

Environmental risk factors for allergy and socioeconomic status in a birth cohort (BAMSE)

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Associations between parental educational level and possible risk factors for atopic disease during the first months of life were explored in a cohort of 4089 neonate children born 1994–96 in Stockholm, Sweden. Reports concerning a number of lifestyle factors during pregnancy and after the baby was born were obtained by questionnaire. There was a strong negative association between duration of education and maternal smoking during pregnancy, parental smoking after the baby was born and keeping of cat and dog (p -trend < 0.001), respectively. For example, smoking during pregnancy was reported by 6.7% (95% CI 5.5–7.9) of mothers with college or university degree and by 22.2% (95% CI 20.1–24.5) of those with the shortest education. Indicators of dampness and poor ventilation were also more common in homes of those with the shortest education. The results show that the educational level has an influence on risk factors for development of atopic disease in childhood and indicates a need of deeper understanding of life style in different socioeconomic groups. The data also indicate that various possible confounding factors need to be thoroughly investigated when analysing studies of risk factors for allergic disease in childhood.

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Exposure to various environmental and life style factors during the first few years of life is thought to be crucial for the development of atopy and atopic disease (1,2). Research has focused on such exposures as explanations to the increase of atopic diseases in the Western world during the past few decades (3–5). Some of these factors may be related to social class, such as tobacco smoking (6,7). Environmental tobacco smoke (ETS) is of importance for wheezy bronchitis (8,9) and is a well-known trigger of asthma in children (10). As regards allergen exposure, there is a clear relationship between exposure and sensitization to house dust mites (11). The risk to become sensitized to furred pets among wheezing children in Stockholm, also seems to increase with the degree of exposure and allergy to fur-coated pets; cats in particular, are of the greatest importance for childhood asthma in Scandinavia (12).

Low socioeconomic status (SES) as indicated by low income, short education or other measures is known to be associated with poor health (13,14). Several studies have focused on the possible association between childhood asthma and low SES (15,16). For example, decreased lung function has been associated with low SES among schoolboys (17). One feature of low SES may be an increased prevalence of severe asthma (18,19). Hay fever on the other hand, has been linked to high SES (20). In order to succeed with a prevention program, knowledge of the relationships between SES and risk factors for asthma and allergy is likely to be important.

The present study is based on a prospective birth cohort study aimed at elucidating the importance of various risk factors for asthma in early infancy. This part presents baseline data in the cohort, and investigates potential risk factors in relation to parental educational level and also

the possible interrelationships between possible risk factors.

Patients and methods

Study subjects

The cohort comprised 4089 infants born from February 11, 1994 until November 22, 1996. The catchment area included central and north-western parts of Stockholm, i.e. the municipalities Järfälla, Solna and Sundbyberg and two inner-city districts, Vasastan and Norrmalm. Thus both urban and suburban districts were represented, including areas with different kinds of buildings (such as apartment blocks and one family houses) and differences in socioeconomy. Access to a community population register ensured that the parents of all infants born in the area during the period under study could be approached.

The families were enrolled at the first visit to the Child Health Centres (CHCs) where they received information about the study from the attending nurse. A total of 99.8% of the eligible families in the catchment area attended a CHC during the first year after the baby was born. Families planning to move within a year, those without sufficient knowledge in Swedish, and families whose infant suffered from a severe disabling disease were not included. The CHC nurses registered all attending families including those excluded according to the criteria above, as well as all refusals. One hundred and sixty-seven infants were not listed at a CHC in the recruitment area and their parents were contacted directly by the study co-ordinating office and received information and questionnaires by mail.

The parents of the included families answered a questionnaire, which was handed out by the CHC nurse or sent from the co-ordinating office. The questionnaire aimed to cover various environmental factors encountered by the newborn. Parents were reminded up to four times.

In the study area 7221 infants were born during the recruitment period. Four hundred and seventy-seven families could never be reached because the correct address was unknown. The actively excluded group included 699 families who planned to move within 1 year, 57 families with a seriously ill child and 331 with insufficient knowledge of Swedish. Another 169 children, who had an older sibling already enrolled in the study, were also excluded. In total 1256 infants were excluded according to these criteria.

Thirteen hundred and ninety-nine never answered the questionnaire or declined participation. Consequently, the final study cohort was

made up of the 4089 children (2065 boys and 2024 girls), which constitutes 75% of the 5488 eligible children born during the recruitment period in the study area.

Questionnaire

The median age of the children when the parents answered the questionnaires was 2 months. At 6 months of age, 96% of the parents of the children in the cohort had returned the questionnaires. A first part of the questionnaire contained questions on housing characteristics, such as type of heating system, ventilation and questions about the child's bedroom, etc. Questions were asked about occurrence of wall-to-wall carpets in the home and about home dampness. Thus, presence of windowpane condensation of at least 2 cm during wintertime, i.e. November to March in the bedroom, signs of damage due to damp and smell of mildew were asked for. A second part of the questionnaire dealt with various indoor environmental exposures in the child's home. Data were obtained about maternal smoking during pregnancy and parental smoking habits after the birth of the child. Direct and indirect contacts with various animal pets were also reported in detail. A third part of the questionnaire covered the health both of parents and siblings with a focus on atopic diseases, i.e. asthma, eczema and allergic rhino-conjunctivitis. These questions have been used in earlier studies (21–23). The socioeconomic status of the parents was graded by questions about educational level, profession and type of work.

The cohort was divided into three SES strata according to reported highest education by the parents. Level I comprised families with one or both parents holding a college or university degree. Level II included those in which one or both parents had up to 3 years of upper secondary education (qualifying for college and university studies) and level III comprised the rest, most of which had passed compulsory school (equivalent to primary and lower secondary education) or 2 years of upper secondary education. The socioeconomic status of the mothers and the fathers was subdivided according to the same principles into three categories.

All questionnaires were scrutinized before registration of the data and about 10% of the parents were contacted by phone for clarification.

Statistical analyses

The statistical analyses were performed with the Stata Statistical Software: release 6.0. For all proportions we have calculated exact binomial

Table 1. Smoking during pregnancy and educational level* of the mother in a cohort of children born 1994–96 in Stockholm, Sweden

	Educational level I (n=1670)		Educational level II (n=1006)		Educational level III (n=1385)		p-trend
	%	95% CI	%	95% CI	%	95% CI	
Smoking during pregnancy†	6.6	5.5–7.9	11.0	8.9–13	22	20–24	<0.001
Smoking‡ during all three trimesters	4.1	3.2–5.1	5.0	3.7–6.5	16	14–18	<0.001
Smoking‡ during the first trimester	6.2	5.1–7.4	9.5	7.8–12	21	19–23	<0.001
Smoking‡ during the second trimester	5.4	4.4–6.6	7.1	5.6–8.8	19	17–21	<0.001
Smoking‡ during the third trimester	4.5	3.5–5.6	7.2	5.6–8.9	17	15–20	<0.001

*Level I comprised mothers holding a college or university degree, level II were those with 3 years of upper secondary education and level III comprised the rest, most of which had passed compulsory school (equivalent to primary and lower secondary education) or 2 years of upper secondary education.

†Smoking of ≥ 1 cigarette a day during one, two or three trimester.

‡Smoking of ≥ 1 cigarette a day.

confidence intervals. The Mantel extension test (24) was used to test for trend of proportions across categories of parental education, stratifying by maternal age. The rank sum test developed by Cuzic was used to test for trend across ordered groups.

This study was approved by the ethical committee of the Karolinska Institute, Stockholm, Sweden.

Results

There was no consistent association between the occurrence of parental atopic disease defined as doctor diagnosed asthma, asthma medication and/or doctor-diagnosed rhinitis combined with diagnosed allergy to furred pets or pollen on the one hand and the educational level of either parent on the other. One or both parents of 30% of the infants fulfilled the criteria of atopic disease, both in 3.1%.

Among the mothers, 13% reported smoking at any time during pregnancy and 8.2% smoked at least one cigarette a day all through the period (Table 1). There was a strong association between the mothers' educational level and smoking during pregnancy. Thus, the highest rate of maternal smoking during pregnancy, 22%, was associated with short maternal education. During the first, second and third trimester, 12%, 10% and 9.4% of the mothers smoked at least one cigarette a day.

Smoking was frequently given up during pregnancy, thus 28% of the mothers who smoked in the beginning of the pregnancy ceased to smoke during the second or third trimester. This was particularly evident for those of educational levels I and II but not to the same extent for level III (p-trend=0.001). Likewise, 41% of the mothers reported giving up smoking when the baby was born. This was also associated with long maternal education (p-trend=0.001).

The differences between the smoking habits of the parents of the three educational levels persisted after birth of the infant. Overall, maternal smoking of at least one cigarette a day after giving birth was reported by 8.5% and paternal smoking among 17% (Table 2). Twenty-one percent of all infants were exposed to ETS, in that any or both parents (4.0%) smoked. However, bi-parental smoking was reported by only 1.9% of those in the highest parental educational level, compared with 4.8% and 8.6% in the intermediate and low educational levels, respectively. Thus, a college/university degree of a parent was reflected in almost a fivefold lower maternal smoking rate as compared with that of those with the shortest education.

In the cohort, 19% of the families kept a pet of some kind (cat, dog, rodent or bird) (Table 3). The most common pets were cats and dogs and the keeping of these pets was associated with low educational level of the parents.

Crowding was associated with educational level of the parents but the differences between the groups were small. The living area was in average 26.9 m², 25.5 m² and 23.8 m² per person in level I, II and III, respectively (p-trend<0.001). Reported 'signs of dampness' and smell of mould were both associated with low educational level (Table 4). Reported condensation on the window glass in the bedroom was likewise associated with low level of education. Living in a single-family house was most common in the intermediate group. In homes with one or two smoking parent(s), reported signs of humidity such as smell of mould and 'signs of dampness' were more frequently reported than in homes where no parent smoked (12% and 8.4%, 29% and 22%, respectively). The keeping of cats and dogs was more common among smokers, e.g. the dog keepers were twice as common in smoking as compared with non-smoking families (8.9 and 4.4%).

Table 2. Parental smoking after the child's birth and educational level* of the parents in a cohort of children born 1994–96 in Stockholm, Sweden

	Educational level I				Educational level II				Educational level III				p-trend
	n	Total	%	95% CI	n	Total	%	95% CI	n	Total	%	95% CI	
Smoking† mothers	92	2160	4.3	3.4–5.2	99	1093	9.1	7.4–11	156	827	19	16–22	<0.001
Smoking† fathers	276	2152	13	11–14	204	1087	19	17–21	187	811	23	20–26	<0.001
Smoking† mother and/or father	328	2152	15	14–17	251	1088	23	21–26	273	820	33	30–37	<0.001
Smoking† mother and father	40	2159	1.9	1.3–2.5	52	1092	4.8	3.6–6.2	70	818	8.6	6.7–11	<0.001

*Refer to Table 1.

†Smoking of ≥ 1 cigarette a day.

To allow for an analysis of possible changes of reported risk factors, during the recruitment period, the cohort was divided into three parts based on infants born during 1994, 1995 and 1996, respectively. Maternal smoking during pregnancy decreased significantly from 14%, 13% to 11% (p-trend=0.015) during the 3 years and maternal smoking during the infants first 6 months of life decreased from 10%, 8% to 6.9% (p-trend=0.002). Paternal smoking and the keeping of cats and dogs were unchanged during the period.

During the 3-year recruitment period smoking among mothers with a college/university degree (p-trend=0.003) decreased. There was also a stronger tendency to give up smoking during pregnancy in that group (p-trend=0.005). Fathers representing level III, on the other hand, reported an increase in the rate of smoking from 21%, 20% to 31% during the same period (p-trend=0.014).

Discussion

In the present study, a strong relationship was found between smoking and parental educational level, i.e. those with a long education did not smoke as much as those with a short education. This observation is consistent with other studies (7). It indicates that the effects of the health information program in Sweden, however extensive, do not influence all strata in our society to the same extent. For example, the extensive information about the health effects of smoking during pregnancy provided by personnel of prenatal clinics, as well as that given by the

nurses of the child health centres, is obviously not received as well by parents with low as with a high degree of education. Further, the generally decreasing trend of tobacco smoking was not as obvious with a short parental education, particularly among fathers with short education, where smoking in fact had increased during the recruitment period. It is well known that combating against tobacco smoking must be perpetuated (25). To further increase the effects it appears that a more tailored attempt focused on groups of parents with short education might be more efficient than the present strategies.

Maternal daily smoking during pregnancy is a risk factor for recurrent or persistent bronchial obstruction in childhood (26) and ETS is associated with persistent wheezing and specific allergen sensitization (27,28). Indoor keeping of furred pets is common in Sweden and infants exposed to furred pets in early life exhibit an increased risk of sensitization (12,29), which may be associated with an enhanced risk for asthma later in life (30). Home dampness increases the risk of asthma symptoms in small children (31,32) and is also associated with increased risk of infestation with house dust mites and an increased risk of sensitization to mite as well as animal pets. In our study both the keeping of indoor pets and home dampness as indicated by windowpane condensation, 'signs of dampness' and mouldy smell were related to short parental education. Further, there were interrelationships between risk factors, in that parents who smoked, kept a dog or a cat and reported home dampness more frequently. Thus, a complex pattern was

Table 3. Keeping of pets and socioeconomic (educational level* of the parents) in a cohort of children born 1994–96 in Stockholm, Sweden

	Educational level I (n=2161)		Educational level II (n=1094)		Educational level III (n=827)		p-trend
	%	95% CI	%	95% CI	%	95% CI	
Keeping of pets†	14	13.0–16.0	21	19.0–24.0	27	24.0–30.0	<0.001
Keeping of a cat	7.7	6.6–8.9	12	9.9–14	13	11.0–16.0	<0.001
Keeping of a dog	3.2	2.5–4.0	6.3	4.9–7.9	10	8.1–12	<0.001

*Refer to Table 1.

†Cat, dog, rodent or bird

Table 4. Housing and living conditions in relation to socioeconomic status assessed by educational* level of the parents in a cohort of children born 1994–96 in Stockholm, Sweden

	Educational level I				Educational level II				Educational level III				p-trend
	n	Total	%	95% CI	n	Total	%	95% CI	n	Total	%	95% CI	
Single-family house	330	2161	15	13.0–16	211	1094	19	17.0–21	148	827	18	15.0–21	<0.001
Living space <80 m ²	853	2161	40	37.0–41	487	1094	44	41.0–47	375	827	45	43.0–49	0.794
Wall-to-wall carpet in nursery	96	2161	4.4	3.6–5.4	72	1094	6.6	5.2–8.2	37	827	4.5	3.2–6.1	0.393
Condensation on bedroom window	359	2109	17	15.0–18	203	1068	19	16.0–21	172	805	21	19.0–24	0.007
Signs of dampness	363	1852	19	17.0–22	243	923	26	24.0–29	205	671	31	27.0–34	<0.001
Mouldy smell	164	1921	8.5	7.3–9.9	70	918	7.6	6.0–9.5	89	692	13	11.0–16	0.004

*Refer to Table 1.

demonstrated where low educational level apparently is related to a multitude of known or suspected risk factors for asthma and allergy. These interrelationships indicate that evaluations of the effect on health by single risk factors in epidemiological studies must be interpreted cautiously as there are ample possibilities both for effect modification of various kinds and confounding. The strong relationship between educational level and various risk factors suggests that other life style factors than those under study in a particular study may also play a role.

The studied cohort comprises children born in the catchment area during the recruitment period, after exclusion of families according to certain criteria. Of the eligible families, 75% joined the study. Thus, the results in this report reflect the socioeconomic differences in risk factors for allergy in the BAMSE cohort, which must be taken into consideration when generalizing the findings to the whole population. In fact, the prevalence in the cohort of reported maternal smoking in early pregnancy was lower than that in the population according to official statistics (12% and 17%, respectively) (33). This was also true for maternal smoking during the first 6 months after the baby was born, which during 1996 was 12% as compared with 6.9% reported in the cohort. The smoking prevalence of the fathers in the cohort was the same as that of the whole population (17%). Another observation is that exposure to tobacco smoke in early life is more prevalent in other European countries than in Sweden. For example, in the ETAC study the reported figures from Belgium/Luxembourg and France were found to be almost 50% compared with 30% in Sweden (34).

The potential for selection bias has to be considered in the interpretation of the findings. For example, the well educated are more aware of the different risk factors and may, to a higher extent, participate in a study like ours than those with a shorter education (35). For similar reasons smokers may abstain from participation. The

actively excluded group of families who planned to move within a year may more often comprise families from lower socio-economic groups where smoking is more common and this may also be true for the excluded families with language skills considered insufficient for participation. Another reason for selection bias is that parents with atopic diseases may be more likely to participate. However, the demonstrated relationship between parental educational level and reported risk factors, e.g. tobacco smoking and the keeping of fur-coated animals, appears too strong to be explained by bias.

Several recent studies have shown that the impact of socioeconomic inequalities per se on mortality and disease is substantial (36,37). Consequently the confounding effect of SES should be considered in the analyses of the potential association between risk factors and disease.

In a complex way living conditions and social factors seem to influence different risk factors and have to be considered as potential confounders or mediators of effect when analysing the significance of these risk factors in the development of atopic disease in childhood.

In this first report from a birth cohort we describe different occurrence of risk factors for asthma and allergy related to parental educational levels, parental smoking in particular.

The results indicate a need of a deeper understanding of what is determining life style in different socioeconomic groups in order to identify strategies in primary prevention, which successfully reach and influence particularly parents with short education.

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