

Prevalence of hay fever and allergic sensitization in farmer's children and their peers living in the same rural community

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Summary

Introduction Lower prevalence rates of allergic diseases in rural as compared with urban populations have been interpreted as indicating an effect of air pollution. However, little is known about other factors of the rural environment which may determine the development of atopic sensitization and related diseases.

Objective The authors tested the hypothesis that children growing up on a farm were less likely to be sensitized to common aeroallergens and to suffer from allergic diseases than children living in the same villages but in nonfarming families.

Materials and methods Three age groups of schoolchildren (6–7 years, 9–11 years, 13–15 years) living in three rural communities were included in the analyses. An exhaustive questionnaire was filled in by 1620 (86.0%) parents. A blood sample was provided by 404 (69.3%) of the 13–15 year olds to determine specific IgE antibodies against six common aeroallergens.

Results Farming as parental occupation was reported for 307 children (19.0%). After adjustment for potential covariates such as family history of asthma and allergies, parental education, number of siblings, maternal smoking, pet ownership, indoor humidity and heating fuels, farming as parental occupation was significantly associated with lower rates of sneezing attacks during pollen season (adjusted OR 0.34, 95% CI 0.12–0.89) and atopic sensitization (adjusted OR 0.31, 95% CI 0.13–0.73) whereas the association with wheeze (adjusted OR 0.77 95% CI 0.38–1.58) and itchy skin rash (adjusted OR 0.86, 95% CI 0.49–1.50) was not statistically significant. The risk of atopic sensitization was lower in children from full-time farmers (adjusted OR 0.24, 95% CI 0.09–0.66) than from part-time farmers (adjusted OR 0.54, 95% CI 0.15–1.96).

Conclusion Factors directly or indirectly related to farming as parental occupation decrease the risk of children becoming atopic and developing symptoms of allergic rhinitis.

Keywords: hay fever, allergic sensitization, farming, children

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Introduction

Several recent population studies demonstrated lower

prevalence rates of allergic diseases in rural as compared with urban populations [1–3], which has been interpreted as indicating an effect of air pollution. However, the role of air pollution in the development of allergic diseases and sensitization to inhalant allergens is still controversial. The principal literature arguing for a significant role of air

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pollution comprises toxicological studies showing increased primary IgE responses in animals exposed acutely to relatively high levels of pollutants, concomitantly with allergen aerosols [4,5]. Several comparative epidemiological studies in Eastern and Western Europe [6,7], and the authors' own recently conducted Swiss Study on Childhood Allergy and Respiratory symptoms with respect to air Pollution (SCARPOL) could not demonstrate an association between long-term air pollution and the prevalence of allergic diseases [8,9].

The clinical observation of one of the SCARPOL investigators that allergic diseases such as hay fever were extremely rare among farmers' children [10] and a report from rural South Bavaria relating lower rates of allergic diseases to the use of coal and wood stoves for heating [11] led us to investigate whether factors of the rural environment other than air pollution were associated with lower rates of allergic disease and sensitization rates, and thus might explain the lower prevalence rates of allergies in rural communities.

The present study was part of the ongoing Swiss multicentre study SCARPOL. The analyses focused on school-children living in three rural communities. Little is known about factors of the rural environment determining the development of atopic sensitization and related diseases. Therefore, the hypothesis that children growing up on a farm were less likely to be sensitized to common aeroallergens and to suffer from allergic diseases than children living in the same villages but in nonfarming families was tested.

Methods

Study organization and participation rate

The Swiss Study on Childhood Allergy and Respiratory Symptoms with Respect to Air Pollution (SCARPOL) is a multicentre study designed to investigate associations between air pollution and respiratory and allergic symptoms in school children living in 10 communities [8]. It was first conducted during the school year 1992/1993 and repeated with identical methods as part of an environmental health monitoring program in 1995/96.

The study was organized within the framework of the School Health Services thereby taking advantage of an existing structure of the Health System. The children visit the School Health Services routinely at the age of 6–7 years (1st grade), 9–11 years (4th grade) and 13–15 years (8th grade).

The present analyses are restricted to the children living in the three rural SCARPOL communities (Grabs, Langnau, Payerne and surrounding villages). To avoid problems relating to language proficiency and literacy, the sample is

restricted to Swiss nationals. Since there were no systematic differences in prevalence rates of respiratory and allergic symptoms or in atopic sensitization rates between the two surveys, data of both surveys were pooled. The second survey included only children who did not take part in the first survey.

All children visiting the School Health Services in their respective communities were invited to participate in the study. A total of 1620 (86.0%) parents filled in the questionnaire and allowed their children to participate in the study.

In addition, the 13–15 year olds were asked to provide a blood sample for specific IgE-testing, and 404 (69.3%) of the invited adolescents accepted. The prevalence rates of respiratory and allergic symptoms did not differ between those who provided blood samples and those who refused.

The study protocol was approved by the Ethics Committee of the University of Bern.

Questionnaire

The detailed questionnaire completed by the parents included questions on respiratory and allergic symptoms, family history of respiratory and allergic diseases, number of siblings, parental education, indoor fuels, passive smoking, indoor humidity, pet ownership, and study area. The core questions on asthma and allergy of the International Study on Childhood Asthma and Allergy (ISAAC) [12] were incorporated into the questionnaire.

Parents had to indicate whether the family was running a farm and if so, whether this was a full-time or part-time activity.

Eight respiratory and allergic illness and symptom responses obtained from the questionnaire were considered: repeated episodes of cough, and bronchitis occurring during the past year, current wheeze, asthma, sneezing attacks during pollen season, hay fever, itchy skin rash, and eczema.

Wheeze was defined as a positive response to the question: 'Has your child had wheezing or whistling in the chest in the last 12 months?' Sneezing during pollen season was an affirmative answer to the question: 'In the past 12 months, has your child had a problem with sneezing or a runny or blocked nose when he/she did not have a cold or the flu?' combined with the indication of the symptoms occurring during the months of April through September (pollen season), a symptom that showed high validity in the authors' recent validation study [13]. Itchy skin rash was defined as a positive response to the question: 'Has your child ever had an itchy rash which was coming and going for at least 6 months?' In addition, affirmative answers to the questions: 'Has your child ever had asthma, hay fever or eczema?' were considered.

Serological tests

Blood samples (10 cm³) were taken and the serum separated by spinning 10 min at 1000 *g*. The samples were kept frozen and sent to the allergy laboratory of the Department of Dermatology in Zürich.

The multiscreen test, SX₁ (screening test for eight common inhalative allergens, Pharmacia,) was performed

with all serum samples by CAP-FEIA technology. If the SX₁ test was positive, the specific IgE levels to six allergens (timothy grass, birch, mugwort, house dust mite, cat and dog dander) were determined by CAP-FEIA. The cutoff for a positive result was defined as a specific IgE concentration ≥ 0.69 KU/L (CAP class ≥ 2). In addition to the SX₁ test, positive reactions to any of the outdoor allergens (timothy grass, birch, mugwort) and to any of the indoor allergens

Table 1. Characteristics of the study population according to farming as parental occupation

	Total study population <i>N</i> = 1620 (<i>n</i> ,%)	Parental occupation		<i>P</i> value (χ^2 test)
		Farming <i>N</i> = 307 (<i>n</i> ,%)	Non-Farming <i>N</i> = 1313 (<i>n</i> ,%)	
<i>Sex</i>				
Boys	844/52.1	161/52.4	683/52.0	n.s.
Girls	776/47.9	146/47.6	630/48.0	
<i>Age group</i>				
6–7	555/34.3	108/35.3	447/34.0	n.s.
9–12	481/29.7	83/27.1	398/30.3	
13–15	583/36.0	115/37.6	468/35.6	
(Missing: 1)				
<i>Parental education</i>				
Low	135/8.3	66/21.5	69/5.3	<0.001
Medium	952/58.8	201/65.5	751/57.2	
High	469/29.0	33/10.7	436/33.2	
(Missing: 64)				
<i>Number of siblings</i>				
None	97/6.0	9/2.9	88/6.7	<0.001
1	677/41.8	55/17.9	622/47.4	
2	508/31.4	94/30.6	414/31.5	
3+	257/15.9	108/35.2	149/11.3	
(Missing: 81)				
<i>Mother smoking</i>	375/23.2	55/18.0	320/24.4	0.015
(Missing: 12)				
<i>Father smoking</i>	473/29.2	88/28.7	385/29.3	n.s.
(Missing: 12)				
<i>Furred pets</i>	1041/64.3	268/87.3	773/58.9	0.001
<i>Pets in bedroom</i>	430/26.5	56/18.2	374/28.5	0.001
<i>Indoor humidity</i>	353/21.8	87/28.3	266/20.3	0.02
<i>Heating</i>				
Central	1284/79.3	206/67.1	1078/82.1	<0.001
Single space gas/oil	30/1.9	6/2.0	24/1.8	
Electric	38/2.4	7/2.3	31/2.4	
Wood/coal	187/11.5	72/23.5	115/8.8	
(Missing: 81)				
<i>Family history of asthma</i>	265/16.4	38/12.4	227/17.3	0.05
(Missing: 27)				
<i>Family history of hay fever</i>	425/26.2	39/12.7	386/29.4	0.001
<i>Family history of eczema</i>	415/25.6	65/21.2	350/26.7	0.05

(house dust mite, cat and dog dander) were considered. Because of the small numbers, it was not possible to further analyse individual allergens.

Ambient monitoring

Air pollutants and meteorological parameters were monitored by local authorities and the Swiss Institute of Meteorology, Zürich, respectively. Annual mean concentrations of air pollutants such as NO₂, PM₁₀ or ozone were similar in the three communities, ranging from 13.2 to 19.2 µg/m³ for PM₁₀, 19.7–21.9 µg/m³ for NO₂, and 43–50 µg/m³ for ozone. Mean annual temperature ranged from 8 to 10 °C, and mean relative humidity from 73.3% to 81.1%. The study communities were situated between 451 and 557 m above sea-level.

Statistical analyses

Symptom prevalence and atopic sensitization rates were analysed for the total study population and stratified by farming as parental occupation. Since farming families may differ in many respects from nonfarming families,

socioeconomic, personal, and indoor characteristics were analysed according to farming as parental occupation. Differences between categorical variables were assessed by the χ^2 test. Logistic regression analysis was used to evaluate whether the association between farming as a parental occupation and allergic symptoms, and sensitization rates persisted after adjustment for potential confounders. The models included age, sex, parental education, a family history of asthma, a family history of hay fever or eczema, number of siblings, maternal smoking, pet ownership, indoor humidity, and heating fuels. Crude and adjusted odds ratios (OR) and the corresponding 95% confidence intervals (CI) were computed.

Results

Study population

The study population consisted of three age groups of school children: 555 (34.3%) from 1st grade, 481 (29.7%) from 4th grade and 583 (36.0%) from 8th grade. Their respective mean ages were 6.5 years (SD $\pm$ 0.5), 10.0 years (SD $\pm$ 0.7) and 14.1 years (SD $\pm$ 0.7). Eight hundred and forty-four

Table 2. Association of respiratory and allergic symptoms¹ and allergic sensitization with farming as parental occupation

	Total study population (n,%)	Symptom prevalence according to parental occupation		Association with farming as parental occupation	
		Farming (n,%)	Non-Farming (n,%)	Crude OR (95% CI)	Adjusted ³ OR (95% CI)
<i>Questionnaire (N = 1620)</i>					
Repeated cough	594/36.7	103/33.6	491/37.4	0.85 (0.65–1.10)	0.90 (0.63–1.29)
Bronchitis	156/9.6	31/10.1	125/9.5	1.07 (0.71–1.62)	1.37 (0.77–2.40)
Wheeze	135/8.3	16/5.2	119/9.1	0.55 (0.33–0.94)	0.77 (0.38–1.58)
Asthma (ever)	150/9.3	24/7.8	126/9.6	0.80 (0.51–1.26)	1.17 (0.64–2.13)
Sneezing during pollen season	125/7.7	8/2.6	117/8.9	0.27 (0.14–0.54)	0.34 (0.12–0.89)
Hay fever (ever)	197/12.2	22/7.2	175/13.3	0.50 (0.32–0.79)	0.89 (0.49–1.59)
Itchy skin rash (ever)	193/12.0	27/8.9	166/12.7	0.67 (0.41–1.02)	0.86 (0.49–1.50)
Eczema (ever)	305/18.8	48/15.6	257/19.6	0.76 (0.54–1.07)	1.15 (0.74–1.81)
<i>Serological tests² (N = 404)</i>					
Positive SX ₁ test (CAP-class ≥ 2)	139/34.4	16/18.6	123/38.7	0.33 (0.18–0.59)	0.31 (0.13–0.73)
Specific IgE's to outdoor allergens (CAP class ≥ 2)	119/29.5	15/17.4	104/32.7	0.43 (0.24–0.78)	0.38 (0.16–0.87)
Specific IgE's to indoor allergens (CAP class ≥ 2)	81/20.1	4/4.7	77/24.2	0.15 (0.06–0.38)	0.15 (0.04–0.57)

¹during the past 12 months if not otherwise specified. ²318 serological tests were done in children from nonfarming families, 86 in farmers' children. ³The logistic regression model included the following variables: age, sex, parental education, a family history of asthma, hay fever, eczema, number of siblings, maternal smoking, pet ownership, indoor humidity, study area and heating fuels.

(52.1%) were boys and 776 (47.9%) were girls. Farming as parental occupation was reported for 307 (19.0%) children, 220 (13.6%) as a full-time activity, and 87 (5.4%) as a part-time activity.

The characteristics of the total study population according to farming as a parental occupation are given in Table 1. The socioeconomic and home characteristics of farming families differed in many respects from nonfarming families living in the same rural communities. Farming families were of lower socioeconomic status, had more children, often reported more humidity spots or visible molds in their home, heated their homes more often with traditional heating systems using mainly coal and wood and were more likely to keep furred pets, but these pets were less often allowed in the child's bedroom. Mothers in farming families were less likely to smoke and a family history of asthma, hay fever or eczema was reported less often in these families.

The bivariate analyses of respiratory and allergic symptoms and sensitization rates showed that significantly lower rates of current wheeze (5.2% vs 9.5%), sneezing attacks during the pollen season (2.6% vs 8.6%), and hay fever (7.2% vs 13.3%) were reported for farmers' children as compared with children from a nonagricultural environment, whereas the association with a reported diagnosis of asthma, itchy skin rash and eczema did not reach statistical significance (Table 2). The prevalence of bronchitis and repeated cough during the past year was similar in children from farming and nonfarming families. Children from farming families were significantly less likely to have a positive SX_1 test (18.6% vs 38.7%), and specific IgEs to outdoor allergens (17.4% vs 32.7%) and to indoor allergens (4.7% vs 24.2%) than children from nonfarming families.

Since many of the characteristics in which farming and nonfarming families differed have been associated with an increased risk for allergic disease (e.g. family history of asthma, hay fever or eczema), or a lower risk of allergies, such as the number of siblings and the use of wood for heating, the authors evaluated whether these potential confounders would affect the observed association of atopic sensitization and related diseases and farming as parental occupation. The covariates listed in Table 1 were incorporated into a logistic regression model (Table 2). Adjustment for covariates reduced the association of farming as parental occupation with current wheeze, hay fever and itchy skin rash, but was essentially unchanged and remained statistically significant for reported sneezing attacks during the pollen season (adjusted OR 0.34, 95% CI 0.12–0.89) and for a positive SX_1 -test (adjusted OR 0.31, 95% CI 0.13–0.73). The low risk of a sensitization to outdoor and indoor allergens associated with farming as parental occupation was also unaffected by the adjustment of covariates.

The association between reported sneezing attacks and a positive SX_1 test with farming as parental occupation for

children from full-time and part-time farmers as compared with nonfarming families was separately assessed. The adjusted ORs for sneezing attacks during the pollen season associated with part-time and full-time farming were 0.31 (95% CI 0.06–1.35) and 0.36 [0.10–1.22], respectively. For a positive SX_1 test the adjusted ORs were 0.54 [0.15–1.96] and 0.24 [0.09–0.66], respectively, indicating a gradient in atopic sensitization from nonfarming to full-time farming as parental occupation.

Discussion

The results of this analysis suggest that factors directly or indirectly related to farming as parental occupation reduce the risk of producing specific IgE antibodies to aeroallergens and of developing the clinical symptoms of allergic rhinitis. The amount of risk reduction for the development of atopic sensitization determined in this study is similar to the one observed in children from East Germany as compared with West Germany [6]. However, the children of the present study are living in the same villages.

Lower rates of sensitization to pollen and animal dander and self-reported hay fever have been observed in occupational studies of adult farmers [14–17]. The results of the present study are also supported by a study in Swedish conscripts [18] and a more recent study among Finnish university students demonstrating lower prevalence rates of self-reported allergic rhinitis in students who had been raised on a farm as compared with students from a non-agricultural environment [18,19].

Children from rural South Bavaria in Germany had lower rates of hay fever, atopic sensitization and bronchial hyper-responsiveness when living in a home where coal or wood was used for heating compared with children from homes with other heating systems [11]. In the present study, coal or wood as heating fuel was also associated with a lower risk of atopic sensitization (adjusted OR 0.77, 95% CI 0.35–1.64), but the effect of farming as a parental occupation was stronger. Although no information on parental occupation was available in the German study, it seems quite likely that most of the families with traditional heating systems were farmers.

A serious concern when interpreting the results of the present study is selection bias. If farmers suffering from allergic diseases such as hay fever move into other jobs a 'healthy or nonallergic' farmer effect would occur resulting in lower rates of atopic disease in the farming parents of this study population. This has indeed been observed in the authors' data. However, the association between atopic sensitization and farming as parental occupation remained significant after adjustment for family history of allergic diseases. In addition, the observation of a gradient in the prevalence of atopic sensitization from full-time to part-

time and nonfarming subjects argues against selection bias. Many farmers had to give up farming as a full-time activity and move to other jobs because of economic constraints during recent years, and not because one of the children developed hay fever. Usually, the family remains in the farm house and does some farming as part-time activity. Thus, full-time and part-time farming may indicate different degrees of exposure to a factor which interferes with the production of specific IgE antibodies to allergens.

Farms are rather small in these communities, usually managed by one family and farming activities include dairy farming and agriculture. Thus, one might speculate that children living in this environment may be more exposed to pollen when playing outdoors or in barns where hay for feeding cattle is kept. High exposure to allergens may thus contribute to the development of tolerance in these children, as has been shown in animal experiments [20]. Repeated exposure of the upper respiratory or gastrointestinal mucosae to microgram levels of protein antigen leads to the preferential suppression of TH2-dependent IgE production via immune deviation. Consequently, it has been suggested to expose children to a mixture comprising the 3–4 dominant inhalant allergens from a particular environment as a measure of primary prevention of allergic respiratory disease [21]. Thus, the possibility exists that living in a agricultural environment provides a model of such primary prevention.

Previous studies have pointed towards a protective role of early childhood exposure to infectious diseases for the development of atopic sensitization and hay fever [22]. Although the number of siblings was adjusted for, a factor which has been postulated to indicate increased childhood exposure to microbial infections [23,24], it is conceivable that the farming environment in itself (e.g. contact to cattle in barns) provides additional exposure to microbial antigens from both commensal organisms and pathogens, thus, stimulating the immune response of farmers' children to a TH1 immunity.

Alternatively, farming as a parental occupation may be an indicator of a more traditional lifestyle which has been proposed to explain the differences in atopic sensitization between Eastern and Western European populations [2,25]. Although the study assessed some of the most important socioeconomic and environmental factors by questionnaire and controlled for these in the analyses, it cannot be ruled out that uncontrolled confounding may still influence the results of this study. For example, dietary factors are potentially important and have not been assessed in the present study. It has recently been postulated that changes in the consumption of omega-3 fatty acids and fresh foods containing antioxidants and magnesium may be responsible for the higher prevalence of asthma observed in affluent countries [26–28]. All these factors may have a potential

influence on inflammatory reactions. However, whether dietary factors interfere with the production of specific IgE antibodies against allergens has still to be shown. In addition, dietary factors during pregnancy may be important as the overall health of the mother through pregnancy and, therefore, the growth trajectory of the fetus may have particular relevance [29,30].

In summary, this study indicates that children from a farming population represent an informative population to study the role of environmental factors in the development of atopic sensitization. Whether the observed protective effect of the farming environment on atopic sensitization is explained by high exposure to microbial stimulation in childhood, by different exposures to dietary factors or other indicators of a 'traditional lifestyle', or whether it is the result of preferential suppression of TH2-dependent IgE production due to high allergen exposure remains to be elucidated.

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