

Low socioeconomic status as a risk factor for asthma, rhinitis and sensitization at 4 years in a birth cohort

C. Almqvist*†, G. Pershagen‡ and M. Wickman*†§

*Department of Occupational and Environmental Health, Karolinska Hospital, Stockholm, †Department of Woman and Child Health, Karolinska Institutet, Astrid Lindgren Children's Hospital, Stockholm, ‡Institute of Environmental Medicine and §Center for Allergy Research, Karolinska Institutet, Stockholm

Summary

Background The relation between socioeconomic status and allergic diseases in childhood is controversial. Some studies have proposed childhood asthma to be more common in families with low socioeconomic status, while sensitization to airborne allergens seems to be more frequent in individuals with higher socioeconomic status in childhood.

Objective To assess the relation between socioeconomic status and asthma, rhinitis and sensitization in an unselected prospective birth cohort.

Methods Four thousand and eighty-nine families with children born 1994–1996 in predefined areas of Stockholm answered questionnaires on environmental factors, socioeconomic status (parental occupation), and symptoms of allergic disease at birth, 1, 2 and 4 years of age. Blood samples taken at 4 years from 2614 children were analysed for specific IgE to common airborne and food allergens. Odds ratios (OR) and 95% confidence intervals (CI) for various outcomes in relation to socioeconomic status were estimated with a multiple logistic regression model, adjusting for potential confounders such as heredity for allergic diseases, maternal smoking, short duration of breastfeeding and house construction.

Results There was a decreasing risk of asthma and rhinitis with increasing socioeconomic status. The OR for asthma was 0.33 (95% CI 0.17–0.66) and for rhinitis 0.50 (0.32–0.79) comparing the highest and the lowest socioeconomic groups, with a tendency to stronger effects in those with heredity for allergic disease. The risk of sensitization to food allergens also decreased with increasing socioeconomic status; OR 0.65 (0.41–1.02) in the highest socioeconomic group ($P_{\text{trend}} = 0.03$), which was not clearly seen for airborne allergens.

Conclusion Asthma, rhinitis and sensitization is more common in lower than in higher socioeconomic groups after adjustment for traditional risk factors. This may be related to additional uncontrolled differences in life style and environmental exposures between the groups, and calls for further studies.

Keywords allergy and immunology, asthma, child, primary prevention, rhinitis, socioeconomy

Submitted 9 May 2004; revised 26 January 2005; accepted 24 February 2005

Introduction

The relation between socioeconomic status and asthma or allergic diseases in childhood remains controversial. Recent studies have shown that childhood asthma is more common in families with low socioeconomic status [1–3], which may not have been the case some years ago [4, 5]. Some reported findings are consistent with a model in which an increase in the incidence of asthma is driven by factors associated with improved social circumstances, whereas severity is determined by factors associated with poverty [6]. Particularly in Canada and the US a higher frequency of hospital admission and less

medication are seen in the lower socioeconomic groups [7–9]. It has been suggested that while the prevalence of inhalative allergies is higher among parents of high socioeconomic status, their favourable life style prevents the development of atopic disorders in their children [10].

Reports on associations between socioeconomic status and risk of sensitization in adults are contradictory, and the topic has barely been investigated at all in children. A higher prevalence of sensitization to aeroallergens has been noted in individuals with higher socioeconomic status in childhood [11, 12], along with an association to longer formal education [13]. The relation between socioeconomic status and sensitization to food allergens has not previously been studied.

The aim of this study is to assess the relation between socioeconomic status and asthma, allergic diseases and sensitization in a birth cohort with prospective design.

Correspondence: Catarina Almqvist, Department of Occupational and Environmental Health, Karolinska Hospital, Norrbacka 3rd floor, S-171 76 Stockholm, Sweden.

E-mail: catarina.almqvist@kbh.ki.se

Methods

Study population and questionnaire data

From February 1994 until November 1996, 4089 newborn infants (2065 boys and 2024 girls) were included in a prospective study. Study design, enrolment, criteria for inclusion and the data collection procedure are described in detail elsewhere [14, 15]. Data on allergic heredity, details concerning family housing, parental smoking and socio-economic factors were requested in questionnaires filled out by the parents when the child was 2 months old (median age). When the children were 1 and 2 years old, similar questionnaires were mailed to all parents, with main focus on symptoms related to wheezing and other allergic diseases in young children, including information on breastfeeding and parental smoking. At 4 years, new questionnaires on symptoms were distributed to all parents. The response rates for the questionnaires at 1, 2 and 4 years of age were 96%, 94% and 91%, respectively.

Socioeconomic status was classified according to the Nordic standard occupational classification (NYK) and Swedish socio-economic classification (SEI) [16]. The children were categorized on the basis of their parents' occupation into unskilled and skilled blue-collar workers, low, intermediate and high-level white-collar workers, and others (students, unemployed). Heredity for allergic disease was defined as doctor-diagnosed asthma and/or hayfever in combination with allergy to furred pets or pollens in any (mother, father or both) or no parent. Questions on wheezing were slightly modified from ISAAC questionnaires [17]. Asthma at 4 years of age was defined as >3 episodes of wheezing over the last year, or >1 episode if the child had been given inhaled steroids. Recurrent, transient wheezing was defined as ≥ 3 episodes of wheezing between 3 months and 2 years of age, but no episode in the last 12 months at 4 years. Early-onset persistent wheezing was defined as ≥ 1 episode of wheezing between 3 months and 2 years of age and ≥ 1 episode in the last 12 months at 4 years, and late-onset wheezing was denoted in children with no episode of wheezing between 3 months and 2 years, combined with ≥ 1 episode in the last 12 months at 4 years. Rhinitis was defined according to the ISAAC criteria; sneezing, runny or blocked nose without common cold more than once in the last 12 months. Eczema denoted reports of dry skin and itchy rash on specific locations more than once in the last 12 months, or that the child had a doctor's diagnosis of eczema at 4 years.

Clinical examination and allergen-specific immunoglobulin E

At 4 years of age, the children were invited to a clinical examination for blood sampling. All sera were analysed with Phadiatop[®], containing a combination of the eight most common inhalant allergens (Pharmacia CAP SystemTM Uppsala, Sweden) and fx5, a combination of the six most common food allergens (Pharmacia CAP SystemTM). Sensitization to airborne allergens was defined as a positive Phadiatop (≥ 0.35 kU/L) and sensitization to food allergens as a positive fx5 (≥ 0.35 kU/L).

Statistical analyses

An exposure variable was created, consisting of socio-economic status categorized into four levels: blue-collar worker (reference category), low or intermediate white-collar worker, one parent high-level white-collar worker and both parents high-level white-collar workers. The group 'others', consisting of 38 individuals, was included in the reference category and did not affect the results. The relationship between the health outcomes asthma, rhinitis, eczema or sensitization by Phadiatop and fx5 and the exposure variable was analysed with multivariate logistic regression and the results are presented as adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs). Prevalence is given in percent. All logistic regression analyses were controlled for potential confounders such as heredity, smoking, breastfeeding, maternal age, damp housing and year of construction of the child's residence [18, 19]. We used logistic regression in trend analyses treating the exposure as a linear variable, and a *P*-value for the coefficient of less than or equal to 0.05 was considered statistically significant, *P*_{trend}. To investigate if there were different trends between the two categories of heredity, we included the interaction term between trend and heredity in the model. A *P*-value for the interaction coefficient of less than or equal to 0.05 was considered statistically significant, *P*_{interact}. Data on key variables such as exposure, outcome and potential confounders had to be complete for the individual to be included in the analyses, leaving 3586 individuals to the adjusted analyses on asthma, 3572 for rhinitis and 3604 for eczema. A total of 2614 children agreed to let blood samples be drawn at the examination, of which 2530 had complete data on the questionnaires and were included in the adjusted analyses on sensitization.

All analyses were performed with the statistical software program Stata 8.0.

Permission for the study was obtained from the Ethics Committee of Karolinska Institutet. Informed consent was obtained from the parents.

Results

In the whole cohort, 17.6% of the children had parents who were blue-collar workers, 44.1% were low or intermediate white-collar workers, 26.5% had one parent with a high-level white-collar occupation, and 11.8% had both parents in high-level white-collar occupations.

Table 1 illustrates some background factors in the different socioeconomic groups. With higher socioeconomic groups, a longer duration of breastfeeding, lower prevalence of maternal smoking, higher maternal age and more houses built before 1940 were seen. There was no clear trend in the proportion of available blood samples in different socioeconomic groups.

At 4 years, 7.0% of the children reported asthma, 11.0% fulfilled the criteria for rhinitis and 20.6% had eczema. There was a decreasing risk of asthma with increasing socioeconomic status, most prominent for children whose parents both had high-level white-collar occupations, *P*_{trend} 0.003, with a tendency towards stronger effect in children with heredity for allergic disease (Table 2). For rhinitis, there was

Table 1. Distribution of background factors among children 4 years of age in the BAMSE cohort*

	N	%	Blue-collar		White-collar low, intermediate		White-collar high		White-collar high, both	
			n	%	n	%	n	%	n	%
Gender										
Boy	1853	50.7	340	52.7	811	50.3	463	47.8	239	55.3
Girl	1805	49.3	305	47.3	802	49.7	505	52.2	193	44.7
Heredity†										
None	2542	70.0	455	71.6	1129	70.4	669	69.7	289	66.9
Any	1088	30.0	180	28.4	474	29.6	291	30.3	143	33.1
Breastfeeding exclusively										
< 4 months	738	20.2	172	26.7	314	19.5	177	18.3	75	17.4
> 4 months	2916	79.8	473	73.3	1299	80.5	788	81.7	356	82.6
Maternal smoking during pregnancy and after birth										
No	3163	86.5	488	75.8	1392	86.3	879	90.8	404	93.5
Yes	494	13.5	156	24.2	221	13.7	89	9.2	28	6.5
Damp housing										
No	3351	91.9	579	90.3	1460	90.7	903	93.5	409	94.9
Yes	296	8.1	62	9.7	149	9.3	63	6.5	22	5.1
Mother's age > 25										
No	270	7.5	132	20.5	113	7.0	22	2.3	3	0.7
Yes	3388	92.5	513	79.5	1500	93.0	946	97.7	429	99.3
House construction year										
–1939	1164	31.8	89	13.8	469	29.1	367	38.0	239	55.3
1940–	2491	68.2	555	86.2	1143	70.9	600	62.0	193	44.7
Blood sample available‡										
No	1120	30.1	204	33.4	454	27.7	286	29.3	141	36.2
Yes	2596	69.9	455	66.6	1184	72.3	691	70.7	301	63.8

The whole study group subdivided on the basis of socioeconomic status.

*The total number of individuals varies for each background variable, since some have not responded to some questions. †Heredity for allergic disease defined as doctor-diagnosed asthma and/or hayfever in combination with allergy to pets or pollens in any (mother or father) or no parent. ‡Test of trend for available blood samples: $P_{\text{trend}} = 0.71$.

also a decreasing risk of rhinitis with increasing socioeconomic status, which remained significant after adjustments for confounders, $P_{\text{trend}} 0.004$, and a nearly significant stronger effect among those with heredity, $P_{\text{interact}} 0.07$. There was no clear association between socioeconomic status and risk of eczema.

For early-onset persistent wheeze, there were decreasing risks with increasing socioeconomic status; this was most evident among children with both parents in high-level white-collar occupations, $P_{\text{trend}} 0.005$ and there was a suggestive stronger effect among those with heredity $P_{\text{interact}} 0.13$ (Table 3). No significant association was seen between socioeconomic status and early-onset transient or late-onset wheeze.

Among children with wheezing or asthma, there was a trend towards more acute visits to emergency departments with decreasing socioeconomic status, but there was no statistically significant difference in the frequency of doctor's diagnosis of asthma or prescription of steroids between the groups (Table 4).

Fifteen percent of the children were sensitized to airborne allergens (positive Phadiatop) at 4 years of age, and 16.0% of the children were sensitized to food allergens (positive fx5). No significant associations were found between positive Phadiatop and socioeconomic status (Table 5). However, for fx5, there were decreasing risks with increasing socioeconomic status, $P_{\text{trend}} 0.03$. There was no clear difference between groups of heredity.

Discussion

The main finding of this prospective birth cohort study is that there seems to be an inverse relation between socioeconomic status and risk of asthma, rhinitis and sensitization, especially to food allergens, in 4-year-old children. The results are surprisingly consistent even when adjusted for traditional risk factors, which indicates that there may be additional uncontrolled differences in life style between socioeconomic groups.

There was an increased risk of early-onset persistent wheeze with decreasing socioeconomic status, which was not seen among those with early-onset transient or late-onset wheeze. One can speculate that early wheezing is more easily recognized and prevented in higher socioeconomic groups. However, among children with wheezing > 3 times in the last year there was a trend towards more emergency visits with decreasing socioeconomic status, but no clear difference in the frequency of doctor's diagnosis of asthma or prescription of steroids between the socioeconomic groups. This may reflect that Sweden is a country where health care is fairly easily accessible and medication not very costly, as opposed to the US and Canada, although there may still very well be differences in environmental exposures and life style between the socioeconomic groups [7–9].

Our most intriguing result is the finding of increasing risk of sensitization with decreasing socioeconomic status. This was

Table 2. Asthma, rhinitis and eczema at 4 years of age, by socioeconomic status and stratified for heredity of allergic diseases

	Asthma, N = 250					Rhinitis, N = 395					Eczema, N = 741				
	N	n	OR	OR†	95% CI	N	n	OR	OR†	95% CI	N	n	OR	OR†	95% CI
Socioeconomic status															
Blue-collar*	623	64	1			617	97	1			628	141	1		
White-collar (low, intermediate)	1587	118	0.70	0.87	(0.62–1.22)	1591	170	0.65	0.69	(0.52–0.91)	1595	321	0.87	0.89	(0.71–1.12)
White-collar (high)	949	57	0.56	0.76	(0.51–1.14)	938	96	0.61	0.69	(0.50–0.95)	952	192	0.87	0.91	(0.70–1.18)
White-collar (both high)	427	11	0.23	0.33	(0.17–0.66)	426	32	0.43	0.50	(0.32–0.79)	429	87	0.88	0.91	(0.66–1.26)
No heredity‡															
Socioeconomic status															
Blue-collar*	445	37	1			440	53	1			449	81	1		
White-collar (low, intermediate)	1119	60	0.63	0.78	(0.50–1.21)	1119	96	0.68	0.74	(0.52–1.07)	1123	197	0.97	1.00	(0.74–1.33)
White-collar (high)	662	31	0.54	0.76	(0.45–1.26)	650	58	0.71	0.82	(0.54–1.23)	662	119	1.00	1.05	(0.76–1.33)
White-collar (both high)	284	7	0.28	0.42	(0.18–0.98)	285	20	0.54	0.66	(0.38–1.15)	286	46	0.86	0.93	(0.76–1.45)
Heredity‡															
Socioeconomic status															
Blue-collar*	178	27	1			177	44	1			179	60	1		
White-collar (low, intermediate)	468	58	0.79	1.00	(0.60–1.66)	472	74	0.56	0.61	(0.40–0.94)	472	124	0.70	0.73	(0.50–1.07)
White-collar (high)	287	26	0.55	0.78	(0.43–1.41)	288	38	0.47	0.52	(0.36–0.86)	290	73	0.66	0.70	(0.46–1.07)
White-collar (both high)	143	4	0.16	0.25	(0.08–0.74)	141	12	0.28	0.34	(0.17–0.68)	143	41	0.80	0.86	(0.52–1.40)

*Reference category. †Adjusted for maternal smoking, breastfeeding, dampness, mother's age and housing construction year. ‡Heredity for allergic disease defined as doctor-diagnosed asthma and/or hayfever in combination with allergy to pets or pollens in any (mother or father) or no parent. Test of trend for asthma in the whole group: $P_{\text{trend}} = 0.003$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.584$. Test of trend for rhinitis in the whole group: $P_{\text{trend}} = 0.004$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.071$. Test of trend for eczema in the whole group: $P_{\text{trend}} = 0.65$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.579$. OR, odds ratio; CI, confidence interval.

Table 3. Wheezing over time, at 4 years of age, by socioeconomic status and stratified for heredity of allergic diseases

	Early onset transient wheeze, N = 267					Late onset wheeze, N = 193				Early onset persistent wheeze, N = 320			
	N	n	OR	OR†	95% CI	n	OR	OR†	95% CI	n	OR	OR†	95% CI
Socioeconomic status													
Blue-collar*	610	39	1			27	1			84	1		
White-collar (low, intermediate)	1557	129	1.22	1.40	(0.96–2.06)	92	1.34	1.38	(0.88–2.17)	140	0.63	0.76	(0.56–1.04)
White-collar (high)	936	63	0.99	1.15	(0.74–1.78)	58	1.39	1.46	(0.89–2.39)	72	0.53	0.69	(0.48–0.98)
White-collar (both high)	427	36	1.20	1.43	(0.87–2.37)	16	0.79	0.86	(0.44–1.68)	24	0.37	0.50	(0.30–0.83)
No heredity‡													
Socioeconomic status													
Blue-collar*	433	25	1			19	1			48	1		
White-collar (low, intermediate)	1100	95	1.45	1.67	(1.05–2.67)	55	1.15	1.20	(0.69–2.07)	83	0.69	0.81	(0.55–1.20)
White-collar (high)	655	41	1.01	1.21	(0.71–2.05)	34	1.18	1.26	(0.69–2.28)	41	0.56	0.71	(0.45–1.21)
White-collar (both high)	285	20	1.18	1.41	(0.75–2.65)	11	0.84	0.95	(0.43–2.08)	18	0.55	0.74	(0.41–1.34)
Heredity‡													
Socioeconomic status													
Blue-collar*	177	14	1			8	1			36	1		
White-collar (low, intermediate)	457	34	0.88	0.94	(0.49–1.84)	37	1.67	1.78	(0.80–3.97)	57	0.57	0.68	(0.42–1.10)
White-collar (high)	281	22	0.92	1.04	(0.50–2.13)	24	1.82	1.92	(0.82–4.47)	31	0.50	0.65	(0.38–1.13)
White-collar (both high)	142	16	1.18	1.37	(0.63–3.00)	5	0.65	0.74	(0.23–2.38)	6	0.17	0.24	(0.10–0.60)

*Reference category. †Adjusted for heredity, maternal smoking, breastfeeding, dampness, mother's age and housing construction year. ‡Heredity for allergic disease defined as doctor-diagnosed asthma and/or hayfever in combination with allergy to pets or pollens in any (mother or father) or no parent. Test of trend for early onset transient wheeze: $P_{\text{trend}} = 0.49$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.56$. Test of trend for late onset wheeze: $P_{\text{trend}} = 0.94$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.81$. Test of trend for early onset persistent wheeze: $P_{\text{trend}} = 0.005$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.13$. OR, odds ratio; CI, confidence interval.

particularly evident for sensitization to food allergens, which has not previously been investigated in children. Strachan et al. [12] found higher prevalence of positive skin prick test to aeroallergens in adults with higher socioeconomic status in childhood, and similar results were seen in an Italian cohort of 7–11-year-old children [11]. The authors attributed these

findings to the smaller families found in the higher socioeconomic groups, and thus interpreted their data as consistent with the hygiene hypothesis. However, to find a reason for differences in sensitization to food allergens between socioeconomic groups, it may be also be appropriate to look at differences in the diet; either the mother's diet during

Table 4. Steroid prescription, doctor's diagnosis and emergency department visits, by socioeconomic status, among those with wheezing >3 times in the last year

	Steroid prescription					Doctor's diagnosis				Emergency visit				Any			
	<i>N</i>	<i>n</i>	OR	OR†	95% CI	<i>n</i>	OR	OR†	95% CI	<i>n</i>	OR	OR†	95% CI	<i>n</i>	OR	OR†	95% CI
Socioeconomic status																	
Blue-collar*	43	27	1			32	1			35	1			38	1		
White-collar (low, intermediate)	70	44	1.00	1.09	0.47–2.54	45	0.62	0.62	0.25–1.53	48	0.50	0.46	0.17–1.25	54	0.44	0.46	0.14–1.46
White-collar (high)	41	22	0.69	0.82	0.31–2.12	23	0.44	0.45	0.16–1.24	25	0.36	0.31	0.10–0.95	33	0.54	0.58	0.16–2.13
White-collar (both high)	9	5	0.74	0.97	0.20–4.64	5	0.43	0.42	0.08–2.07	5	0.28	0.25	0.05–1.33	6	0.26	0.26	0.04–1.61

*Reference category. †Adjusted for heredity, maternal smoking, breastfeeding, dampness, mother's age and housing construction year.

Test of trend for steroid prescription: $P_{\text{trend}} = 0.70$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.33$.

Test of trend for doctor's diagnosis: $P_{\text{trend}} = 0.12$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.06$.

Test of trend for emergency visit: $P_{\text{trend}} = 0.03$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.63$.

Test of trend for any of the above: $P_{\text{trend}} = 0.26$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.21$.

OR, odds ratio; CI, confidence interval.

Table 5. Sensitization at 4 years of age, by socioeconomic status and stratified for heredity of allergic diseases

	Sensitized to airborne allergens (Phadiatop®), N = 387					Sensitized to food allergens (fx5), N = 406			
	N	n	OR	OR†	95% CI	n	OR	OR†	95% CI
Socioeconomic status									
Blue-collar*	426	71	1			88	1		
White-collar (low, intermediate)	1154	179	0.91	0.95	(0.70–1.30)	186	0.72	0.78	(0.57–1.03)
White-collar (high)	674	98	0.85	0.89	(0.63–1.27)	97	0.63	0.70	(0.49–0.97)
White-collar (both high)	276	39	0.81	0.88	(0.56–1.38)	35	0.55	0.65	(0.41–1.02)
No heredity‡									
Socioeconomic status									
Blue-collar*	308	40	1			62	1		
White-collar (low, intermediate)	802	107	1.01	1.10	(0.74–1.64)	122	0.71	0.77	(0.54–1.09)
White-collar (high)	461	56	0.92	1.00	(0.64–1.56)	57	0.55	0.62	(0.41–0.92)
White-collar (both high)	180	19	0.77	0.88	(0.49–1.60)	22	0.54	0.65	(0.38–1.12)
Heredity‡									
Socioeconomic status									
Blue-collar*	118	31	1			26	1		
White-collar (low, intermediate)	352	72	0.72	0.76	(0.46–1.24)	64	0.78	0.83	(0.49–1.40)
White-collar (high)	213	42	0.68	0.74	(0.43–1.28)	40	0.81	0.90	(0.51–1.58)
White-collar (both high)	96	20	0.74	0.83	(0.43–1.61)	13	0.55	0.66	(0.31–1.40)

*Reference category. †Adjusted for heredity, maternal smoking, breastfeeding, dampness, mother's age and housing construction year. ‡Heredity for allergic disease defined as doctor-diagnosed asthma and/or hayfever in combination with allergy to pets or pollens in any (mother or father) or no parent.

Test of trend for sensitization to airborne allergens: $P_{\text{trend}} = 0.46$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.88$.

Test of trend for sensitization to food allergens: $P_{\text{trend}} = 0.03$, interaction between individuals with or without heredity $P_{\text{interact}} = 0.48$.

OR, odds ratio; CI, confidence interval.

pregnancy and lactation or the child's diet postnatally. ω -3 fatty acids (polyunsaturated fats) have been proposed to be beneficial to children with bronchial asthma [20] and may even reduce the prevalence of wheeze during the first 18 months of life [21]. It is possible that socioeconomic groups differ in their selection of which fatty acids are used in the diet, for spreads and cooking. Moreover, lung function levels have been found to be lower in children with inadequate dietary antioxidant vitamin intake [22], so it may be worthwhile to investigate whether there is a difference in dietary intake between socioeconomic groups. It is possible that a later follow-up will show a significant difference in sensitization to inhalant, rather than food, allergens between socioeconomic groups, as that would reflect the natural course of sensitization.

A direct causal chain between stress and wheeze in early childhood has been suggested to contribute significantly to

the population burden of preventable childhood respiratory illness, especially in areas of lower socioeconomic standard. It is conceivable that prolonged maternal stress leading to sustained excessive cortisol secretion could affect the developing immune system – especially T helper type 1/T helper type 2 cell differentiation – and further increase the susceptibility of predisposed individuals to asthma and atopy [23, 24]. Furthermore, parents or children in lower socioeconomic groups may perceive stress differently than other groups, and mechanisms for this must be further looked into.

Socioeconomic status can be measured in many different ways: parental occupation, household income, ethnicity, and type of dwelling [3, 5, 7, 9]. We do not have data on household income in this study, as it is information that many people are reluctant to provide and not necessarily a relevant estimation of socioeconomic standard. Neither have we enquired about the family's ethnicity, although all children

in our cohort were born in Sweden and we have reason to believe that their parents had at least lived in Sweden for some time, as sufficient knowledge of Swedish language was an inclusion criterion. Concerning type of dwelling, we do see a relation between socioeconomic status and house construction year or indoor dampness, but the main results were unchanged after adjustments. Likewise, although maternal smoking, short duration of breastfeeding and young mother, considered risk factors for asthma and rhinitis, were all more common in lower socioeconomic groups, adjustments did not change our main results. Nevertheless, we have reason to believe that there may be other sources of residual confounding that need to be identified. We assume that selection bias is not a major problem in the study, as follow-up rates are high in the cohort.

Level of formal education has also been used as a proxy for socioeconomic status in previous studies [3, 11, 13, 14], although this may place individuals somewhere between their original and their present socioeconomic group. We noted a particularly low prevalence of asthma, rhinitis and sensitization to food allergens in the high-level white-collar worker group (the majority of whom held an academic degree), and one can speculate whether they are more prone to a life style that prevents development of allergic disease. This possibility is further reinforced by even lower prevalence of asthma, rhinitis and sensitization in the group of children with two parents in the high-level white-collar category.

Importantly, the effects of socioeconomic status on asthma, rhinitis and early-onset persistent wheezing seemed to be stronger in our group of children with heredity for allergic diseases, irrespective of maternal or paternal heredity. This may be interpreted as a possibility to prevent asthma and rhinitis especially among children with heredity for allergic disease, by changing certain life style factors associated with socioeconomic status.

In conclusion, our data from a population-based birth cohort suggest that there is an inverse relation between socioeconomic status and asthma, rhinitis and sensitization to food allergens among 4-year-old children. These findings are novel and should prompt a search for preventable environmental risk factors or differences in life style over socioeconomic groups, which may be added to primary preventive strategies to reduce the burden of asthma and allergic diseases in childhood.

Acknowledgements

The authors are greatly indebted to the children and parents of the BAMSE cohort. We also gratefully acknowledge Prof. Marianne van Hage, Department of Medicine, Unit of Clinical Immunology and Allergy, Karolinska Institutet and Hospital for providing analyses of the blood samples, and Niklas Berglind at the Department of Occupational and Environmental Health for statistical support.

The study was supported by the Heart-Lung Foundation, the Konsul ThC Bergh Foundation, the Stockholm County Council, the Swedish Asthma and Allergy Association, and the Swedish Foundation for Health Care Sciences and Allergy Research.

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