

Age at adoption, ethnicity and atopic disorder: A study of internationally adopted young men in Sweden

Hjern A, Rasmussen F, Hedlin G. Age at adoption, ethnicity and atopic disorder: A study of internationally adopted young men in Sweden. *Pediatr Allergy Immunol* 1999; 10: 101–106. © Munksgaard, 1999

Epidemiological and laboratory studies have implied that the environment during early childhood is important for the risk of developing atopic disorders. In this study we analyzed the prevalence of asthma, hayfever and eczema among 1901 internationally adopted young men at the military-induction medical examination in relation to indicators of their early childhood environment. The adopted young men who came to Sweden before 2 years of age suffered from asthma, hayfever and eczema significantly more often than those who came to Sweden between 2 and 6 years of age; the risk ratios (RR) were 1.6, 2.5 and 2.1, respectively. The young men who were born in the Far East were identified as being particularly susceptible to the development of hayfever and eczema, with RRs of 1.3 and 1.7. This study demonstrates that the environment during the first 6 years of life has a profound influence on the risk of suffering from atopic disorders as young adults.

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Key words: allergy; asthma; ethnicity; migration; adoption

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Accepted 12 March 1999

Atopic disorders are the fastest increasing public health concerns among children and youth in Scandinavia (1,2). The international study of Asthma and Allergies in Childhood (ISAAC) has demonstrated large differences in the prevalence of atopic disorders in children in different regions in the world (3,4). Populations with a higher standard of living and a more Westernized lifestyle generally have higher rates of atopy and asthma (5,6), but there are also intriguing differences between different populations in the West. The prevalence of asthma among school children in Sweden, for example, is only 30–40% of the prevalence in the UK, Australia and New Zealand (3,7).

The importance of the environment during early childhood in the development of atopic disorder has been suggested in a number of studies. Season of birth and early feeding with foreign protein as well as exposure to certain infections during infancy have been linked to the development of atopic disorder later on (8,9).

Experimental studies of the development of the immune system in rodents have given rise to a model for atopic sensitization, the Th1/Th2 model, where the IgE-mediated immune response to exposure to a persistent allergen is determined by the functional activity that becomes established in relevant T-memory populations during early childhood (10–12).

In the 1960s, adoption of children from developing countries became a common practice of Swedish parents. From 1960 to 1992, 32 000 foreign-born children were adopted in Sweden; 66% of the children were born in Asia, 29% in Latin America and the remaining 5% in Africa and Eastern Europe (13).

The age on arrival in Sweden differed greatly among the adopted children, but the majority of the children came to Sweden before their second birthday. In this study, we use this natural experiment, where a diverse population of small children was moved from an underprivileged third-world environment to Sweden, to study the

influence of the early childhood environment on the risk of suffering from atopic disorders as young adults.

Methods

Adopted individuals

All males born between 1973 and 1977 were identified at 17 years of age – using their unique personal ID number – in Statistics Sweden's Registers of the Total Population (RTPs) from 1990 to 1994. All individuals recorded as living in Sweden are included in these registers.

From the total population of 275 026 young men born in 1973–1977, a study sample was created of the 2156 who were identified as internationally adopted before 7 years of age. The study sample fulfilled the criteria of having a place of birth in Latin America, the Indian Subcontinent or the Far East, having a register record with a year of immigration as well as having two parents who, according to the register, were born and had always lived in Sweden. The age criterion was included to ascertain that the young men in the study had spent at least two-thirds of their lifetime in Sweden, and excluded only 3% of all the identified adopted young men in the register. A total of 1901 (88.2%) of the sample of 2156 adopted young men participated in the military service induction examination as indicated by the presence of data on height in their record in the Military Service Conscription Register (MSCR). These 1901 individuals comprise the study population. Table 1 presents the nations and subcontinents of birth of the study population.

Registers with socio-demographic data

Statistics Sweden maintains a register with records of the unique personal ID numbers of individuals registered as mothers and fathers of nearly all individuals born after 1941 and living in Sweden after 1991. The Swedish parents of the adopted study subjects were identified by record linkage to this register, after approval for the study had been obtained by the Ethics Committee at Karolinska Institutet. By record linkage, information on the following variables was then collected about both the young men and their mothers and fathers: educational level, country of birth, place of residence at 17 years of age (county, municipality, parish). For young men born in 1973, this socio-demographic information was extracted from RTPs and Statistics Sweden's Population and Housing Census from 1990, and for those born 1974–1977 from RTPs

and the Education Register from 1991 to 1994. Age on arrival was calculated from records of year of birth and year of immigration in the RTP.

Military Service Conscription Register

Information from the nationwide MSCR from 1991 to 1995 was employed. The Swedish military service conscription examination is compulsory by law for Swedish citizens, and anyone not participating is required to present a medical certificate. Otherwise he will be confined to prison. A chronic disease such as severe asthma may preclude an individual from participating in the military induction examination. In such cases, which are uncommon, a judgement written by a physician is required. Up to six ICD diagnoses may be included in the register. By means of the unique personal ID numbers, record linkages were effected between the MSCR and the registers containing socio-demographic information described above. Medical information was searched for in the MSCR for the calendar year when the young men reached 18 years of age and for the two following calendar years.

Medical induction examination

Military conscription in Sweden is usually at the age of 18. Examination of the conscripts consists of a health questionnaire, a personal interview by a medical doctor and a comprehensive physical and psychological examination. The examination also includes an exercise test, which yields data on working capacity only. The health questionnaire is sent to the conscripts prior to the examination. It includes specific questions regarding itchy or watery eyes, congested nose/hayfever, wheezing, asthma and eczema. Diagnosis registration is made on a practical clinical basis by the examining doctor, with emphasis on conditions that may affect the conscript's performance in military service.

In this study, the presence of an ICD-9 diagnosis of asthma (493), hayfever (477) and/or eczema (691) in the register were used as outcome variables.

Statistical analyses

The study had a cross-sectional design, and risk ratios were calculated in a stratified analysis using the Mantel-Haenzel method (14). The test-based method was used to calculate 95% confidence intervals. In these analyses, some important risk factors in earlier studies of atopic disorder in the MSCR were added to the variables related to the main focus of this study (2). The variables were

Table 1. Nation and subcontinent of birth of the 1901 internationally adopted young men in the study

Subcontinent	Nation	n	%
Latin America	Chile	262	31.3
	Colo	146	
	Ecuador	87	
	Peru	30	
	Bolivia	19	
	Salvador	11	
	Guatemala	10	
	Brazil	10	
	Costa Rica	7	
	Honduras	7	
	Mexico	5	
	Paraguay	1	
Indian subcontinent		489	25.7
	India	297	
	Sri Lanka	158	
	Bangladesh	17	
	Nepal	10	
	Pakistan	7	
Far East		817	43.0
	South Korea	401	
	Thailand	307	
	Indonesia	76	
	Philippines	18	
	Vietnam	14	
	Kampuchea	1	
Total		1901	100.0

categorized as dichotomous variables: adopted from the Far East (yes/no), age above 2 years on arrival to Sweden (yes/no), living in any of the three largest cities in Sweden (Stockholm, Gothenburg and Malmö) (yes/no), educational level of the adoptive mother: 12 years or more (yes/no), living in the northern part of Sweden (yes/no). Statistical analyses were carried out using the SAS 6.12 for Windows software package.

Results

The adopted young men who were born in the Far East had a higher prevalence of hay fever (31.8%; 28.8–34.8) and eczema (5.0%; 3.4–6.6) than those born in the Indian subcontinent (23.5%; 19.7–27.3/2.9%; 1.3–4.5) and Latin America (22.5%; 19.1–25.9/3.2%; 1.8–4.6),

whereas the prevalence of asthma did not differ between the different subcontinents of birth (Table 2).

Asthma was reported in the register just as often among the adopted young men who did not come to military conscription as in the study group (6.9%). Hayfever was present in 4.2% and eczema in 3.6% of those who did not enter military conscription.

As seen in Fig. 1, the prevalence of all three atopic disorders was higher among the boys who came to Sweden before 2 years of age when compared with those who came between 2 and 6 years of age: hayfever 31.0% (28.3–33.5) versus 19.0% (16.0–22.0), asthma 9.0% (7.4–10.6) versus 3.6% (2.1–5.1), and eczema 4.9% (3.7–6.0) versus 2.1% (1.0–3.2).

The mean age on arrival was higher in children adopted from Latin America, and they also more often tended to be raised in Swedish families in the big cities of Stockholm, Malmö and Gothenburg as well as to have mothers with a higher socio-economic status according to educational level (Table 3). This necessitates a stratified analysis of the risk attributed to age on arrival and subcontinent of birth. Table 4 shows three stratified analyses with hayfever, asthma and eczema as outcome variables. Being adopted before 2 years of age is the main explanatory variable in all three models, with risk ratios (RR) of 1.6 (1.4–1.9), 2.5 (1.7–3.8) and 2.1 (1.2–3.7), respectively. Being born in the Far East significantly increases the risk of suffering from hayfever (RR 1.3; 1.1–1.5) and eczema (RR 1.6; 1.01–2.4) whereas no significant association with subcontinent is present for asthma.

Discussion

Indicators of the environment during the first 6 years of life were strongly related to the risk of suffering from an atopic disorder at 18 years of age in the study population of internationally adopted young men. The adopted children who came to Sweden before their second birthday had a substantially higher risk of developing an atopic disorder. Since we lack specific information about the environment of the children in the country of

Table 2. Unadjusted prevalences of atopic disorders of 1901 internationally adopted young men by subcontinent of birth: percentage, and 95% confidence intervals (in parentheses)

Subcontinent of birth	Asthma	Hayfever	Eczema
Latin America (n = 595)	7.2 (5.2–9.3)	22.5 (19.1–25.9)	3.2 (1.8–4.6)
Indian subcontinent (n = 489)	7.2 (5.1–9.4)	23.5 (19.7–27.3)	2.9 (1.3–4.5)
Far East (n = 817)	7.0 (5.1–8.9)	31.8 (28.8–34.8)	5.0 (3.4–6.6)
Total (n = 1901)	7.1 (5.9–8.3)	26.8 (24.8–28.8)	3.9 (3.0–4.8)

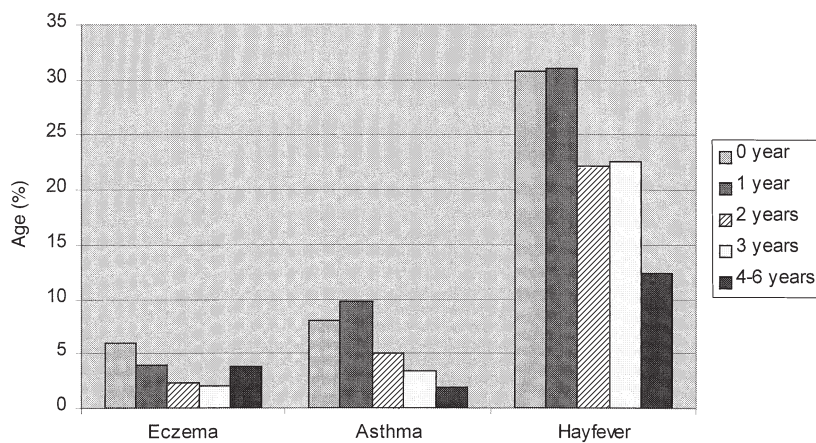


Fig. 1. The prevalence of asthma, hayfever and eczema in percentage by age on arrival in Sweden among 1901 internationally adopted young men.

birth we can only speculate about the environmental risk/protective factors that explain this higher risk. It could either be attributed to exposure to risk factors in the 'Western' environment in Sweden, such as being exposed to relevant allergens at a sensitive period in the development of the immune system (15) and/or to a lack of exposure to protective factors in the country of origin. The adopted children came from underprivileged environments in the country of birth. Very often the children had lived in orphanages before adoption (16). A study of adopted girls from India showed that as many as 81% had a birth weight below 2500 g and that 54% were stunted with regard to height for age on arrival in Sweden, giving evidence to the harsh living conditions of these children before adoption (17,18). A comparison of the bacterial colonization of the intestine after birth in Swedish and Pakistani children revealed that the Pakistani children were colonized with *Escherichia coli* within 3 days while Swedish children had not been colonized within their first week of life (19). A 'Western composition' of the microflora of infants has been suggested to be an important risk factor for the development of atopic disorders (20). It seems probable, however, that other factors, beyond the neonatal period, explain the main results of the present study, since it can be expected that almost all of the children were born in an environment where the

hygienic conditions lead to rapid colonization. In the study mentioned above, 45% of the adopted girls from India were found to be suffering from a parasite or pathogenic bacteria in their intestine (17,18). Exposure to intestinal parasites has been linked to a lower level of allergic reactivity in childhood (21). It seems probable that the adopted children who remained in the country of birth to an older age were exposed to a higher number of different infections; such as intestinal parasites and hepatitis A (22), which might lower the risk of atopy in children, than those who were adopted in infancy.

The results of the present study are consistent with the 'Th1/Th2 hypothesis' that the environment during early childhood has a profound influence on development of the immune response to potential allergens (23,24). The present study therefore gives indirect support to emerging theories proposing that the early childhood environment is an important focus for efforts regarding primary prevention of atopic disorders (6,9).

In the present study, the young men who were born in the Far East had a higher risk of suffering from hayfever and eczema than the other two groups. This increased risk might well be explained by environmental factors in the home country such as those mentioned above. It is noteworthy, however, that populations with roots in the Far East included in several previous

Table 3. Socio-demographic characteristics of the 1901 internationally adopted young men by subcontinent of birth: percentage, and 95% confidence intervals (in parentheses)

Subcontinent	Lives in big city	Educational level of mother*	Living in northern Sweden	Mean age at adoption	Mean height at conscription
Latin America (n = 595)	27.9 (24.3–31.5)	54.2 (50.1–58.3)	6.1 (4.1–8.1)	1.8 (1.6–1.9)	169.8 (169.3–170.3)
Indian subcontinent (n = 489)	19.8 (16.6–23.0)	51.6 (47.1–56.1)	6.5 (4.3–8.7)	1.5 (1.4–1.7)	168.5 (167.9–169.1)
Far East (n = 817)	21.5 (18.6–24.4)	46.6 (43.1–50.1)	6.9 (5.2–8.6)	1.4 (1.3–1.5)	169.8 (169.4–170.2)
Total (n = 1901)	23.1 (21.2–25.0)	26.8 (24.8–28.8)	6.5 (5.4–7.6)	1.5 (1.4–1.6)	169.5 (169.2–169.8)

*At least 12 years. Mean age is given in years; mean height in cm.

Table 4. Stratified analyses of risk ratios (RR; 95% CI) for risk factors of atopic disorders at military conscription of the 1901 internationally adopted young men

Socio-demographic risk factors	n	Unadjusted RR	Adjusted RR
<i>Asthma</i>			
Adopted < 2 years of age	1237	2.04 (1.41–2.95)	2.51 (1.66–3.80)
Born in the Far East	837	0.99 (0.85–1.15)	0.90 (0.65–1.25)
Lives in big city	439	1.00 (0.91–1.09)	1.05 (0.70–1.56)
Mother well educated	954	0.90 (0.76–1.04)	0.77 (0.55–1.07)
Living in northern Sweden	124	1.02 (0.97–1.07)	1.26 (0.70–2.30)
<i>Hayfever</i>			
Adopted < 2 years of age	1237	1.56 (1.32–1.84)	1.62 (1.36–1.92)
Born in the Far East	837	1.23 (1.11–1.35)	1.30 (1.12–1.51)
Lives in big city	439	1.00 (0.94–1.06)	1.04 (0.86–1.24)
Mother well educated	954	0.90 (0.82–1.00)	0.86 (0.74–1.00)
Living in northern Sweden	124	0.99 (0.97–1.02)	0.92 (0.68–1.27)
<i>Eczema</i>			
Adopted < 2 years of age	1237	1.88 (1.17–3.02)	2.15 (1.23–3.73)
Born in the Far East	837	1.29 (1.00–1.67)	1.58 (1.01–2.45)
Lives in big city	439	1.17 (0.99–1.38)	1.69 (1.05–2.73)
Mother well educated	954	1.19 (0.91–1.57)	1.32 (0.84–2.01)
Living in northern Sweden	124	1.02 (0.95–1.09)	1.40 (0.61–3.20)

studies in different environmental contexts in the West – Australia (25), America (26) and Sweden (27) – have been described as having a higher risk of atopy than the general population in the host country. The possibility of lifestyle factors as well as a genetic susceptibility to atopic disorders need to be addressed in further studies of atopy in this ethnic group.

Estimates of the prevalence of allergic disorder tend to differ substantially between different data collection methods (28). A previous study by Åberg (2) compared the prevalences of asthma and hayfever recorded routinely in the medical military induction examination with those diagnosed by a trained allergist. A lower rate was found in the routine examination, particularly with regard to hayfever where 20% of the cases were missed. It is possible that the prevalence estimates of allergic diseases in this study are subjected to bias that may affect comparisons between adopted young men and other populations of military conscripts. Parents of adopted children may be more attentive to health problems than other parents. If the tendency to report allergic problems is higher among the adopted young men at military induction examination, this may bias their prevalence estimates towards higher values when compared with the total population of conscripts. It is very unlikely, however, that this type of possible bias affected the comparisons between the different subgroups in the present study. The doctors responsible for making the diagnosis of an atopic disorder were unaware of the age of adoption of the conscript, and although it seems probable that the doctors were often aware of the subcontinent of birth of

the young men, because of the characteristic physical appearances of different ethnic group, it seems unlikely that this awareness biased their diagnosis in a systematic way.

In conclusion, this study indicates the importance of the early childhood environment for the risk of atopic disorders in young adults. It also confirms findings from earlier studies that immigrant populations with roots in the Far East might be particularly susceptible to hayfever and eczema. Further studies of children of diverse ethnicity growing up in the same environment, and of children from the same ethnic group raised in diverse environments, are needed to better understand the complex interaction between genetic and environmental factors in the development of atopic disorders.

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