

Atopic sensitization and respiratory symptoms among Polish and Swedish school children

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Summary

Allergic sensitization and symptoms from the airways in relation to air pollution were compared in 10–12-year-old school children ($n = 1113$) from urban Konin in central Poland and both urban and rural parts of Sundsvall in northern Sweden. The measurements included parental questionnaires, skin-prick tests and serial peak flow measurements during 2 weeks with simultaneous monitoring of outdoor air pollutants. The skin-prick test technique was validated by IgE antibody determinations. The levels of common industrial pollutants, SO_2 and smoke particles were much higher in Konin than in urban Sundsvall and the levels of NO_2 were similar. Various respiratory symptoms were more often reported among school children in Konin (except for wheezing and diagnosed asthma). Multiple logistic regression analyses yielded the following increased odds ratios for children in Konin as compared with the reference group (rural Sundsvall): chest tightness and breathlessness 3.48 (95% confidence interval 2.08–5.82), exercise-induced coughing attacks 3.69 (95% confidence interval 1.68–8.10), recurrent episodes of common cold 2.79 (95% confidence interval 1.53–5.09) and prolonged cough 4.89 (95% confidence interval 2.59–9.23). In contrast, as compared with rural Sundsvall, the adjusted odds ratio for a positive skin-prick test was decreased in Konin, but increased in urban Sundsvall, 0.58 (95% confidence interval 0.37–0.91) and 1.67 (95% confidence interval 1.15–2.42) respectively. The study confirms that living in urban, as compared with rural areas, is associated with an increased prevalence of respiratory symptoms and sensitization to allergens. These differences could be explained by air pollution. Respiratory symptoms were more common in a similar urban group of Polish children who were exposed to even higher levels of air pollution. These children, however, had a much lower prevalence of sensitization to allergens, as compared with the Swedish children. This indicates that differences in lifestyle and standard of living between western Europe and a former socialist country influences the prevalence of atopy.

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Introduction

Recent studies indicate an increasing prevalence of allergic diseases, including asthma [1–3]. Reasons for this are poorly understood but clinical observations and

studies in animals indicate that air pollution can enhance sensitization to allergens, particularly in individuals with a genetic propensity to allergic disease [4]. Thus, exposure of animals to SO_2 [5], NO_x , O_3 [6], diesel exhaust fumes [7] and tobacco smoke [8] all facilitate sensitization to common allergens. These observations support epidemiological studies indicating an adjuvant effect of air pollution [4,9], including tobacco smoke [10]. Several

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studies also indicate that allergy is more common in urban than in rural areas [11–14].

If air pollution was the main explanation for an increased prevalence of allergy and asthma, then these diseases would be even more common in polluted industrial regions. We therefore compared the prevalence of atopy and symptoms from the respiratory tract in school children in an urban area of central Poland with two well-defined areas in northern Sweden. The Polish children were more exposed to indoor and outdoor pollution than the Swedish children.

Materials and methods

Study areas

Sundsvall is an administrative and industrial centre on the Baltic coast in northern Sweden covering an area of 3219 km². The municipality's population (town and rural hinterland) was 94 000 in 1992. Most of the population lives in the coastal area. The inland comprises mainly forest and agricultural land. An aluminium plant, a paper mill, a chemical industry and a district heating power plant are located on the coast close to the town centre. The total emission of SO₂ was 515 t in 1992 and the half annual mean SO₂ value was 3 µg/m³ in 1991/1992. The centre of Sundsvall is situated in a hollow with mountains to the north and south and a bay of the Baltic Sea in the east. During the winter there is a tendency to inversion in the valley between the mountains. In the centre of Sundsvall outdoor levels of NO₂ are sometimes high by Swedish standards as a result of inversion, in conjunction with dense motorized traffic. The mean outdoor temperature in Sundsvall is –6.4°C in January and +16.4°C in July.

Konin is an industrial town with 85 000 inhabitants situated in central Poland about 200 km west of Warsaw. The town is located on a low hill with flat and open surroundings. Most people live in blocks of flats with 5–12 floors. The houses are generally concrete and were constructed between 1960 and 1980. Konin has an aluminium plant and three brown coal power stations (two of them situated close to the central part of the town). Ten per cent of the total electricity production in Poland is supplied by the three brown coal power stations in Konin. The power stations emit about 120 000 tons of sulphur dioxide per year. The chimneys in the power stations are high (between 100 and 200 m).

Subjects

All pupils born between 1979 and 1981 (1113 children) in grade 4, 5 and 6 (10–12 years) from all schools in a rural

area 30–70 km from the centre of Sundsvall (318 children), all schools in central Sundsvall (370 children) and one school in central Konin (425 children) were compared.

Procedures

This prevalence study was carried out mainly between September 1991 and February 1992.

Questionnaire to parents The parents of the pupils received a questionnaire with 60 questions concerning home environment (past and present), present clinical symptoms of allergy in the study child and past or present allergies in other members of the family. The questionnaire was a revised and extended version of a questionnaire used in a previous study [14]. Atopic heredity was defined as presence of self-reported atopic disease (i.e. bronchial asthma, allergic rhinoconjunctivitis or eczema) in other members of the family (i.e. parents, brothers and sisters). Replies to the questionnaire were received from the parents of 303 (95.3%) children in rural Sundsvall, 362 (97.8%) in urban Sundsvall and 410 (96.5%) in Konin.

Skin-prick test Skin-prick tests (single tests) were performed on the volar aspects of the forearms with standardized allergen extracts in 50% glycerol (Solu-Prick SQ, ALK, Hørsholm, Denmark), using a lancet of Østerballe type with 1 mm tip [15]. The allergens were labelled in histamine equivalent prick units (HEP) or w/v: birch (10 HEP), timothy (10 HEP) and mugwort pollen (10 HEP), *Dermatophagoides pteronyssinus* (10 HEP), *Cladosporium* (1:2 w/v), and horse (10 HEP), cat (10 HEP) and dog dander (10 HEP). Histamine dihydrochloride 10 mg/ml was employed as positive control and 50% glycerol as negative control. The skin-prick tests were performed as recommended [16]. All tests were performed during January and February 1992 by one nurse in Sweden and one paediatrician in Poland. Skin-prick tests were performed on 289 (90.6%) children in rural Sundsvall, 351 (94.6%) in urban Sundsvall and 358 (84.2%) in Konin.

To validate the skin-prick test technique blood samples were taken in March and in April 1993 from 145 children in Sundsvall (a random sample among all those having reported ocular and/or respiratory symptoms, which could indicate allergy). All these children had been skin-prick tested in January and February 1992 (as a part of the main study). In Konin, blood samples were taken in March and in April 1993 from 49 children with symptoms which could indicate allergy (aged 10–13). Thirteen of those had been skin-prick tested in the

main study in 1992, and 36 were skin-prick tested at the same time as the blood sampling. The same paediatrician performed all skin-prick tests in Poland, both in the main study and in the validation study.

All sera were stored at -20°C until analysed. An immunochemiluminometric assay was used for the detection of specific IgE antibodies to birch and timothy grass pollen, dog and cat dander and *Dermatophagoides pteronyssinus* (Magic Lite/ALK, Denmark). All sera from Poland and Sweden were assayed in duplicate at the Department of Chemistry in Sundsvall in the same run. As clinical allergy could not be objectively verified by the questionnaires, the results of the skin-prick tests were compared with those of the *in vitro* determinations.

Serial peak flow measurements Each child was supposed to measure the peak expiratory flow rate with a mini-Wright peak flow meter four times daily during a 2-week-period (January 8–21, 1992). The measurements were performed in a standing position on rising from bed in the morning, between 10.00 h and 14.00 h and before bedtime. During school-days at least one of the measurements was performed in the classroom and supervised by the teacher. Each peak flow meter was individual. A diary sheet was completed daily (usually in the classroom) by each child recording peak flow values, symptoms and medication. The school children and their teachers had been instructed class by class by a doctor or a study nurse in November and December 1991.

They were instructed in the use of the peak flow meter and the daily diary following a uniform protocol and they were also given written instructions. Serial peak expiratory flow rate measurements were performed by 304 (95.6%) children in rural Sundsvall, 361 (97.3%) in urban Sundsvall, and 416 (97.9%) in Konin.

Monitoring of outdoor air pollutants The measurements were performed and organized by the Swedish Environmental Research Institute, IVL. The sampling was carried out at five of the study schools with semi-automatic samplers constructed by IVL. These samplers have been used for monitoring of outdoor air pollutants in 40–55 Swedish towns since 1986 (The Swedish Urban Network). Each sampler is equipped with eight channels in which the sample air flow first passes a soot filter and thereafter is divided so that one air fraction (0.4 l/min) passes an impregnated sintered glass filter for absorption of NO_2 and a second fraction (1.1 l/min) passes through an impinge bottle filled with acidified hydrogen peroxide solution for absorption of SO_2 . The amount of the soot particles is estimated by the blackness of the exposed filter based on a simple reflectometric analysis. Analyses

of SO_2 and NO_2 are performed using ion chromatography and spectrophotometry respectively.

Statistics The statistical calculations were done with the Statistical Package for Social Sciences (personal computer version). Comparisons were made using Student's *t*-test for continuous variables, and the chi-squared test for proportions. All of the tests were two-tailed. Multiple linear regression analysis was used to test for prediction of peak expiratory flow rate with the following independent variables included in the final model: location (using dummy coding with rural Sundsvall as reference), height, sex, current parental smoking, age and atopic heredity.

The odds ratios for multivariate associations with respiratory symptoms and atopic sensitization within each group were estimated by logistic regression modelling. Rural Sundsvall was used as reference group. The final logistic model included only significant predictors. Hypothesis testing was performed using likelihood ratio tests.

The study was approved by the Ethics Committees of Umeå University in Sweden and Poznan University School of Medical Sciences in Poland.

Results

Social and demographic conditions

There were obvious differences in social and dwelling conditions between the three geographical areas. Thus, 40.5% of all children in rural Sundsvall had lived in the same residence since birth compared with 24.4% in urban Sundsvall and 54.5% in Konin. Seven per cent of the families in rural Sundsvall lived in apartments compared with 36.3% in urban Sundsvall and 94.6% in Konin. The average number of persons per room in the residence were 0.9 in Sundsvall and 1.7 in Konin. The mean number of children in the families were 2.2, both in Sundsvall and in Konin. Contacts with furry animals were most frequent among rural children. Past or present contacts at home with cats were reported by 71.5%, 42.8% and 17.8% in rural Sundsvall, urban Sundsvall and Konin respectively. Corresponding figures for dogs were 66.3%, 36.0% and 48.8%. Horse riding was rare among children in Konin, reported only by 2.5% as compared with 21.3% in urban Sundsvall and 31.4% in rural Sundsvall.

Exposure to air pollutants

Children in Konin were more exposed to air pollutants, both indoors and outdoors. The ambient mean concentrations of smoke and SO_2 outside school were seven

Table 1. Levels of NO₂, SO₂ and smoke (12 h-mean values) (8–21 January 1992)

	NO ₂ μg/m ³ (range)	SO ₂ μg/m ³ (range)	Smoke μg/m ³ (range)
Rural Sundsvall	8.4 (1.0–34.8)	1.9 (0.8–3.9)	4.9 (0–11.2)
Urban Sundsvall	19.0 (1.3–66.9)	2.3 (1.0–14.7)	4.4 (0–21.2)
Konin	17.5 (3.9–25.9)	17.1 (4.3–70.9)	32.3 (4.9–99.0)

times greater in Konin than in Sundsvall (Table 1). Most families in Konin and almost none in Sundsvall used a gas stove. Exposure to environmental tobacco smoke was much more common in Konin. Thus, 59% of the children in Konin and 30% of the children in Sundsvall had currently smoking fathers and 51% and 37%, respectively currently smoking mothers.

Respiratory symptoms

Prevalences of respiratory symptoms in rural and urban Sundsvall and Konin are presented in Table 2. Chest tightness, exercise-induced coughing attacks, frequent respiratory infections and prolonged coughing periods

after a common cold were more often reported among school children in Konin compared with rural Sundsvall. Chest tightness and frequent respiratory infections were more common in Konin compared with urban Sundsvall. Prevalence of wheezing were approximately similar in all three areas. Asthma diagnosed by a doctor was uncommon in Konin as compared with Sundsvall. Adjustment for the effects of gender, current dampness in the dwelling, exposure to environmental tobacco smoke during the child's first year of life, current exposure to environmental tobacco smoke at home and atopic heredity, was made in the analyses. The adjusted odds ratios for respiratory symptoms in urban Sundsvall and Konin were then compared with the reference group (rural Sundsvall). The adjusted odds ratios are given in Table 3. There is a general tendency to slightly increased risk for respiratory symptoms in urban Sundsvall and highly significant, increased risk for respiratory symptoms in Konin.

Atopic sensitization

Prevalence rates and adjusted odds ratios for atopic sensitization in rural and urban Sundsvall and in Konin are presented in Tables 4 and 5. Positive skin-prick test reactions to pollen and pets were uncommon in Konin even compared with rural Sundsvall. In Konin, 48.8% of all school children had current or previous contacts with dog at home but only 2.0% were sensitized

Table 2. Twelve-month prevalence of symptoms from the airways among school children in rural Sundsvall, urban Sundsvall and Konin. Figures based on parent's replies to questionnaire (absolute numbers in brackets)

	Rural Sundsvall <i>n</i> = 303 %	Urban Sundsvall <i>n</i> = 362 %	Konin <i>n</i> = 410 %
Wheezing in the chest during, e.g. a cold, physical exertion or in contact with animals	9.3 (27/289)	11.6 (40/345)	10.4 (42/403)
Chest tightness and breathlessness during, e.g. a cold, physical exertion and/or in contact with animals	10.8 (32/295)	13.1 (46/352)	19.0** (77/406)
Nocturnal cough for a period longer than 4 weeks (without signs of cold or whooping cough)	3.7 (11/295)	4.6 (16/349)	4.2 (17/403)
Exercise-induced coughing attacks (without concomitant cold)	4.1 (12/291)	9.1** (32/351)	8.4* (34/405)
Diagnosed as being asthmatic by a doctor	6.7 (19/285)	9.5 (32/337)	2.9* (12/407)
Common cold more than six times a year	6.3 (19/301)	8.0 (28/352)	14.0** (57/406)
Coughing bouts for more than 2 weeks when having a common cold	5.7 (17/297)	12.0** (42/350)	15.1*** (61/405)

P* < 0.05, *P* < 0.01, ****P* < 0.001 indicate values significantly different from the reference (rural Sundsvall).

Table 3. Adjusted odds ratios (after multiple logistic regression analyses) for complaints from the airways among school children in urban Sundsvall ($n = 362$) and in urban Konin ($n = 412$) compared with school children in rural Sundsvall (odds ratio = 1, $n = 303$)

	Odds ratio	95% CI
<i>Chest tightness and breathlessness</i>		
Urban Sundsvall	1.07	0.63–1.80
Konin	3.48***	2.08–5.82
<i>Exercise-induced coughing attacks</i>		
Urban Sundsvall	2.98**	1.39–6.39
Konin	3.69***	1.68–8.10
<i>Common cold more than six times a year</i>		
Urban Sundsvall	1.29	0.68–2.45
Konin	2.79***	1.53–5.09
<i>Coughing bouts for more than 2 weeks when the child has a cold</i>		
Urban Sundsvall	2.68**	1.43–5.05
Konin	4.89***	2.59–9.23

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ indicate values significantly different from the reference (rural Sundsvall).

to dog dander. No association was seen between the number of children in the family and the prevalence of positive skin-prick tests.

The histamine weals were slightly smaller in Konin (mean value 5.5 mm) compared with Sundsvall (mean value 6.2 mm, 95% CI 0.6–0.8 mm for difference). The prevalence of positive skin-prick tests defined as allergen weals of at least half of the histamine weals, were similar as those presented in Table 4.

The skin-prick tests were positive in 63 children out of 69 with detectable serum IgE antibodies in Sundsvall (sensitivity 91.3%) and in 16 out of 21 in Konin (sensitivity 76.2%). The skin-prick tests were negative in 62 out of 76 children with no detectable serum IgE antibodies in Sundsvall (specificity 81.6%) and in 27 out of 28 in Konin (specificity 96.4%). Detectable levels of specific IgE antibodies to animal dander were rare among children from Konin (Table 6).

Table 4. Positive skin-prick test reactions (≥ 3 mm) in school children from rural Sundsvall, urban Sundsvall and Konin

	Rural Sundsvall ($n = 289$) (%)	Urban Sundsvall ($n = 351$) (%)	Konin ($n = 358$) (%)
Birch	10.4	12.0	2.2***
Timothy	13.8	20.2*	9.8
Mugwort	3.1	10.0***	2.2
Cat	12.5	21.1**	2.5***
Dog	11.8	14.5	2.0***
Horse	7.6	12.0	0.3***
<i>D. pteronyssinus</i>	1.7	3.4	3.4
<i>Cladosporium</i>	1.7	2.3	0.3

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ indicate values significantly different from the reference (rural Sundsvall).

Table 5. Prevalences and adjusted odds ratios (rural Sundsvall used as reference) for positive skin-prick tests among school children in rural Sundsvall, urban Sundsvall and Konin (positive skin-prick test defined as an allergen weal size ≥ 3 mm)

	Prevalence (%)	Odds ratio	95% CI
<i>At least one positive skin-prick test</i>			
Rural Sundsvall	24.2 (70/289)	1.00	
Urban Sundsvall	35.3 (124/351)	1.67**	1.15–2.42
Konin	13.7 (49/358)	0.58*	0.37–0.91
<i>At least one positive test to pollen</i>			
Rural Sundsvall	19.0 (55/289)	1.00	
Urban Sundsvall	26.8 (94/351)	1.57*	1.05–2.34
Konin	10.1 (36/358)	0.58*	0.35–0.96
<i>At least one positive test to animal dander</i>			
Rural Sundsvall	15.6 (45/289)	1.00	
Urban Sundsvall	26.2 (92/351)	1.79**	1.18–2.73
Konin	4.2 (15/358)	0.28***	0.15–0.54

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ indicate values significantly different from the reference (rural Sundsvall).

Peak flow measurements

The maximum number of measurements during the 2-week period was 56 in each child. At least 50 measurements were performed by 74% of the participating school children in rural Sundsvall, 67% in urban Sundsvall and 73% in Konin.

Children with parent-reported wheezing had lower mean peak expiratory flow rate (mean difference 11.5, 95% CI 0.6–22.4). Mean peak expiratory flow rate were similar in urban Sundsvall as in Konin. Mean peak expiratory flow rate were significantly lower both in urban vs rural Sundsvall (mean difference 10.6, 95% CI 2.2–19.0) and in Konin vs rural Sundsvall (mean

difference 12.3, 95% CI 4.3–20.2). The latter difference in mean peak expiratory flow rate in Konin vs rural Sundsvall was, however, only of borderline significance ($P = 0.06$) after adjustment for height. Children's mean height in January 1992 was in Sundsvall 151.2 cm and in Konin 148.2 cm, mean difference 3 cm (95% CI 1.9–4.1).

The agreement was poor between increased diurnal peak expiratory flow rate variability ($>30\%$) and parent-reported wheezing in the child (κ coefficient 0.06). Increased diurnal peak expiratory flow rate variability ($>30\%$) was seen in 15.3% of all children in Konin, compared with 8.6% in urban Sundsvall and 9% in rural Sundsvall. The difference in peak expiratory flow rate variability between Sundsvall and Konin was statistically

Table 6. Elevated levels of specific IgE antibodies and positive skin-prick tests among school children participating in the validation (All children had symptoms suggesting possible allergy)

	Swedish school children ($n = 145$)		Polish school children ($n = 49$)	
	Positive specific IgE	Positive skin-prick test	Positive specific IgE	Positive skin-prick test
Birch	30	35	9	6
Timothy	43	53	17	13
Cat	43	54	5	5
Dog	26	40	2	6
<i>D. pteronyssinus</i>	8	9	11	9

significant but disappeared when adjustments were made for sex and current parental smoking.

Discussion

This cross-sectional study demonstrates a higher prevalence of various symptoms from the respiratory tract among school children in Konin than in less polluted urban and rural areas in Sweden. In contrast, the prevalence of atopic sensitization was remarkably low among the Polish children, despite exposure to higher levels of air pollution. In a recent prevalence study from Germany [17], cough and unspecified symptoms from the airways were reported to be more common in polluted areas in eastern Germany where the standard of living is also lower than in western Germany. Symptoms of allergic rhinoconjunctivitis, as indicated by a questionnaire were, however, less common in the eastern part. Our study verifies the lower prevalence of atopy in the previously socialist Europe by objective methods.

The prevalence of asthma was similar in the three areas, according to the adjusted prevalence of wheezing and increased peak expiratory flow rate variability. Thus, wheezing was equally often reported in Konin and Sundsvall. This symptom is related to asthma, although not diagnostic of it. The very low prevalence of diagnosed asthma in Konin probably indicates an underdiagnosis of the disease. We therefore based our assessment on parent reported symptoms in the questionnaires, rather than a particular disease diagnosis. We did not observe any relation between allergy and the size of the family as has been suggested previously [18].

There are no objective methods giving a close relation between bronchial hyperreactivity and symptoms of asthma in large epidemiological studies [19,20]. Increased diurnal variations in peak expiratory flow rate has been suggested as a useful indicator in epidemiological studies of bronchial hyperreactivity and asthma [21]. This could not be confirmed by our study showing a poor agreement between peak expiratory flow rate variability and parent-reported wheezing.

Various symptoms from the respiratory tract, particularly cough and recurrent infections were common in Konin. The results should be interpreted with caution, as there may have been differences in perception of the questions in two countries. It is, however, reasonable to suggest that air pollution contributed to the high prevalence in Konin. This is supported by other studies showing that the number of upper respiratory infections and chronic respiratory symptoms may be related to even low levels of air pollution [22,23], other explanations are, however, also possible. Low standard of living [24] and

congested housing [25] are associated with an increased number of infections. The Polish apartments are generally smaller than the Swedish ones and are inhabited by about twice as many people per room. Exposure of school children to tobacco smoke is associated with an increased prevalence of bronchial hyperreactivity [10], as well as prolonged cough and wheezing [4,26] and respiratory infections [27]. It has also been reported that use of gas stoves may be associated with an increased frequency of various respiratory symptoms [28,29].

The most surprising finding in our study was the low prevalence of atopy in Konin, as defined by positive skin-prick tests. There are many technical factors that influence the test, thus limiting the use in epidemiological studies [30]. In this study identical extracts and needles were used and great care had been taken to train the persons performing the tests to use a similar technique. Despite these precautions, the mean diameter of the histamine controls was slightly smaller in Konin than in Sundsvall. This could be due to minor differences in technique or to a slightly lower reactivity to allergens in the Polish children [31]. We therefore related the size of the weals caused by allergen to the size of the histamine controls in the individuals. This did not significantly alter the number of positive tests. We also validated the skin-prick test technique with serum IgE antibody determinations among school children with symptoms suggesting possible allergy. Elevated levels of specific IgE antibodies to animal dander were uncommon among the Polish school children. This seems to confirm the very low number of positive skin-prick tests to animal dander in Konin. The validation, however, showed some discrepancy in the sensitivity and specificity between Sundsvall and Konin. This indicates that differences in skin-prick test technique has to some extent influenced our results. After adjustment for the validation, the differences in skin-prick positivities between urban Sundsvall and Konin will be smaller though still significant.

Genetic differences can never be excluded when three populations are compared. Studies of allergies among migrants indicate, however, that environmental factors are much more important factors helping to explain differences in asthma and sensitization [32–34]. Our results are also consistent with the recent study comparing the prevalences of atopic diseases among school children from a similar genetic background in East and West Germany [17].

The 120 000 t of SO₂ that are emitted in Konin every year correspond to about 50% of all SO₂ emissions in entire Sweden. Although the levels of SO₂ and particles were much higher than in the Swedish study sites they are well below the upper levels as defined by the WHO [35]. The levels measured during the study period are similar

to the official levels measured during 1991 and 1992 and are thus representative for the period. The likely explanation for the moderate levels of air pollution is the topography of Konin. The town is situated on a hill surrounded by a flat and open area.

The outdoor levels of NO₂ were similar in urban Sundsvall and in Konin. Probably, the Polish children were exposed to even more NO₂ as almost all the homes had a gas stove. Normal use of a gas stove in homes without a kitchen fan may increase the background levels of NO₂ to over 50 µg³/m³ [36]. As compared with the Swedish children, the Polish children were also much more exposed to tobacco smoke as smoking was twice as common in Konin and the consumption per capita was higher. This is supported by a report from 1990 that the average consumption of cigarettes was 3060 per adult in Poland and 1700 in Sweden [37]. Further, Polish cigarettes contain more tar than the Swedish ones. It is thus reasonable to assume that the Polish children were much more exposed to air pollution than their Swedish counterparts.

Several recent reports indicate an increasing prevalence of allergic diseases over the past 20–30 years [2,3,38–40]. Experimental and epidemiological studies from Japan suggest that this could be due to increased exposure to exhaust fumes from cars [7,9]. In a very recent German study, however, no association was seen with asthma or hay fever among school children although high rates of road traffic had a slightly negative effect on the peak expiratory flow rate [41]. The differences in respiratory symptoms and skin-prick test positivity between rural and urban Sundsvall could be explained by traffic and other sources of pollution. This is, however, not the most likely explanation for the observed differences between Konin and urban Sundsvall as the outdoor levels of NO₂ were similar. The principal sources of NO₂ in outdoor air are car exhaust and fossil fuel combustion [42]. Although traffic in Konin is less dense than in Sundsvall, diesel buses are more common and very few Polish cars have catalytic converters.

The indoor air may be more important than the outdoor conditions. A recent study shows that Swedish children spend about 90% of their time indoors [43]. The indoor climate has deteriorated in many countries as a consequence of extensive energy-conserving measures, less ventilation and the introduction of new building materials. As a consequence of this, sensitization to house dust mites has become much more common, even in a cold climate unsuitable for mite growth [44]. Changes in the indoor climate may possibly explain that the observed prevalence of asthma and allergic rhinoconjunctivitis in Sweden are more pronounced in the northern parts, where the cold climate has resulted in meticulous energy con-

servation. Possibly, this is a factor that could explain part of the differences in the prevalence of atopy between the Polish and Swedish school children.

Other factors could also influence the low prevalence of atopic sensitization in Polish school children. Elevated levels of total serum IgE were found recently among East German pre-school children. Total serum IgE levels were related to a high number of parasitic infections and exposure to outdoor air pollutants but they were not related to high prevalences of atopic diseases [45]. A negative association between parasitic IgE and atopic disease has also been reported in a Swedish study [46]. Overcrowding and a decreased standard of living may increase the risk for parasitic infections among children in Eastern Europe whereas an increased standard of living and numerous changes in life style seem to have resulted in more allergic diseases in industrialized countries. Konin is in many respects similar to Swedish towns 30 years ago. The standard of living is lower, the dwellings are well ventilated, although smaller and poorly insulated, and allergy is less common than in Western Europe.

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