

The prevalence of atopic sensitization and respiratory symptoms among Estonian schoolchildren

M. A. RIIKJÄRV, K. JULGE*, M. VASAR*, L. BRABÄCK†, A. KNUTSSON‡ and B. BJÖRKSTÉN*

*Tallinn Children's Hospital, Tallinn, Estonia, *Department of Paediatrics, University Hospital, Tartu, Estonia, †Department of Paediatrics and ‡Department of Occupational Health, Sundsvall, Sweden and §Department of Paediatrics, Linköping University, Linköping, Sweden*

Summary

Objectives To assess the prevalence of atopic sensitization, asthma and other respiratory disorders among Estonian schoolchildren in a coastal industrial city and an inland university town, i.e. Tallinn and Tartu.

Design Prevalence surveys by self-completion of questionnaires by the children's parents and skin-prick tests (SPT) with eight common allergens.

Subjects A total of 1519 schoolchildren aged 10–12 years.

Results The prevalence of positive SPT was 11.4%, with significant differences between Tallinn (14.3%) and Tartu (8.1%). RR 1.89, 95% CI 1.13–2.73, $P < 0.001$.

Dermatophagoides pteronyssinus, cat (6.1%) and timothy (4.8%) were the most prevalent sensitizing allergens in Tallinn. The prevalence of asthma diagnosed by a doctor was 2.9%, of wheezing 7.0% and of rhinoconjunctivitis 7.4%, as assessed by questionnaire.

Conclusions The prevalence of atopy as defined by a positive SPT, asthma and corresponding respiratory symptoms is low in Estonia similar to other post-socialist countries of Europe. The lower prevalence rates of allergic disorders are possibly explained with differences in lifestyle and living conditions. The relative significance of air pollution was apparently similar in Estonia and western Europe, however, as indicated by the higher prevalence of sensitization in the more polluted city, Tallinn than in Tartu.

Keywords: atopic sensitization, respiratory symptoms

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Introduction

Increasing trends in the prevalence of atopic sensitization and atopy related diseases in children have been reported from western industrialized countries. Recent estimates of the prevalence of allergic diseases and allergic respiratory symptoms among children range between 6 and 30% [1–4], and for diagnosed asthma between 4 and 10% [5–7]. Several authors have suggested that there has been a true increase in the prevalence of asthma and

allergic diseases in children over the past decades [8–10]. A review of 17 population-based studies in Australia between 1969 and 1989 indicates an increase in diagnosed asthma and reported wheeze by almost 1% per year [8]. A similar trend towards an increasing prevalence has not been established for BHR, as verified by objective measurements [8]. Reasons for this increase are poorly understood. It may, however, be difficult to exclude changed medical practice and diagnostic criteria, as well as an increased awareness of asthma symptoms [8]. An effect of air pollution on the prevalence of asthma and respiratory symptoms has been suggested but the data are conflicting [3,7,11–15]. Thus, recent studies

Correspondence: B. Björkstén, Department of Paediatrics, University Hospital, S-581 85 Linköping, Sweden.

from previously socialist countries in Eastern Europe have reported a high prevalence of respiratory symptoms but not allergic disorders and a low rate of atopic sensitization in a highly polluted environment, suggesting that changes in lifestyle could be responsible for the increase in allergy prevalence in the industrialized world [6,7,13].

In this study, the prevalence of atopic sensitization and various respiratory symptoms in schoolchildren in two towns from a previous socialist republic of the former Soviet Union are described. The study was carried out as a part of an epidemiological study in north-east Europe (Sweden, Poland, Estonia) and included a comparison between children living in a polluted and a less polluted region.

Materials and methods

Study areas and populations

Estonia is a country with northern European culture traditions on the shores of the Baltic Sea, 80 km south of Finland, with an overall population in 1992 of about 1.5 millions. Tallinn, the capital on the northern coast of the Baltic Sea, has a population of about 490 000. The climate is maritime, with mean temperatures in January -0.7°C and in July $+15.9^{\circ}\text{C}$ (1992–1993). In 1992 the main sources of pollution were district heating power plants and moderate traffic, using low quality oil. A heavily polluting paper mill on the south-eastern border of the town was closed in 1991. The official daily mean value in 1992 for SO_2 emission was $4\text{ }\mu\text{g}/\text{m}^3$, for NO_2 $10\text{ }\mu\text{g}/\text{m}^3$ and for dust $100\text{ }\mu\text{g}/\text{m}^3$ (with single peaks for SO_2 $930\text{ }\mu\text{g}/\text{m}^3$, for NO_2 $170\text{ }\mu\text{g}/\text{m}^3$ and for dust $700\text{ }\mu\text{g}/\text{m}^3$). Tartu is an inland university town with a population in 1992 of about 113 000. It has a continental climate with mean temperatures in January -1.5°C and in July $+16.0^{\circ}\text{C}$ (1992–1993). There are only some light industries. The traffic is light, and low quality oil was used. There is no permanent air pollution monitoring in Tartu. In both towns, there are new regions with block houses of industrial building style, detached houses and old wooden dwellings.

Schoolchildren ($n = 1580$) attending the fifth and sixth grade in 11 of 40 Estonian-language schools in Tallinn ($n = 806$) and five of 11 schools in Tartu ($n = 774$) were asked to participate in study. In Tallinn, schools comprising 16% of all the children in the age group were selected from three main districts of the town. In one district, five of seven Estonian language schools were chosen, in the second district two of five schools and in the third district all the four Estonian-language schools were chosen. In Tartu, one or two

Estonian-language schools were chosen from each part of the town, i.e. the central part, an inner suburb with detached houses and a new area with apartment houses. The study population comprised 35% of the children in the age group. The prevalence study was carried out between October 1992 and April 1993. The children live permanently and attend the schools in the same district.

Questionnaire to parents

A version in Estonian of a self-administered questionnaire that was previously used in Sweden and Poland [7] was distributed through the schools to the parents. The questionnaire included 60 questions concerning their occupation, housing conditions, household pets (past and present), smoking habits in the families, atopic heredity and the presence of allergic disorders and respiratory symptoms in the study child. The questions included: 'Has your child experienced any of the following symptoms in the last year: 1. allergic reactions in the eye or nose, 2. wheezing in the chest, chest tightness and breathlessness during, e.g. cold, physical exertion or in contact with animals, 3. nocturnal cough for a period longer than 4 weeks without signs of whooping cough, 4. exercise induced coughing attacks' and 'Has your child ever been diagnosed as being asthmatic by a doctor'. The response rate to the questionnaire was 96% (93% in Tallinn and 99% in Tartu).

Skin-prick tests

Sensitivity to eight standardized allergen extracts (Solu-Prick SQ, ALK, Hørsholm, Denmark) was assessed by skin-prick tests (SPT), performed in duplicate on the volar aspects of the forearms, using a lancet from ALK. The potency of the allergens was 10 histamine equivalent skin-prick units (HEP) for birch, timothy, mugwort, *Dermaphagoides pteromalus*, horse, cat and dog and 1:20 w/v for *Athysaria*. Histamine dihydrochloride 10 mg/mL was used as positive control and 50% glycerol as negative control. The skin-prick tests were performed according to the instructions of the European Academy of Allergy and Clinical Immunology (EAACI) [16].

The SPT were performed from November 1992 to March 1993 by two paediatricians in Tallinn and two in Tartu. In order to allow comparison with similar studies in Sweden and Poland [7] the test procedure was compared between the four paediatricians and the Swedish nurse, who performed the tests in Sweden and also instructed the Polish co-workers. Each person performed 20 SPT with histamine on the lower arms of volunteers. The individual wheal reactions and variations between the testers were measured, and found to be

similar for all the five persons. Skin-prick tests were performed on 597 (74%) children in Tallinn and on 637 (82%) children in Tartu. Only the largest wheal from the duplicate tests were registered. The child was considered to be sensitized if a wheal reaction to an allergen was 3 mm or more.

To validate the skin-prick technique, the SPT results were compared with the levels of IgE antibodies in serum to birch and timothy grass pollen, dog and cat dander and *Dermatophagoides pteromyssinus* (Magic Lite, ALK) in 156 randomly obtained blood samples of children with ocular and/or respiratory symptoms, as identified by the questionnaire (75 from Tallinn, 87 from Tartu). The blood samples were taken in May, i.e. 3–7 months after the skin-prick tests 1993. The sera were stored at -20°C until analysed.

Statistical analysis

The chi-square test or when appropriate Fisher's exact test were used for testing differences in the prevalence of respiratory symptoms and skin prick tests (two-tailed tests).

Ethical considerations

The study was approved by the Ethics Committee of Tartu University in Estonia.

Results

Respiratory symptoms and allergic disorders

Respiratory symptoms, such as wheezing, breast tightness and breathlessness, nocturnal cough and exercise induced cough were reported in 5–7% of the Estonian children (Table 1). The prevalence of doctor's diagnosed asthma was 3.2%. The only significant difference in symptoms prevalence was that wheezing was more common in coastal Tallinn than in inland Tartu. Common colds more than six times a year was reported by 10.5% and prolonged coughing periods after respiratory infections by 16.3% of the children. The prevalence of seasonal rhinoconjunctivitis (hay fever) was 7.4% and of eczema 13.5%. The main triggers for allergic rhinoconjunctivitis were furry animals and pollens.

Atopic sensitization

At least one positive SPT to any allergen, as well as to animal dander were both significantly more common in coastal Tallinn than in Tartu ($P < 0.001$, RR 1.89, 95% CI 1.31–2.73 and $P < 0.05$, RR 1.81, 95% CI 1.09–3.02 respectively, Table 2). The prevalence of sensitization to the individual eight allergens tested was similar in the two towns, except for *Dermatophagoides pteromyssinus*, which was twice as high in Tallinn compared with Tartu ($P < 0.01$).

Table 1. Prevalence of respiratory symptoms and allergic disorders in Estonian schoolchildren. The figures are based on parents' replies to questionnaires. Absolute numbers in brackets

	Tallinn $n = 753$ %	Tartu $n = 760$ %	Total $n = 1519$ %
Wheezing	9.4* (67/711)	5.8 (41/709)	7.0 (99/1420)
Chest tightness and breathlessness	6.2 (44/709)	4.9 (35/709)	5.6 (79/1418)
Nocturnal cough longer than 4 weeks	5.1 (36/708)	4.1 (29/709)	4.6 (65/1417)
Exercise-induced coughing attacks	5.7 (40/705)	6.2 (44/707)	5.9 (84/1412)
Common cold more than 6 times a year	10.4 (77/739)	10.5 (75/712)	10.5 (152/1451)
Coughing bouts more than 2 weeks, having common cold	18.8 (139/739)	13.8 (98/712)	16.3 (237/1451)
Asthma diagnosed by doctor	3.2 (23/714)	2.5 (18/709)	2.9 (41/1423)

* $P < 0.05$ vs. Tartu.

Table 2. Prevalence (%) of positive skin-prick tests (>3 mm) to eight allergens among 11–12-year-old Estonian schoolchildren

	Tallin <i>n</i> = 589	Tartu <i>n</i> = 631
Birch	2.6	2.2
Timothy	4.8	3.5
Mugwort	2.6	2.5
Cat	6.1	3.8
Dog	2.0	1.4
Horse	1.0	0.3
<i>Dermatophagoides pteronyssinus</i>	6.1**	2.9
<i>Alternaria</i>	0.2	0.3
≥ 1 positive to pollen	7.0	5.4
≥ 1 positive to animal dander	7.0*	4.0
≥ 1 positive to any allergen	14.3**	8.1

* $P < 0.05$, ** $P < 0.01$ vs. Tartu.

As the mean histamine weal was 4.8 mm (SD 1.0 mm), i.e. smaller than in previous similar studies in Sweden [7,12], a positive SPT was also defined as an allergen weal at least half the diameter of the corresponding histamine weal. The prevalence of sensitization, as expressed in this way, was similar to that shown in Table 2 (data not shown).

Serum IgE antibodies against five allergens were determined in serum samples from 156 children and compared with the SPT results. Of the 780 comparisons of IgE antibody levels in skin and serum against individual allergens, both were negative in 702 cases (90%). Circulating IgE antibodies were detected in 71 cases. The corresponding SPT were positive in 32 (45%) of them. In the 39 cases of negative SPT, the level of circulating IgE

antibodies was low, i.e. $\leq$ class 2. The agreement between the two methods to detect IgE antibodies was higher for cat (77%) and for *Dermatophagoides pteronyssinus* (79%) than it was for birch (31%) and timothy (21%) pollen. Most of the children with circulating IgE antibodies but negative SPT to pollen lived in Tartu. Corresponding circulating IgE antibodies were not found in seven cases of positive skin-prick tests.

The prevalence of different respiratory symptoms in relation to the presence of IgE antibodies is presented in Table 3. The various respiratory symptoms, except those, associated with infections, as well as symptoms from the eye and nose were all significantly more common in the atopic children. Atopic status was a significant risk factor for development of obstructive respiratory symptoms, i.e. wheezing and cough (RR 4.51).

Social and demographic data

About 1/3 children had lived in the same residence since birth, mostly in apartments (76%). The average number of persons per room in the residence was 1.5. Past or present contact with dogs was reported in 53% of families and with cats in 45%. Horse riding was uncommon (3.6%). Atopic heredity in at least one family member was reported in 39% of the families.

Exposure to air pollutants

In half of the families in Tartu (54%) a gas stove was used, compared with 19% in Tallinn. Dampness in the house was reported more frequently in Tallinn than in Tartu (29% vs. 15%, $P < 0.05$). Exposure to tobacco smoke was common. In almost half of the families father was current smoker (49% and 44% in Tallinn and Tartu,

Table 3. Prevalence of clinical symptoms in relation to atopic sensitization (at least one positive SPT) in Estonian schoolchildren

	Negative SPT %	Positive SPT %	RR with 95% CI
Wheezing	6.2	20.3*	3.88 (2.36–6.38)
Tightness and breathlessness	4.9	13.4*	2.97 (1.86–5.32)
Nocturnal cough (>4 weeks)	3.0	11.1*	3.69 (1.83–5.84)
Exercise-induced coughing attacks	6.0	10.4	1.82 (0.97–3.41)
Wheezing and cough	2.3	9.5*	4.51 (2.20–9.27)
Common cold >6 times a year	11.2	10.6	0.95 (0.53–1.70)
Coughing periods >2 weeks after a cold	15.5	22.0	1.53 (0.98–2.38)
Rhinoconjunctivitis	13.0	40.2*	4.50 (3.04–6.66)

* $P < 0.001$ vs. negative SPT.

NS), while this was less common among the mothers (29% and 19% respectively, NS).

Discussion

The prevalence of asthma, corresponding respiratory symptoms and sensitization in this cross-sectional study among 10–12-year-old schoolchildren in a post-socialist East European country was low. The most striking result of our study was the low prevalence of atopy in the Estonian schoolchildren, as assessed by positive skin-prick tests. The prevalence of atopic sensitization in epidemiological studies in children, characterized by at least one positive SPT, is about 30–40% in western countries [6,7,12,17–20], although there are some exceptions [19]. The figures were much lower in former socialist countries like East Germany [13] and Poland [7] (Table 4). Technical factors can influence the SPT results [16]. In this study, defined standardized extracts and lancets were used, the staff was trained and the tests were performed in duplicate. Despite these precautions, the histamine weals were smaller than those obtained by us in similar studies in Sweden [7]. Smaller histamine weals have also been observed in East German, as compared with West German children (v. Mutius, personal

communication). Reasons for these differences remain unexplained.

The validation of skin-prick tests with specific serum IgE antibodies showed a good sensitivity of SPT in relation to *Dermatophagoides pteronyssinus* and cat dander (>75%), but it was lower for timothy grass and birch pollens. The poor correlation between circulating IgE antibodies to pollen and SPT results may be due to a seasonal influence [21], as the blood samples were taken in the last days of May and the skin-prick tests were performed 3–7 months earlier.

It has been suggested that the prevalence of sensitization in children is affected by an adjuvant effect of pollutants [12,22]. Our findings could to some extent support this, as the relative risk for a positive SPT in Tallinn was 1.89 as compared with Tartu. This figure is close to the RR of 1.71 observed in recent comparisons between urban and rural areas in Sweden [7,12]. Outdoor pollution could perhaps partly explain the regional differences, but certainly not the large differences between countries in Eastern and Western Europe [6,7,13].

There are no data about exposure to indoor or outdoor allergens in any of the East European countries. It is, however, not likely that there are any major differences in exposure as compared with Western Europe.

Table 4. Prevalence rates of respiratory symptoms, diagnosed asthma and atopic sensitization in studies comparing Eastern and Western Europe

Country	Estonia*		Sweden		Poland	Germany		Germany	
	Tallinn	Tartu	Sundsvall urban	rural	Konin	Leipzig	Munich	East	West
Year	1992–93		1991–92			1991–92	1989–90	1993	
Reference			7			14		19	
Diagnosed asthma	3.2	2.5	9.5	6.7	2.9	3.9	5.9	1.2	0.9
Bronchitis						30.9	15.9		
Common colds >6x	10.4	10.5	8.0	6.3					
Coughing bouts >2x	18.8	13.8	12.0	5.7					
Hay fever	7.7	7.1				2.7	8.6		
Wheeze	9.4	5.8	9.3	11.6	10.4	26.8	17.0		
Shortness of breathing	6.2	4.9	13.1	10.8	19.0	9.6	8.7		
Nocturnal cough	5.2	4.1	4.6	3.7	4.2	3.4	3.4		
Positive SPT:								RAST:	
mite	6.1	2.9	3.4	1.7	3.4	4.2	10.3	10.0	11.7
cat	6.1	3.8	21.1	12.5	2.5	2.9	7.3		
dog	2.0	1.4	14.5	11.8	2.0	2.5	2.7		
birch	2.6	2.2	12.0	10.4	2.2	3.3	12.7	3.7	7.6
grass	4.8	3.5	20.2	13.8	9.8	7.9	21.3	11.7	9.7
At least 1 pos. SPT	14.3	8.1	35.3	24.2	13.7	18.2	36.7	24.0	21.4

*Estonian, Polish and Swedish version of the same questionnaire was used and staff involved in skin-prick testing compared their technique.

Exposure to animals was as common in Estonia as it is in Sweden. Sensitization to house dust mite was 6.1% in Tallinn. This was higher than the comparable Swedish and East German data [6,7,23] and is surprising considering the cold climate. The high prevalence of home dampness, reported by 30% of families in Tallinn and the fact that the indoor temperature during winters in previous years was high in the flats due to the cheap energy, are possible explanations for this finding.

Comparisons between eastern and western countries in Europe generally show lower rates of asthma and sensitization in the former, while the prevalence of other respiratory symptoms vary (Table 4). Thus, the prevalence of doctor's diagnosed asthma in Estonia was two to three times lower than that reported in recent studies from Sweden [7] and West Germany [6,23], but was similar to that reported in Poland and East Germany [6,7,18,23]. The criteria for asthma in Estonia are traditionally more narrow than in many western countries, as atopic sensitization is required in addition to recurrent airway obstruction. This could at least in part explain the low prevalence of diagnosed asthma.

Common colds >6 times per year and prolonged cough were frequently reported by the Estonian schoolchildren. The figures were similar to those recorded in Poland and much higher than in Sweden, employing the same questionnaire [7]. An increased prevalence of respiratory tract infections ('bronchitis') was also reported in eastern as compared with western Germany [23]. Multiple studies have reported a relationship between outdoor air pollution and the prevalence of respiratory symptoms and changes in lung function. The relationship between air pollution and non-atopic respiratory symptoms is, however, not yet clear [3,24]. The higher prevalence of respiratory symptoms in Estonian schoolchildren is more likely related to other factors, as living standard and indoor climate. Compared with western standards, living conditions in Estonia are poor and most people live in crowded, small apartments. The number of infectious diseases in infants and toddlers is high, as most children attend day-care settings. Thus, 72–78% of children from 1 to 3 years, and 78–88% of children up to 5 years in Tartu and Tallinn attended day care centres in 1984.

Living conditions seem to have an influence on the prevalence of respiratory symptoms, as well as on the prevalence of atopy (Table 4). Overcrowding was a negative risk factor for atopic sensitization in Estonia and Poland [7,25]. This is compatible with a reported inverse relation between the number of siblings in families and allergy [13,26]. Experimental studies indicate that a high rate of respiratory infections early in life can induce an immunological tolerance, selecting interferon gamma

(IFN- γ) secreting TH-1 cells, which inhibit the development of interleukin (IL)-4 secreting TH-2 cells [27,28]. The report by Behrendt *et al.* [29] of high total serum IgE levels in East German children with a correlation to parasitic infections and the number of person per dwelling, yet with a low prevalence of sensitization, are also compatible with our data, as the morbidity from parasitic infections in children in Estonia is high (4700 reported cases per 100 000 children in 1993). This figure is probably too low as many cases are not diagnosed.

The lower building standards, more traditional building materials, good natural ventilation in flats, overcrowding, high rate of respiratory and parasitic infections and locally produced foods are all examples of a still prevailing lifestyle, which is now rapidly changing in Estonia.

Studies in eastern European countries may be relevant to the question whether atopic sensitization really has increased in western countries, or whether the perceived increase is due to increased awareness of symptoms. The changes in the Estonian society that presently take place, offer a good opportunity to study environmental influences on the prevalence of atopic sensitization and allergic diseases.

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