

Asthma in children: Prevalence, treatment, and sensitization

Hesselmar B, Åberg B, Eriksson B, Åberg N. Asthma in children: prevalence, treatment, and sensitization.
Pediatr Allergy Immunol 2000; 11: 74–79. © Munksgaard, 2000

This study compares the prevalence of asthma and sensitization in children from two Swedish regions with different climates: Göteborg on the southwest coast and Kiruna in the northern inland, north of the Arctic Circle. The 412 children of a population-based sample, 203 in Göteborg and 209 in Kiruna, were investigated at age 7–8 and 12–13 years. Questionnaire reports and interviews were obtained from all children at 7–8 years of age, and 192 children were skin-prick tested for common aeroallergens in Göteborg and 205 in Kiruna. At the follow-up, 5 years later, almost all the children were re-investigated. The prevalence of asthma, wheeze, and sensitization had increased with increasing age during the follow-up period. The questionnaire reports revealed that the prevalence of asthma was 8.5% at 12–13 years of age. All children who in the questionnaire reported current asthma, were using asthma medication. The interviews indicated that the prevalence of a clinically significant asthma might be even higher, reaching $\approx 12\%$. Asthma and wheeze were as common in Göteborg as in Kiruna despite large differences in prevalence of sensitization. Sensitization, and especially sensitization to animals, was far more common in Kiruna than in Göteborg. This study shows that asthma and wheeze are increasingly prevalent even in school age children and that sensitization does not necessarily reflect the prevalence of asthma in a population.

**Bill Hesselmar¹, Birgitta Åberg¹,
Bo Eriksson² and Nils Åberg¹**

¹Department of Paediatrics, University of Göteborg, Sweden, ²Nordic School of Public Health, Göteborg, Sweden

Key words: asthma; sensitization; epidemiology; children

Bill Hesselmar, The Queen Silvia Children's Hospital, 416 85 Göteborg, Sweden
Tel.: +46 31 343 4000
Fax: +46 31 343 4760
E-mail: bill.hesselmar@medfak.gu.se

Accepted 12 January 2000

During the last few decades, asthma and allergy in Sweden have become increasingly prevalent in childhood, in common with other western societies (1,2). In many countries, sensitization has been shown to be an important risk factor for asthma in children (3–5). The relationship between sensitization and the disease, however, is not always unambiguous. In the Far East, large differences are seen in the prevalence of childhood asthma between different cities, despite a similar level of sensitization (6). In areas of Ethiopia, and among Aboriginal children, there is almost no asthma, despite sensitization (7,8). Therefore, it appears that the consequences of allergic sensitization for the prevalence of childhood asthma in different geographic areas need further clarification before any connection can be made between risk factors for sensitization and risk factors for disease. We report on a study of

the development of asthma and sensitization during school age in two different climatic areas of Sweden.

Materials and methods

In 1991, a questionnaire study of allergic diseases was conducted in the Göteborg area (Göteborg and Mölndal) on the southwest coast of Sweden, and in Kiruna, a mining town in the mountains inland, north of the Arctic Circle. In Göteborg, a sample of schools with 7-year-old children were chosen to represent all areas of the city, covering known variations in socio-economic scale and environmental pollution. There were 1115 complete answers from the parents (response rate 83%). In addition, all 7-year olds in Mölndal, a smaller town adjacent to Göteborg, were included, yielding 534 complete answers

(response rate 93%). In Kiruna, all 7–9-year olds were included to obtain a sufficient number for geographic comparisons. There were 832 complete answers (response rate 91%). The questions in regard to disease and symptoms were, among others:

Has your child ever had asthma/asthmatic bronchitis, allergic rhinitis/conjunctivitis (ARC), eczema or urticaria/allergic congestion?

Have there been any symptoms in the last year?

A sub-sample selected from the main sample was given a more detailed interview and skin-prick tests (SPTs). The children in the main sample were stratified into four groups: positive for asthma; positive for ARC; positive for eczema; and healthy controls. Each stratum was given a weight according to its relative size. Equal numbers of patients (children with a history of asthma, ARC or eczema) and controls were randomly selected from the respective strata (Fig. 1). In the Göteborg area, 203 children were interviewed. Eleven refused SPTs. In Kiruna, 209 children were interviewed and four refused SPTs.

The 412 children who underwent the interview and SPTs in 1992 were contacted once again in the winter of 1996 for a follow-up investigation. The children in the Göteborg area were now 12 years old and, in Kiruna, 12–13 years old. In both areas, 201 parents completed a questionnaire. The questions in regard to disease and symptoms were the same as in 1991. The children were also invited to participate in an interview and to undertake SPTs. In contrast to the earlier interview in 1992, we questioned the children and not their parents. The questions, however, were the same as in 1992 and they asked about wheeze, chest tightness, exercised-induced cough, and the use of asthma medication. The Swedish language lacks a proper word for 'wheeze'. To help the children understand her questions, the nurse who performed the interviews imitated respiratory sounds. A diagnosis of asthma from the interview

data was based on the use of asthma medication or the presence of symptoms affecting daily life for at least 1 day every month. In the Göteborg area, 200 children underwent interview and 188 SPTs. In Kiruna, the corresponding numbers were 196 and 183, respectively.

The SPTs were performed as previously described with a good reproducibility over time and between the regions (9). Allergen extracts from the same manufacturer were used in 1992 and 1996. The allergens investigated were: birch, timothy-grass, dog, cat, horse, and *Dermatophagoides pteronyssinus* (Soluprick SQ 10 HEP, ALK; Hørsholm, Denmark). In 1996, *Dermatophagoides farinae* was added to the panel. The airborne mould spore *Cladosporium herbarum* was represented by Soluprick at a dilution of 1:20. Histamine 10 mg/ml in Soluprick was employed as positive control. A positive SPT corresponded to a weal with a diameter exceeding the negative control (NaCl 9 mg/ml) by at least 3 mm.

The power calculations for the original cross-sectional study in 1991 were based on the results of a previous study performed in 1979 in which three Swedish regions were compared (10). The size of the stratified sub-sample was calculated to detect similar differences as those observed between Kiruna and Göteborg in 1979.

All estimated prevalences were calculated in the sub-sample as weighted proportions using the estimates in the individual strata and the weights from the original 1991 sample. The estimated prevalences in Göteborg and Kiruna were compared using large sample normal approximation tests. Differences between the two ages over time, namely between 7 and 8 and 12–13 years of age, were assessed using McNemar corrected chi-square analysis, and differences between proportions with chi-square tests. A multiple logistic regression model was used to identify risk factors for sensitization. Statistical analyses were performed using the statistical package sas for Windows, version 6.12 and Epi-Info version 6.04b. The Ethics Committee of Gothenburg University approved the study.

Results

During the 5-year follow-up period, increasing symptoms associated with bronchial hyper-responsiveness were seen with asthma and other respiratory symptoms (Table 1). From the interviews, the prevalence of asthma was found to be higher than in the questionnaire and reached 12% at 12–13 years of age. Approximately 25% of the children reported wheeze and/or chest tightness.

1991 Questionnaire survey (7–9 year) n=2481

Asthma ever n=185	AR ever n=172	Eczema ever n=480	Healthy n=1644
↓	↓	↓	↓

1991/1992 Subsample (7–8 year) n=412

Asthma ever n=54	AR ever n=66	Eczema ever n=88	Healthy n=204
↓ Missing n=10			

1996 Follow up of subsample (12–13 year) n=402

Fig. 1. Flow sheet of the population studied from 1991–96.

Table 1. Questionnaire data for asthma and interview data for wheeze and other respiratory symptoms in 7–8 and 12–13-year-old children

Questionnaire	Age (years)	Total % (SE)	Göteborg % (SE)	Kiruna % (SE)	Difference (p-value)
Asthma, cum. inc.	7–8	7.6 (0.40)	7.7 (0.83)	8.1 (0.45)	> 0.20
	12–13	12.2 (1.17)	13.4 (2.09)	12.2 (1.44)	> 0.20
	Difference	< 0.001	0.006	0.027	
Asthma prevalence	7–8	4.5 (0.63)	4.2 (1.05)	5.15 (0.85)	> 0.20
	12–13	8.5 (1.08)	7.6 (1.80)	10.3 (1.40)	> 0.20
	Difference	< 0.001	0.06	0.002	
Interview					
Wheeze	7–8	7.6 (0.98)	6.9 (1.64)	8.8 (1.26)	> 0.20
	12–13	17.7 (1.82)	17.3 (2.66)	17.4 (2.50)	> 0.20
	Difference	< 0.001	< 0.001	0.025	
Chest tightness	7–8	8.4 (1.24)	6.0 (1.61)	10.4 (1.70)	0.06
	12–13	23.7 (2.05)	21.6 (2.91)	25.7 (2.95)	> 0.20
	Difference	< 0.001	< 0.001	< 0.001	
Exercised-induced cough	7–8	5.7 (1.05)	6.4 (1.69)	5.2 (1.33)	> 0.20
	12–13	10.2 (1.51)	11.3 (2.33)	9.0 (2.00)	> 0.20
	Difference	0.07	0.10	> 0.20	
Wheeze and/or chest tightness	7–8	8.4 (1.24)	6.04 (1.61)	10.4 (1.69)	0.06
	12–13	27.6 (2.17)	25.9 (3.12)	28.7 (3.09)	> 0.20
	Difference	< 0.001	< 0.001	< 0.001	
Asthma prevalence*	7–8	8.6 (1.03)	8.4 (1.70)	9.4 (1.24)	> 0.20
	12–13	12.7 (1.43)	13.2 (2.26)	12.4 (1.89)	> 0.20
	Difference	0.008	0.006	> 0.20	

*Asthma prevalence in interview is based on the use of medication and/or symptoms affecting daily life for at least 1 day a month.

All figures are weighted proportions from the sub-sample.

cum. inc., cumulative incidence; SE, standard error.

The figures for Göteborg and Kiruna showed no consistent difference.

All children who in the questionnaires reported the presence of asthma during the previous year used asthma medication. The pattern of usage was similar on the two occasions: 50% of the children used only bronchodilators as required and the other 50% had received anti-inflammatory treatment. Approximately 50% of those who had received anti-inflammatory treatment used it for more than 6 months a year. Of the children who reported wheeze and/or chest tightness in the interview at 7–8 years of age, 75% used asthma medication. The corresponding usage at 12–13 years of age was slightly less than 50% and the majority of those without treatment had only sporadic symptoms.

The prevalence of sensitization increased significantly during the follow-up period. In Kiruna, the rate of sensitization was about twice as high as in Göteborg, both at 7–8 and 12–13 years of age (Table 2). Sensitization to animals was about three times more common in Kiruna than in Göteborg and the tendency was similar for pollens. Mite sensitization, however, was more common in Göteborg.

Children with current asthma, according to questionnaire reports, were already sensitized in ≈ 70–75% at 7–8 years of age (Table 3). The proportion of sensitization did not increase

significantly during the follow-up period. Sensitization to animals was more common in Kiruna than in Göteborg, both in children with asthma as well as in the whole population. Current exposure or contact with animals was, however, similar. Thirty-six per cent of the children in Göteborg had a pet (cat or dog) or went horseback riding. The corresponding figure in Kiruna was 34%.

A multiple logistic regression model was used to identify putative risk factors for sensitization. The difference in sensitization at 12–13 years of age, with a higher frequency in Kiruna than in Göteborg, remained after adjustment for: gender; season of birth (before the pollen season: February–April, during the pollen season: May–August, during the autumn and winter period: September–January); age (12 or 13 years); parental history of allergy; parental smoking; pet keeping during the first year of life; number of colds during the first year of life; day-care during the first 2 years of life; asthma ever; allergic rhinoconjunctivitis ever; eczema ever; current pet keeping; current horseback riding (odds ratio [OR] 2.5, 95% CI 1.23–5.10, $p < 0.01$). With asthma ever as the dependent variable, current sensitization was a risk factor (OR 3.1, 95% CI 2.64–6.52, $p < 0.05$) whereas area (Kiruna or Göteborg) was not (OR 0.84, 95% CI 0.35–2.03, $p > 0.2$).

Table 2. The prevalence of sensitization to airborne allergens in Kiruna and Göteborg

	Age (years)	Total % (SE)	Göteborg % (SE)	Kiruna % (SE)	Difference (p-value)
SPT total	7–8	20.8 (1.90)	13.8 (2.03)	27.0 (2.98)	<0.001
	12–13	31.7 (2.36)	22.5 (3.36)	38.1 (3.31)	<0.001
	Difference	<0.001	0.001	0.002	
Pollens*	7–8	12.8 (1.50)	8.9 (1.48)	15.8 (2.44)	0.04
	12–13	22.4 (2.09)	20.4 (3.00)	25.4 (3.06)	>0.20
	Difference	<0.001	<0.001	0.005	
Animal†	7–8	14.3 (1.57)	6.8 (1.13)	21.9 (2.71)	<0.001
	12–13	19.2 (1.93)	9.7 (1.93)	25.4 (3.14)	<0.001
	Difference	0.024	>0.20	0.007	
Mite‡	7–8	2.9 (0.78)	3.3 (1.19)	2.4 (1.11)	>0.20
	12–13	5.9 (1.21)	10.3 (2.39)	2.1 (1.02)	0.002

*Birch and grass.

†Dog, cat, and horse.

‡*Dermatophagoides pteronyssinus* at 7–8 years. At 12–13 years, *D. farine* was added.

All prevalences are weighted proportions from the sub-sample.

SPT, skin-prick test.

Discussion

The prevalence of asthma and sensitization in children has been estimated in a follow-up study in two Swedish regions: Kiruna in the north and Göteborg on the southwest coast. In the total population of 12–13-year-old children, the interview data revealed that almost 13% used asthma medications or had asthma symptoms that affected their daily life for at least 1 day every month. Almost 18% had experienced wheeze in the previous year and slightly more than 30% were sensitized to common airborne allergens. The results from our study are in concordance with other recent studies (11) but higher than reported from the ISAAC study (12), probably because of different methods and questions used. In the ISAAC study the questionnaire asked for asthma ever, whereas we asked for asthma or asthmatic bronchitis ever. The occurrence of wheeze was based on questionnaire reports in the ISAAC study, whereas on interviews in ours. Questionnaire reports are more likely to underestimate a symptom such as wheeze, particularly

as a proper translation for the word is lacking in Swedish.

It is obvious from the interview data that many children experienced symptoms from the respiratory tract. In particular, wheeze and chest tightness was common at 12–13 years of age. Contributing to the increase of these symptoms with age could be that we interviewed the children themselves at 12–13 years of age and the parents when the children were 7–8 years of age. In many cases these symptoms were mild and non-specific and probably do not represent a clinical diagnosis of asthma. Even with a more strict criterion for the diagnosis of asthma in the interview – based on either the use of asthma medication or the presence of recurrent asthma symptoms affecting their daily life for at least 1 day a month – the prevalence was high and increased over time.

The prevalence of asthma in school children has previously been relatively constant during the school period (10–13). We found a significant increase in asthma prevalence during follow-up and this appears as a changing pattern in

Table 3. The frequency of sensitization to common aeroallergens in children with asthma

	Age (years)	Total (%)	Göteborg (%)	Kiruna (%)	Difference (p-value)
SPT total	7–8	69	61.5	75	>0.20
	12–13	77.3	70	83	>0.20
Pollens*	7–8	39.3	38.5	40	>0.20
	12–13	61.4	60	62.5	>0.20
Animal†	7–8	64.3	46.2	80	0.06
	12–13	56.8	40	70.8	0.04
Mite‡	7–8	10.7	23.1	0	0.09
	12–13	15.9	25	8.3	0.13

*Birch and grass.

†Dog, cat, and horse.

‡*Dermatophagoides pteronyssinus* at 7–8 years. At 12–13 years, *D. farine* was added.

childhood asthma. This increase with age may contribute substantially to the currently increasing prevalence of childhood asthma.

A most striking finding in the present study was the difference in sensitization of children from the two cities, despite a similar occurrence of asthma and wheeze. This raises at least two questions: why is sensitization more common in Kiruna and why was the difference not associated with a similar difference in asthma and wheeze?

There are indeed differences between the two regions. Kiruna is located to the north of Sweden, inside the Arctic Circle. The climate is cold and the pollen season short. Göteborg is on the southwest coast of Sweden where the climate is warmer and more humid; the pollen season is almost twice as long as in Kiruna (The Pollen Group, University of Göteborg, personal communication) and mite infestation is probably more common (14). Current exposure to animals, i.e. cat or dog keeping or horseback riding, is, however, similar in the two regions. But even with these differences in mind, as well as all other factors tested for in the multiple logistic regression model, we were not able to find an explanation for the difference in sensitization. One could only speculate that the long winter in Kiruna forces the children to spend a longer period of the year indoors, in a closed indoor environment. In such a milieu, adjuvant factors might enhance sensitization, especially to animal dander and other indoor aeroallergens.

The second question, why this higher level of sensitization in Kiruna was not associated with a corresponding difference in asthma and wheeze, is also of principal interest. With a 3-fold difference in sensitization to animal dander and a cold climate precipitating for wheeze and other asthma symptoms, especially during exercise, one would expect a higher prevalence of asthma in Kiruna than in Göteborg. However, this was not the case: the occurrence of asthma and wheeze was almost identical in the two regions. This lack of a direct correlation among the occurrence of sensitization, wheeze, and asthma underline that sensitization and childhood asthma are two different entities, even if there is a substantial overlap. As a consequence, risk (or protective) factors for sensitization are not necessarily the same as for asthma development.

Similar findings indicating a discrepancy between sensitization and asthma have been observed in other parts of the world. In the Far East, a 3-fold gradient in childhood asthma occurs despite a similar prevalence in sensitization of $\approx 50\%$ (6). In Australia, 10-year-old Aboriginal children are sensitized at almost the

same level as children in Göteborg, but they seldom have asthma (8). In Ethiopia, sensitization was a risk factor for asthma in the urban population, but not the rural. Remarkably, of those in the rural population who were sensitized no one had asthma, not even those sensitized to mites (7).

In conclusion, we found that wheeze and respiratory symptoms were common in 12 and 13-year olds and that the prevalence of asthma increased markedly with age in all school children studied. Similar prevalences of asthma were seen in two widely separate regions of Sweden, despite large differences in sensitization.

Acknowledgments

The authors would like to express their gratitude to the nurses at the Paediatric Clinic, Kiruna Hospital. Grants from the Vardal Foundation and the Swedish Association against Asthma and Allergy supported this study.

References

1. ABERG N, HESSELMAR B, ABERG B, ERIKSSON B. Increase of asthma, allergic rhinitis and eczema in Swedish schoolchildren between 1979 and 1991. *Clin Exp Allergy* 1995; 25: 815–9.
2. NINAN TK, RUSSELL G. Respiratory symptoms and atopy in Aberdeen schoolchildren: evidence from two surveys 25 years apart *BMJ* 1992; 304: 873–5. [Published erratum appears in *BMJ* 1992; 304: 1157.]
3. SIGURS N, HATTEVIG G, KJELLMAN B, KJELLMAN NI, NILSSON L, BJORKSTEN B. Appearance of atopic disease in relation to serum IgE antibodies in children followed up from birth for 4–15 years. *J Allergy Clin Immunol* 1994; 94: 757–63.
4. HATTEVIG G, KJELLMAN B, BJORKSTEN B, JOHANSSON SG. The prevalence of allergy and IgE antibodies to inhalant allergens in Swedish school children. *Acta Paediatr Scand* 1987; 76: 349–55.
5. SHAW R, WOODMAN K, CRANE J, MOYES C, KENNEDY J, PEARCE N. Risk factors for asthma symptoms in Kawerau children. *N Z Med J* 1994; 107: 387–91.
6. LEUNG R, HO P. Asthma, allergy, and atopy in three south-east Asian populations. *Thorax* 1994; 49: 1205–10.
7. YEMANEBERHAN H, BEKELE Z, VENN A, LEWIS S, PARRY E, BRITTON J. Prevalence of wheeze and asthma and relation to atopy in urban and rural Ethiopia. *Lancet* 1997; 350: 85–90.
8. VEALE AJ, PEAT JK, TOVEY ER, SALOME CM, THOMPSON JE, WOOLCOCK AJ. Asthma and atopy in four rural Australian aboriginal communities *Med J Aust* 1996; 165: 192–6. [Published erratum appears in *Med J Aust* 1996; 165: 308.]
9. HESSELMAR B, ABERG N, ABERG B, ERIKSSON B, BJORKSTEN B. Does early exposure to cat or dog protect against later allergy development? *Clin Exp Allergy* 1999; 29: 611–7.
10. ABERG N, ENGSTROM I, LINDBERG U. Allergic diseases in Swedish school children. *Acta Paediatr Scand* 1989; 78: 246–52.

11. NORRMAN E, NYSTROM L, JONSSON E, STJERNBERG N. Prevalence and incidence of asthma and rhinoconjunctivitis in Swedish teenagers. *Allergy* 1998; 53: 28–35.
12. BJORKSTEN B, DUMITRASCU D, FOUCARD T, et al. Prevalence of childhood asthma, rhinitis and eczema in Scandinavia and Eastern Europe. *Eur Respir J* 1998; 12: 432–7.
13. HOLMGREN D, ABERG N, LINDBERG U, ENGSTROM I. Childhood asthma in a rural county. *Allergy* 1989; 44: 256–9.
14. WARNER A, BJÖRKSTÉN B, MUNIR A, MÖLLER C, SCHOU C, KJELLMAN N. Childhood asthma and exposure to indoor allergens: low mite levels are associated with sensitivity. *Pediatr Allergy Immunol* 1996; 7: 61–7.