm.). The difference in SPT-positivity between the different allergens may well correspond to the pattern of exposure in the respective areas, but the geographical differences may hardly be explained by differences in allergen exposure. A hypothesis regarding hazards in the indoor climate, attributable to increasing insulation of buildings in order to save energy was applied to the pattern of increase between 1971 and 1981 [7,8], with higher increases in more northern and colder region in the country. Over the last decades, the same insulation technique first used in the northern colder parts of the country, has been applied all over Sweden [19], but the effects may vary with a climatic gradient: the longer and colder winter, the less people keep windows and doors open. Consequently, it is possible that the changes in the indoor climate may be involved in both the general increase in the country as well as the geographical pattern. Further analyses of data from the present study will focus on this subject.

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References

- 1 Evans R. Epidemiology of Asthma in Childhood. *Pediatrician* 1991; 18:250–6.
- 2 Burr ML. Epidemiology of Asthma. In: Burr ML, ed.

- Epidemiology of Clinical Allergy. Monogr Allergy. Basel, Karger, 1993; 31:80–102.
- 3 Sibbald B. Epidemiology of Allergic Rhinitis. In: Burr ML, ed. Epidemiology of Clinical Allergy. Monogr Allergy. Basel, Karger, 1993; 31:61–79.
- 4 Ninan TK, Russel G. Respiratory symptoms and atopy in Aberdeen school children: evidence from two surveys 25 years apart. *Br Med J* 1992; 304:873–5.
- 5 Haahtela T, Lindholm H, Björkstén F, Koskenvuo K, Laitinen LA. Prevalence of asthma in Finnish young men. *Br Med J* 1990; 301:266–8.
- 6 Burney PGJ, Chinn S, Rona RJ. Has the prevalence of asthma increased in children? Evidence from the national study of health and growth 1973–86. *Br Med J* 300:1306–10.
- 7 Åberg N. Asthma and allergic rhinitis in Swedish conscripts. *Clin Exp Allergy* 1989; 19:59–63.
- 8 Åberg N. Birth season variation in asthma and allergic rhinitis. *Clin Exp Allergy* 1989; 19:643–8.
- 9 Åberg N, Engström I, Lindberg U. Allergic Diseases in Swedish school children. *Acta Paediatr Scand* 1989; 78:246–52.
- 10 Dreborg S. Skin tests used in type I allergy testing. Position paper. *Allergy* 1989; 44, suppl. 10.
- 11 Rothman KJ. Modern epidemiology. Boston: Little Brown & Company, 1986: 145–7.
- 12 Hattevig G, Kjellman B, Björkstén B, Johansson SGOJ. The Prevalence of Allergy and IgE Antibodies to Inhalant Allergens in Swedish School Children. *Acta Paediatr Scand* 1987; 76:349–55.
- 13 Bråbäck L, Kälvesten L, Sundström G. Prevalence of Bronchial Asthma among Schoolchildren in a Swedish District. *Acta Paediatr Scand* 1988; 77:821–5.
- 14 Andrae S, Axelsson O, Björkstén B, Fredriksson M, Kjellman N-IM. Symptoms of bronchial hyperreactivity and asthma in relation to environmental factors. *Arch Dis Child* 1988; 63:473–8.
- 15 Hattevig G, Kjellman B, Björkstén B. Clinical symptoms and IgE responses to common food proteins and inhalants in the first 7 years of life. *Clin Allergy* 1987; 17:571–8.
- 16 Bråbäck L, Kälvesten L. Urban living as a risk factor for atopic sensitization in Swedish schoolchildren. *Pediatr Allergy Immunol* 1991; 1:14–9.
- 17 Croner S, Kjellman N-IM. Development of atopic disease in relation to family history and cord blood IgE levels. Eleven-year follow-up in 1654 children. *Paediatr Allergy Immunol* 1990; 1:14–20.
- 18 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.
- 19 Engström L. Energy use in the built environment. In: Engström L, ed. Energy in built environment — possibilities of the nineties. Stockholm: Swedish Council of Building Research, Nr G 16. 1987:109–15.

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