Eur Respir J 1998; 12: 432–437
Printed in UK - all rights reserved

European Respiratory Journal
ISSN 0903 - 1936

Prevalence of childhood asthma, rhinitis and eczema in Scandinavia and Eastern Europe

B. Björkstén*, D. Dumitrascu+, T. Foucard‡, N. Khetsuriani#, R. Khaitov§, M. Leja§, G. Lis†, J. Pekkanen**, A. Priftanji++, M.A. Riikjärv‡‡

Prevalence of childhood asthma, rhinitis and eczema in Scandinavia and Eastern Europe. B. Björkstén, D. Dumitrascu, T. Foucard, N. Khetsuriani, R. Khaitov, M. Leja, G. Lis, J. Pekkanen, A. Priftanji, M.A. Riikjärv. ©ERS Journals Ltd 1998.

ABSTRACT: There is evidence that the prevalence of allergies and asthma differs between populations in western and eastern Europe. This study investigated the prevalence of wheezing, rhinitis and eczema among schoolchildren in urban and rural areas of Scandinavia and the formerly socialist countries of Eastern Europe.

A total of 79,000 children from two age groups (13–14 yrs and 6–7 yrs) in 18 study centres responded to a questionnaire within the International Study of Asthma and Allergy in Children (ISAAC). The 12 month period prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema was calculated.

The prevalence of wheezing among the 13–14 yr old children was 11.2–19.7% in Finland and Sweden, 7.6–8.5% in Estonia, Latvia and Poland and 2.6–5.9% in Albania, Romania, Russia, Georgia and Uzbekistan (except Samarkand). The prevalence of itching eyes and flexural dermatitis varied in a similar manner between the three regions. The regional differences were less pronounced among the 6–7 yr old children in the seven participating centres.

The highest prevalence of rhinitis was recorded in April–July in Scandinavia and during the winter months in the other countries.

The prevalence of atopy-related disorders was higher in Scandinavia than in Estonia, Latvia and Poland, which in turn had a higher prevalence than five other countries of eastern Europe with a culture less similar to western Europe. This supports the hypothesis that "Western life style" is associated with a high prevalence of childhood allergy.

Eur Respir J 1998; 12: 432–437.

*Dept of Health and Environment, Division of Paediatrics, Linköping University, Sweden. +3rd Medical Clinic, Cluj, Rumania. ‡Dept of Paediatrics, Uppsala University, Sweden. #Dept of Epidemiology and Immunogenetics, Tbilisi, Georgia. §Institute of Immunology, Ministry of Public Health, Moscow, Russia. §Human Ecology Institute, Riga, Latvia. †Polish-American Children's Hospital, Collegium Medicum UJ, Krakow, Poland. **Unit of Environment-al Epidemiology, National Public Health Institute, Kuopio, Finland. ++Allergology Clinic, University Hospital, Tiranë, Albania. ‡‡Children's Hospital, Tallinn, Estonia.

Correspondence: B. Björkstén, Dept of Paediatrics, University Hospital, Floor 14, S 581 85 Linköping, Sweden. Fax: 46 13148265

Keywords: Asthma, children, eczema, hypersensitivity, prevalence, rhinitis

Received: July 24 1997
Accepted after revision April 21 1998

Supported by grants from GlaxoWelcome, the Swedish Institute and Environmental Protection Agency and the Medical Faculty, Linköping University.

There is considerable evidence that the prevalence of asthma and allergies is increasing in industrialized countries with a market economy, particularly in children and young adults [1]. Similar increases appear to be occurring among affluent people in developing countries [2]. In contrast, recent studies in the formerly socialist countries of central and eastern Europe have revealed a low prevalence of these disorders. Thus, the prevalence of atopy among schoolchildren is much lower in Poland and Estonia than in Northern Sweden, despite higher levels of air pollution in the former countries [3, 4]. Similarly, several studies have revealed a lower prevalence of allergies in the former East Germany than in West Germany [5].

It has been suggested that the increasing prevalence of allergy could be due to a cohort effect, *i.e.* the causative environmental factors would be operating mainly in early childhood. This notion would be supported by the observation that the differences in allergy prevalence between Eastern and Western Europe seem to be limited to populations born after the late 1950s, *i.e.* at a time when the lifestyle between the two parts of the continent began to drift apart [6]. Furthermore, a recent analysis of allergy among Swedish 18 yr old conscripts indicates that there has been a three-fold increase in the prevalence of asthma, allergic rhinitis and flexural dermatitis, but not contact dermatitis, in the cohorts born after 1960 [7].

The studies in the formerly socialist countries of Europe have largely been confined to regions that are culturally and geographically most closely similar to Western Europe, *i.e.* Estonia [3, 4], East Germany [5] and Poland [3], while less is known regarding the situation in Eastern Europe in general. Lack of a standardized protocol allowing international comparisons have, until recently, prevented comparisons between countries with large differences in lifestyle. The International Study of Asthma and Allergy in Childhood (ISAAC) was developed to provide standardized tools for studies of the worldwide prevalence of wheezing, rhinitis and eczema in schoolchildren, employing a similar study design in all participating centres [8]. In the worldwide study, 137 centres in 52 countries, divided into eight regions, participated [9]. This study reports the findings in detail from an area that included studies in urban and rural regions in countries with a market economy and high standard of living, as well as industrialized and less industrialized formerly socialist countries with a lifestyle which, in many respects, is similar to that prevailing in Western Europe after World War II until the 1950s.

Subjects and methods

The study adhered to the ISAAC protocol as described in the manual and the paper concerning rationale and methods [8, 10]. The core study protocol included children aged 13–14 yrs. In addition, groups of children aged 6 and 7 yrs were included in several centres, strictly adhering to the ISAAC protocol for this age group (table 1). The study populations comprised at least 3,000 pupils in each age group and were identified by randomly selecting schools within a specified geographic area or alternatively, all of the schools. The teachers in the selected schools were informed in writing and verbally about the study and written information was then distributed to the pupils and their parents. The written questionnaires were translated into the different languages and then back-translated into English by an independent person. In several languages there is no exact equivalent for the word "wheezing". In these cases the appropriate terms were identified in a pilot study comprising children and their parents with recurrent wheezing, as suggested in the ISAAC core protocol. At least half of the study population was investigated before the major pollen season of the study area, except in Helsinki.

In addition, the 13–14 yr old children in 13 of the centres participated in a survey employing a video questionnaire (European version, except in Finland where the International version was used), which was developed by ISAAC. It comprised five scenes with wheezing children. In two scenes, attacks of asthma were demonstrated, one scene showed a teenager with exercise-induced wheeze and in two scenes night wheeze and night cough were demonstrated. During the surveys at the schools, the written questionnaires were completed before the video questionnaires to avoid potential bias.

Data management and analysis

The data were entered exactly as recorded on the questionnaire at the study centres and checked for coding errors, omissions and inconsistencies at the ISAAC Data Centre in Auckland, New Zealand (T. Clayton). Data were transferred using the protocol described in the ISAAC Coding and Data Transfer Manual to the ISAAC International Data Centre. Data from the 6–7 and 13–14 yr old age groups were analysed separately. A written report was sent back to the collaborator, who responded to the issues and made corrections as needed. A final document on all aspects of the methodology actually used was completed for each centre and checked by the ISAAC International Data Centre and the regional coordinator. This document included information about the sampling frame, the sampling method, the participation rate of schools and of children within schools, the data entry method and the details of translation.

For each of the core symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema, 12-month period prevalences were calculated by dividing the number of positive responses to each question by the number of completed questionnaires. The variation in prevalence rates was determined by calculating the magnitude of the difference between the 10th and 90th percentiles. The association between the prevalence of the different atopic disorders was determined by calculating the Spearman correlation coefficient. The prevalence data for the written and video asthma questionnaires were compared by cross-tabulation of the findings in quartiles.

Results

The number of 13/14 yr old children participating in the survey varied from 2,771–3,631 in the different centres and the response rates to the questionnaires varied from 85%–99% (table 1).

There was a large variation in the prevalence of wheezing, rhinitis and eczema among the 16 study centres (table 2). Thus, the 12-month prevalence of wheezing among the 13–14 yr old children varied from 11.2–19.8% in Finland and Sweden, from 7.6–8.4% in Estonia, Latvia and Poland

Table 1. – Response rates in the participating centres

Country	Centre	13–14 yrs old			6–7 yrs old		
		Invited	Responding		Invited	Responding	
		n	n	%	n	n	%
Sweden	Linköping	3727	3537	94.9	ND		
	Stockholm/ Uppsala	3372	3109	92.2	3317	3029	91.3
Finland	Kuopio	2982	2821	96.5	ND		
	Lapland	3161	3032	97.4	ND		
	Helsinki	3017	2771	94.6	ND		
	Turku/Pori	3185	2983	96.9	ND		
Estonia	Tallinn	3490	3102	88.8	3078	2766	89.8
Latvia	Riga	3152	3004	95.3	3221	3003	93.2
	Rural	3424	3145	91.9	ND		
Poland	Krakow	3013	2793	92.6	2417	2302	95.2
	Poznan	4069	3631	89.2	3163	2710	85.6
Albania	Tirané	3054	2957	96.8	3294	2992	90.8
Rumania	Cluj	3432	3396	99.0	ND		
Russia	Moscow	4013	3411	85.3	ND		
Georgia	Kutaisi	3663	3297	90.0	3570	3356	94.0
	Tbilisi	4001	3449	86.2	3802	3414	89.8
Uzbekistan	Samarkand	1998	1758	88.0	ND		
	Tashkent	3000	2904	96.8	ND		

ND: not done.

Table 2. – Prevalence (%) of wheezing, skin symptoms and rhinitis among 13–14 yr old children participating in the International Study of Asthma and Allergy in Children (ISAAC)

	Study centre																	
	Link.	Stoc.	Kuo.	Lapl.	Hels.	Turku/ Pori	Talli.	Riga	R. Lat.	Krak.	Pozn.	Tira.	Cluj	Mos.	Kuta.	Tbil.	Sama.	Tash.
Wheeze																		
Wheezing ever	18.6	25.2	27.2	29.7	32.7	28.0	16.9	20.9	18.9	15.0	17.2	6.2	5.9	8.2	15.4	12.2	28.9	20.4
Wheezing 12 months	11.2	14.6	13.1	16.1	19.7	15.0	7.6	8.3	8.5	7.5	8.0	2.6	3.1	4.4	3.6	3.7	14.4	5.9
Attacks 12 months	10.9	13.6	10.4	12.6	15.9	11.6	6.8	7.2	6.3	9.0	7.3	1.9	3.0	4.4	3.4	3.0	13.9	4.3
Severe wheeze	1.7	2.3	2.0	2.7	5.1	2.7	1.2	1.4	1.3	1.9	1.3	0.8	0.7	0.8	0.7	0.6	3.8	1.1
Exercise wheeze	17.4	21.4	17.6	20.6	25.1	19.2	8.2	8.6	12.9	10.0	8.3	4.5	6.9	6.6	8.2	4.3	15.1	8.7
Night waking	3.3	3.6	2.4	3.0	3.7	2.9	2.9	2.2	2.8	3.2	2.6	0.9	1.1	1.3	1.3	1.1	3.5	0.8
Night cough	10.2	14.0	14.5	15.6	19.5	16.3	13.0	12.3	17.3	16.3	12.6	5.7	4.4	5.6	9.0	6.0	15.8	6.1
Asthma ever	10.0	10.8	4.6	6.6	7.4	7.8	2.9	3.9	4.6	2.5	2.0	1.6	3.7	2.4	3.8	2.2	2.3	1.4
Video:																		
Wheezing ever	10.4	11.5	8.7	12.0	11.8	11.8	3.9	3.2	2.1		6.8	1.9		2.5				2.5
Wheezing 12 months	5.0	5.2	3.8	5.4	5.8	5.2	1.8	1.2	1.2		3.3	1.0		1.3				1.0
Exercise wheeze	17.8	21.7	13.2	15.4	16.6	18.1	7.4	5.8	4.8		11.8	3.3		3.0				3.0
Exercise 12 months	10.3	13.6	7.5	7.6	9.3	9.9	4.7	3.1	1.8		7.5	1.3		1.9				0.9
Night wheeze	4.5	5.5	2.5	2.9	3.4	3.3	2.3	1.7	3.3		3.2	1.1		1.3				1.9
Night wheeze 12 months	1.0	2.3	0.9	1.2	1.5	1.2	1.0	0.6	1.4		1.3	0.4		0.8				0.6
Night cough	16.3	18.6	18.0	20.6	23.6	20.2	9.9	7.9	2.8		13.4	4.1		1.8				2.9
Night cough 12 months	7.2	9.0	11.1	11.6	14.7	12.5	5.3	3.1	0.9		7.6	1.6		1.1				0.8
Severe wheeze	5.9	6.8	4.9	6.3	5.6	5.2	2.0	1.4	0.2		4.4	1.7		0.5				1.3
Severe wheeze 12 months	2.5	3.3	2.6	3.3	2.6	2.6	0.8	0.6	1.4		2.1	0.6		0.3				0.6
Rhinitis																		
Nose symptoms ever	25.4	34.7	46.6	43.9	55.1	43.6	29.9	28.9	32.9	27.0	19.1	18.7	15.0	12.6	18.9	16.8	24.1	14.8
Nose symptoms 12 months	19.2	26.4	36.2	33.3	45.5	33.3	20.6	21.3	22.4	21.0	13.5	12.8	11.4	9.8	12.3	12.1	17.3	8.8
Eyes affected	12.0	12.4	16.1	15.8	23.6	14.7	4.7	6.0	4.8	16.7	6.4	5.1	5.2	6.4	4.6	4.1	11.5	4.0
Eczema																		
Rash ever	26.7	23.8	23.8	28.5	27.1	25.4	13.6	16.4	18.6	12.4	11.7	2.8	12.5	6.0	9.2	6.8	11.2	5.7
Rash 12 months	19.9	17.2	17.3	21.2	21.8	18.6	9.3	10.0	9.4	9.3	7.4	1.8	8.3	3.9	4.6	3.3	6.7	3.2
Flexural areas ever	17.8	14.8	14.5	18.6	18.6	15.9	6.8	5.9	4.4	7.6	5.1	1.0	6.3	4.2	2.8	2.2	5.2	2.3
Rash cleared	16.6	15.3	15.6	18.9	18.7	15.9	8.4	10.0	7.6	1.9	5.8	1.0	7.4	4.0	3.1	2.3	5.7	2.6
Eczema ever	46.9	48.8	22.8	24.1	25.9	23.6	13.4	5.4	6.5	15.5	13.2	1.3	3.7	4.7	1.8	3.7	4.4	3.0

The figures show the 12 month prevalence unless otherwise stated. Link.: Linköping; Stoc.: Stockholm/Uppsala; Kuo.: Kuopio; Lapl.: Lapland; Hels.: Helsinki; Talli.: Tallinn; R. Lat.: Rural Latvia; Krak.: Krakow; Pozn.: Poznan; Tira.: Tiranë; Mos.: Moscow; Kuta.: Kutaisi; Tbil.: Tbilisi; Sama.: Samarkand; Tash.: Tashkent.

and from 2.6–5.9% in Albania, Romania, Russia, Georgia and Uzbekistan (the only exception was Samarkand with a 14.4% prevalence). The 12-month prevalence of itching eyes and flexural dermatitis varied in a similar manner among the three regions (table 2).

The agreement between the prevalence of wheezing according to the written and video questionnaires varied in Scandinavia from 83.2% in Helsinki to 90.5% in Linköping, in the Baltics and Poland from 91% in Riga to 91.7% in Tallinn and in Eastern Europe from 85.6% in Samarkand to 96.8% in Tiranë.

The highest prevalence of rhinitis was recorded in April–July in Sweden and Finland, except for Lapland, where the highest figures were reported for the winter months. In contrast, with the exception of Krakow, the peak incidence of nasal symptoms in the other countries was recorded during the winter months. In order to compare further the seasonal variations in the 18 centres, the 3 months with the highest incidence of rhinitis were recorded for each centre. In the six Scandinavian centres, 10 of the 18 months with the highest incidence were recorded between April and July, while in eastern Europe this was the case only for seven of the 36 peak months in the centres ($p<0.01$, fig. 1).

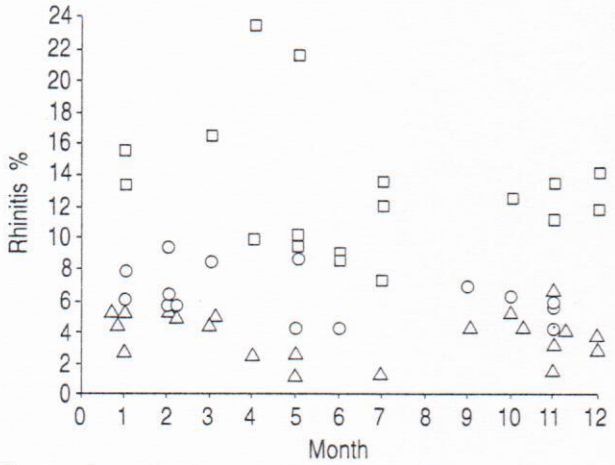

Fig. 1. – Seasonal variations in the prevalence of rhinitis among 13–14 yr old children in the 18 study centres, *i.e.* Scandinavia (□), the Baltics and Poland (○) and Eastern Europe (△). For each centre the 3 months with the highest incidence are shown.

The regional differences between Scandinavia and the other countries were less pronounced among the 6/7 yr old children in the seven participating centres than in the 13–14 yr old group (table 3). Only ever having had asthma, flexural dermatitis and other skin symptoms were more common in Sweden than in the six centres in eastern Europe. Flexural dermatitis was reported in 20.4% in the Swedish centre, 6.5–12.7% in Estonia, Latvia and Poland and 3.2–4.0% in Albania and Georgia. The prevalence of wheezing, rhinitis and itching eyes showed a similar trend, although less pronounced and with the notable exception of Krakow, Poland, where a high prevalence of most symptoms was reported.

Discussion

The prevalence of symptoms that are commonly associated with allergy and atopy among 13–14 yr old schoolchildren was much lower in Eastern Europe than in Scandinavia. In the latter countries the prevalence of asthma, wheezing and rhinitis was similar to that in other countries in Western Europe [9]. The 18 study centres could be divided into three groups based on the 12 month prevalence of wheezing, conjunctivitis and flexural dermatitis, as recorded by the written questionnaire. The highest prevalence was recorded in the six Scandinavian centres, followed by the five centres in Estonia, Latvia and Poland, which are all countries with a culture similar to Western Europe. The lowest prevalence was recorded in the seven centres in Albania, Georgia, Romania, Russia and Uzbekistan.

Table 3. – Prevalence (%) of wheezing, skin symptoms and rhinitis among 6–7 yr old children participating in the International Study of Asthma and Allergy in Children (ISAAC)

	Study centre							
	Stockholm Uppsala	Tallinn	Riga	Krakow	Poznan	Kutaisi	Tbilisi	Tiranë
Wheezing								
Wheezing ever	24.2	17.2	17.6	26.6	17.5	21.0	17.9	13.5
Wheezing 12 months	10.4	8.4	7.2	14.7	8.1	9.3	5.4	7.6
Attacks 12 months	10.4	6.3	4.2	13.5	7.4	8.1	5.0	5.9
Severe wheeze 12 months	1.5	0.7	0.9	2.4	1.7	1.5	1.0	2.4
Exercise wheeze 12 months	6.2	1.5	2.2	5.3	2.9	4.5	1.9	4.8
Night waking 12 months	5.2	4.2	7.4	7.9	4.9	3.9	2.3	3.5
Night cough 12 months	14.6	10.6	7.8	26.7	12.9	9.7	5.0	9.3
Asthma ever	8.0	1.3	1.6	4.3	1.3	4.5	1.6	3.0
Rhinitis								
Nose symptoms ever	17.1	13.6	16.8	30.2	13.2	10.8	8.4	16.4
Nose symptoms 12 months	14.1	10.6	13.3	25.7	11.0	8.0	6.1	13.0
Eyes affected 12 months	6.0	3.5	3.0	11.2	4.7	3.9	2.3	5.1
Activity limited 12 months	8.5	7.3	5.2	22.3	9.7	5.9	4.0	10.5
Hayfever ever	7.5	2.4	0.9	16.4	4.9	5.7	4.0	2.9
Eczema								
Rash ever	28.1	15.3	18.1	16.0	9.3	10.1	7.0	4.9
Rash 12 months	21.9	11.5	12.7	11.9	6.5	6.1	5.0	4.1
Flexural areas ever	20.4	10.9	7.9	8.6	5.2	5.2	4.0	3.2
Rash cleared 12 months	19.3	10.6	10.6	9.0	5.0	4.0	4.0	4.8
Night waking 12 months	4.5	2.8	11.9	4.6	2.4	2.1	2.0	1.7
Eczema ever	35.7	11.2	5.5	20.8	19.4	4.7	10.7	1.5

The findings were similar when the prevalence of wheezing was defined as positive responses to the video questionnaire. Global comparison of the written and video questionnaires employed in the ISAAC has shown a generally good agreement between the two methods [9]. The smaller differences in wheezing prevalence between the Scandinavian and Eastern European centres is probably due to the fact that in the video rather severe cases of asthma were shown. Severe attacks of asthma are uncommon in schoolchildren in Scandinavia as most of them are on continuous medication and thus express milder symptoms.

The regional differences in symptoms were not as obvious among the 6–7 yr olds as among the 13–14 yr old children. Thus, only a diagnosis of asthma and the prevalence of skin symptoms were clearly higher in the Scandinavian centre than in eastern Europe. Furthermore, there were no clear differences between Estonia, Latvia and Poland on one hand and the Albanian and Georgian centres on the other hand. It is possible that the questions were less related to allergy and more associated with infections in the younger children, as allergic asthma and rhinoconjunctivitis is less common and respiratory infections are more common among preschool children and school children than among teenagers.

Rhinitis is a symptom which, in addition to allergy, often has other causes, *e.g.* infections. It may be difficult to differentiate between allergic and infective rhinitis using a questionnaire. In regions with a cold climate and large seasonal variations, however, allergic rhinitis in children mostly appears during the pollen season, while infections are most common during the winter months. In light of this it is interesting that the highest prevalence of rhinitis was recorded in the spring and summer in all of the Scandinavian centres except for Lapland in northern Finland, while in Eastern Europe rhinitis appeared to be most common during the winter months. These differences suggest that in Scandinavia, pollen allergy was a common cause of rhinitis among the 13–14 yr old children, while in eastern Europe it was mostly caused by infection.

In the worldwide ISAAC there were large variations in the prevalence of skin symptoms, with particularly high figures recorded in northern, as compared to central and southern Europe [11]. This could possibly be explained by climatic conditions, *e.g.* cold winters with a low relative humidity indoors. The high prevalence of skin symptoms among the 6–7 yr old children in Sweden compared with Eastern Europe may, therefore, be partly due to a north-south rather than an east-west difference. The climate during the winter is, however, similar in Stockholm, Tallinn and Riga. All of these centres reported more skin symptoms than did Tbilisi in Georgia and Tiranë in Albania.

A lower prevalence of respiratory allergic disorders in Central and Eastern than in Western Europe has been reported in several epidemiological studies comparing Estonia and Poland with Sweden [3, 4] and East with West Germany [5, 6]. The present study supports and extends these findings to several other countries, indicating that among the formerly socialist countries the prevalence is higher in countries with a culture and lifestyle more similar to Western Europe. The findings raise important questions regarding the reasons for the high prevalence of allergic diseases in industrialized countries with a market economy.

It is worth noting that the Scandinavian centres included areas with little air pollution, *e.g.* Lapland in northern Finland, as well as two capital cities. Although none of the cities is heavily polluted in comparison with some cities in continental Europe, the findings indicate that air pollution can explain the observed regional differences only to a small extent. This conclusion is furthermore supported by the similar prevalence of symptoms in urban and rural areas in Scandinavia.

The regional variations are not easily explained by any environmental factors that have been suggested to influence the incidence of allergic diseases. Thus, exposure to tobacco smoke and poor breastfeeding cannot explain the differences, as air pollution and tobacco smoking are generally common, at least in some countries of Eastern Europe [3], while Finland and Sweden have among the highest incidence of breastfeeding in the industrialized world and the rate of tobacco smoking at home has decreased over the past 30 yrs.

The prevalence of allergic diseases seems to have increased particularly over the past 35–40 yrs. It has been suggested that the increasing prevalence of allergic diseases in Western Europe and the differences between Eastern and Western Europe could be due to less microbial pressure in early childhood as a consequence of improved hygienic conditions. This hypothesis has experimental [12] and some epidemiological [13] support. An inverse relationship between the presence of allergic disease and tuberculin reactivity has also been reported [14]. These observations may be spurious, however, since it has been known for a long time that atopic individuals manifest reduced delayed-type hypersensitivity reactions compared with nonatopic individuals [15]. Occasional respiratory tract infections, even if appearing relatively often, would not be expected to exert such continuous pressure on the immune system as to induce an immune deviation similar to that shown in animal experiments. For these reasons, changes in the composition of the intestinal microbial flora in infancy and early childhood have been suggested as a possible explanation, although evidence for this possibility is only circumstantial [16].

In conclusion, the prevalence of atopy-related disorders was much higher among schoolchildren in Scandinavia than in the formerly socialist countries of Central and Eastern Europe. The prevalence was, in turn, higher in Estonia, Latvia and Poland, which have a culture more similar to Western Europe, than in Albania, Romania, Russia, Georgia and Uzbekistan. It is likely that, for unknown reasons, changes in lifestyle in Western Europe, particularly over the past 40 yrs, are responsible for the high prevalence in Scandinavia compared with that in Eastern Europe.

Acknowledgements: In several centres local collaborators helped the co-ordinators to organize and conduct the study, *e.g.* in Finland M. Kajosaari, A. Kovikko and L. Soininen; in Poland, J.J. Pietrzyk, A. Breborowicz and A. Swiatly; and in Sweden, N-I.M. Kjellman and L. Nordvall. The excellent continuous support by T. Clayton at the ISAAC centre in Auckland is gratefully acknowledged.

References

1. Burr M, Butland B, King S, Vaughan-Williams E. Changes in asthma prevalence: two surveys fifteen years apart. *Arch Dis Child* 1989; 64: 1452–1456.

2. Burney P. Epidemiology of asthma. *Allergy* 1993; 48: 17–21.
3. Bråbäck L, Breborowicz A, Julge K, *et al*. Risk factors for respiratory symptoms and astopic sensitization in the Baltic area. *Arch Dis Child* 1995; 72: 487–493.
4. Riikjärv M, Julge K, Vasar M, Bråbäck L, Knutsson A, Björkstén B. The prevalence of atopic sensitisation and respiratory symptoms among Estonian school children. *Clin Exp Allergy* 1995; 25: 1198–1204.
5. von Mutius E, Martinez FD, Fritzsch C, Nicolai T, Roell G, Thiemann HH. Prevalence of asthma and atopy in two areas of West and East Germany. *Am J Respir Crit Care Med* 1994; 149: 358–364.
6. Wichmann H. Environment, life-style and allergy: the German answer. *Allergy J* 1995; 4: 315–316.
7. Björkstén B. The environment and sensitisation to allergens in early childhood. *Pediatr Allergy Immunol* 1997; 8: Suppl., 32–39.
8. Pearce N, Weiland S, Keil U, *et al*. Self-reported prevalence of asthma symptoms in children in Australia, England, Germany and New Zealand: an international comparison using the ISAAC protocol. *Eur Respir J* 1993; 6: 1455–1461.
9. Beasley R, Keil U, von Mutius E, *et al*. Worldwide variation in the prevalence of asthma, allergic rhinoconjunctivitis and atopic eczema: the international study of asthma and allergies in children (ISAAC). *Lancet* 1998; 351: 1225–1232.
10. Asher M, Keil U, Anderson H, *et al*. International study of asthma and allergies in childhood (ISAAC): rationale and methods. *Eur Respir J* 1995; 8: 483–491.
11. Williams H, Robertson C, Stewart A, *et al*. Worldwide variations in the prevalence of atopic eczema in children from the International Study of Asthma and Allergies in Childhood (ISAAC). *J Allergy Clin Immunol* 1998; in press.
12. Holt P. Environmental factors and primary T-cell sensitisation to inhalant allergens in infancy: reappraisal of the role of infections and air pollution. *Pediatr Allergy Immunol* 1995; 6: 1–10.
13. Strachan D. Is allergic disease programmed in early life? (Editorial). *Clin Exp Allergy* 1994; 24: 603–605.
14. Shirakawa T, Enomoto T, Shimazu S, Hopkin J. The inverse association between tuberculin responses and atopic disorders. *Science* 1997; 275: 77–79.
15. Strannegård O, Strannegård I-L. *In vitro* differences between lymphocytes of normal subjects and atopics. *Clin Allergy* 1979; 9: 637–643.
16. Sepp E, Julge K, Vasar M, Naaber P, Björkstén B, Mikelsaar M. Intestinal microflora of Estonian and Swedish infants. *Acta Paediatr* 1997; 86: 956–961.