

Migration and atopic disorder in Swedish conscripts

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We have studied asthma and allergic rhinitis prevalence in Swedish conscripts born 1973–1977 according to the military service conscription register in relation to the socio-economic status and country of birth of the conscripts and their parents, and age when granted residency in Sweden. There was an increase in prevalence of asthma and allergic rhinitis over time in all groups irrespective of country of birth or ethnic origin. Conscripts who themselves were born in Africa, Asia, Latin America and the Mediterranean had a significantly lower risk for asthma and allergic rhinitis than Swedish-born conscripts. The risk of atopic disorder among the foreign-born conscripts increased with time of residency in Sweden. Conscripts with mothers from Latin America, Asia and Africa were identified as having the highest risk for atopic disorder among Swedish-born conscripts with high socio-economic status; the adjusted risk ratio (RR) for asthma was 2.6 (95% CI 1.7–4.0) and that for allergic rhinitis was 2.0 (1.5–2.6). The conscripts with mothers from the Mediterranean had the lowest risk for atopic disorders of the Swedish-born conscripts with low socio-economic status; the RR for asthma was 0.43 (0.34–0.56) and that for allergic rhinitis was 0.84 (0.76–0.93). This study demonstrates that factors related to migration and ethnicity are important determinants of atopic disorder among Swedish conscripts.

**Anders Hjern¹, Finn Rasmussen²,
Malin Johansson² and Nils Åberg³**

¹Department of Clinical Sciences, Huddinge University Hospital, Karolinska Institutet, and Center for Epidemiology, Swedish National Board of Health and Welfare, Stockholm, Sweden, ²Division of Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, and Division of Epidemiology, Karolinska University Hospital, Stockholm, Sweden, and ³Department of Pediatrics 1, Gothenburg University, Sweden

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Anders Hjern, Center for Epidemiology, Swedish National Board of Health and Welfare, 106 30 Stockholm, Sweden
Fax: 46-8-783-33-27
E-mail: anders.hjern@sos.se

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Prevention of asthma and other atopic disorders is one of the major challenges for public health services in Scandinavia today, as several reports have demonstrated an increasing time trend in the population (1,2). Epidemiological studies of atopic disorders have shown large differences in prevalences between different child populations in the world. Atopy occurs more frequently in populations with a higher standard of living (3,4), but there are also intriguing differences between different populations in the affluent part of the world. The prevalence of asthma among school-children in Sweden, for example, is only 30–40% of the prevalence in Wales and New Zealand (5). Children in minority populations often have a prevalence of atopic disorder different than that of the majority: children in the Hispanic and Afro-American minorities in the USA and the South-east Asian minority in Australia tend to

have high prevalences of atopic disorder, whereas children in several minorities in the UK have been reported to have a lower prevalence than the majority population (6–11). Several different explanations for these differences have been proposed: lifestyle, genetically determined susceptibility, family size, culture/language-associated reporting bias, and socio-economic factors such as housing and inequity in access to medical care (10–12).

During the last 30 years, Sweden has become an increasingly multi-ethnic society with the settlement of several hundred thousand immigrants and refugees. In the 1960s, immigrants from Finland and the Mediterranean settled to work in the Swedish industry, but since the beginning of the 1970s Swedish immigration has consisted almost entirely of refugees from countries suffering from political persecution or war.

Table 1. An overview of the selection of the study population in relation to the entire population

	All	No military conscription*	Participation†	Mother's educational level‡
Conscript and both parents born in a foreign country	12 031	6016	6015	5710
Conscript born in Sweden/both parents born in a foreign country	12 490	3875	8615	8446
Conscript and both parents born in Sweden	209 410	16 161	193 249	192 036
Did not fulfil criteria	41 095			
Total	275 026	26 051	207 880	206 192

*Did not enter military conscription; †Participated in military conscription examination (study population); ‡Educational level of the mother (available from the educational register).

This has given rise to a very mixed immigrant population with minority groups from many countries and continents.

The aim of the present study was to describe and analyze the importance of ethnicity and migration for the development of asthma and allergic rhinitis among Swedish military conscripts.

Material and methods

Population registers and population and housing censuses

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 (RTP) from 1990 to 1994. All individuals recorded as living in Sweden are included in these registers. For males born in 1973, record linkage was effected between the RTP in question and Statistics Sweden's population and housing census (PHC) from 1990. No PHCs have been conducted since 1990, and therefore record linkage was instead effected between the relevant RTP and Statistics Sweden's education register (containing information on the educational level of the adult Swedish population) for those born from 1974 to 1977.

Military service conscription register

Information from the nationwide military service conscription register (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. A chronic disease such as severe asthma may preclude an individual from participating in the military-induction examination. In such cases a judgement written by a physician is required. Up to six ICD diagnoses may be included in the register. Children of foreign-born parents often have foreign or double citizenship. They can elect not to enter military conscription if they decide

not to apply for or renounce their Swedish citizenship.

Other registry information

Statistics Sweden maintains a register with records of the unique personal ID numbers of the mothers and fathers of nearly all individuals born after 1941 and living in Sweden after 1991. The parents of the study subjects were identified by record linkage to this register. Information on the following variables was then collected about both the conscripts and their mothers and fathers: educational level, country of birth, place of residence (county, municipality, parish). For conscripts born in 1973, this socio-demographic information was extracted from RTPs and PHCs, and for those born in 1974–1977 from RTPs and the education register.

By means of the unique personal ID numbers, record linkages were effected between the registers 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.

Study population

Table 1 includes information about the study population in relation to the total population of Swedish men born 1973–1977. The study population includes conscripts with two Swedish-born or two foreign-born parents. Conscripts with one foreign-born and one Swedish-born parent and conscripts whose parents were not registered by Statistics Sweden were excluded from the study. Foreign-born children with Swedish-born parents, mostly internationally adopted children, were studied separately and are therefore excluded from the study population in the present study (13).

A total of 14 630 young men with foreign-born parents, 8615 registered as born inside and 6015 as born outside Sweden, and 193 249 young men with Swedish-born parents who fulfilled the criteria of the study were identified as having

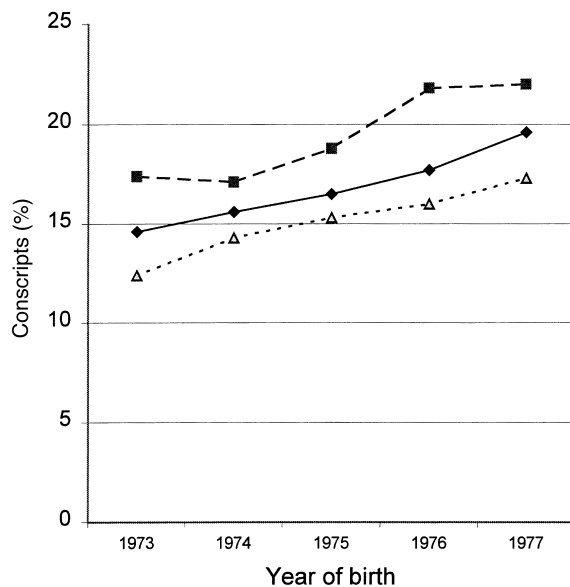


Fig. 1. The prevalence of allergic rhinitis in relation to birth year in foreign-born conscripts (Δ), Swedish-born conscripts with foreign-born parents ($\blacksquare$) and Swedish-born conscripts with Swedish-born parents ($\blacklozenge$).

entered military conscription by having a measurement of height recorded in the MSCR. The country of birth of the mothers of the 14 630 young men with two foreign-born parents in the study population according to the conscript's place of birth in or outside Sweden is available from the authors on request.

Medical examination

The military conscription examination in Sweden is usually performed at the age of 18. The examination of the conscripts consists of a health questionnaire, a personal interview by a medical doctor and a comprehensive physical and psychological examination that includes a physical exercise test. The health questionnaire is sent to the conscripts prior to the examination and has specific questions regarding itchy or watery eyes, congested nose/hayfever, wheezing and asthma. Diagnosis registration is made on a practical clinical basis by the examining doctor, with emphasis on conditions that may affect the boy's performance in the military service. In this study, the prevalence estimates of asthma and allergic rhinitis were based on the presence of the ICD-9 codes 493 and 477, respectively (14) in the registry.

Statistical analyses

Risk ratios were calculated by stratified analysis using the Mantel-Haenszel method for pooling over strata (15). The test-based method was used

to calculate 95% confidence intervals. The variables were dichotomized as follows: being born in Sweden (yes/no), having a mother born in Eastern Europe (yes/no), having a mother born in Scandinavia, Western Europe, Australia or the USA (yes/no), having a mother born in the Mediterranean area (yes/no), having a mother born in Africa (outside of the Mediterranean) (yes/no), Asia (outside of the Mediterranean) or Latin America (yes/no), living in any of the three largest cities in Sweden (Stockholm, Gothenburg and Malmö) (yes/no), high socio-economic status (education of the mother > 11 years) (yes/no). A variable related to living in the northern five counties of Sweden (yes/no) was also entered in the analysis since epidemiological studies have demonstrated a high prevalence of asthma in this region (2). In an analysis of the foreign-born young men, a dichotomous variable defined as having arrived in Sweden before 9 years of age (yes/no) was added. Variables were entered into the analysis when the frequency in the subgroup exceeded 100. Statistical analyses were carried out using the SAS 6.0 software package for Windows.

Results

Figure 1 demonstrates the prevalence of allergic rhinitis in relation to birth year and country of birth of conscripts and their mothers. In the whole sample, the prevalence of allergic rhinitis increased from 14.5% (95% CI 14.3–14.7) in conscripts born in 1973 to 19.7% (19.5–19.9) in those born in 1977. During the same time period, the prevalence of asthma increased from 4.8% (4.7 to 4.9) to 7.7% (7.5–7.8). Foreign-born as well as Swedish-born conscripts showed time trends that increased significantly when the risk ratios (RR) in stratified analysis adjusting for maternal education and living in a big city in those born 1976–1977 were compared with those born 1973–1975. The time trend of the three broader categories of conscripts; foreign-born, Swedish-born with Swedish-born parents and Swedish-born with foreign-born parents, did not differ significantly from each other.

Table 2 demonstrates crude rates of prevalences of atopic disorder in relation to socio-economic status and country of birth of mother and conscript. The foreign-born conscripts with low socio-economic status who were born in Southern Europe had the lowest prevalence of asthma (1.2%) and allergic rhinitis (7.9%). The Swedish-born conscripts with high socio-economic status with mothers born in Africa, Asia and Latin America had the highest prevalences of

Table 2. The prevalence of allergic disorder among military conscripts in Sweden born 1973–1977 in relation to country of birth of the conscript and the country of birth and socio-economic status of the mother

Mother's country of birth	Conscript born outside Sweden			Conscript born in Sweden		
	n	Socio-economic status		n	Socio-economic status	
		Low (%)	High (%)*		Low (%)	High (%)*
Asthma						
Africa	218	3.2	14.3	89	7.0	16.7
Asia	613	4.0	6.7	123	7.5	11.6
Latin America	855	4.7	7.1	133	4.5	14.9
Middle East	1715	2.1	1.9	468	1.9	8.7
Southern Europe	410	1.2	3.0	2159	2.6	5.8
Eastern Europe	760	4.6	2.9	807	5.1	6.1
Western Europe, etc.	1139	5.0	6.3	4667	6.7	6.9
Sweden				192 036	6.3	5.7
Allergic rhinitis						
Africa	218	14.2	21.4	89	19.7	27.8
Asia	613	21.0	20.0	123	32.5	48.8
Latin America	855	14.8	14.2	133	15.2	28.4
Middle East	1715	9.4	17.8	468	13.0	23.9
Southern Europe	410	7.9	10.1	2159	13.8	16.2
Eastern Europe	760	14.9	19.2	807	21.8	23.4
Western Europe, etc.	1139	21.4	16.3	4667	21.0	22.1
Sweden				192 036	16.3	17.4

*Maternal education: 12 years or more.

asthma (16.7, 14.8 and 11.8%, respectively) and allergic rhinitis (27.8, 48.8 and 28.4%, respectively).

Table 3 summarizes the RR of high socio-economic status for atopic disorder in the different ethnic groups. In Swedish-born conscripts with Swedish-born parents, the risk for asthma is slightly lower (RR 0.91) and that for allergic rhinitis slightly higher (RR 1.09) among those of high socio-economic status compared with those who of low socio-economic status. High socio-economic status increased the risk for asthma in conscripts with mothers who were born in Africa, Asia, Latin America and the Mediterranean (RRs 2.01 and 1.62). In conscripts with mothers born in the Mediterranean, high socio-economic status also increased the risk for allergic rhinitis (RR 1.73).

Being born in Sweden significantly increased the risk for asthma and allergic rhinitis in

conscripts with mothers from Africa, Asia and Latin America – RRs in a stratified analysis adjusting for maternal education, living in a big city and birth year of 1.60 (1.04–2.40) and 1.56 (1.27–1.92) – and in those with mothers from the Mediterranean – RRs of 1.62 (1.11–2.35) and 1.38 (1.18–1.61). A similar trend was observed among conscripts with mothers from Eastern Europe – RRs for asthma of 1.54 (0.97–2.44) and for allergic rhinitis of 1.18 (0.96–1.44) – but not in conscripts with mothers from Western countries.

Figure 2 demonstrates the prevalence of asthma and allergic rhinitis in relation to age when granted residency in Sweden of foreign-born conscripts. Foreign-born conscripts who were granted residency in Sweden before 9 years of age had an increased risk for atopic disorder in a stratified analysis adjusting for maternal education, living in a big city and birth year. The

Table 3. Risk ratio (RR) of high (maternal education: 12 years or more) versus low socio-economic status for atopic disorder for each subcontinent in the study, after adjustment for living in a big city, living in the north of Sweden, being born in Sweden and year of birth

Mother's country of birth	n	Asthma RR (95% CI)	Allergic rhinitis RR (95% CI)
Africa, Asia or Latin America	2031	2.01 (1.40–2.90)	1.07 (0.87–1.31)
Mediterranean	4752	1.62 (1.11–2.35)	1.45 (1.21–1.73)
Eastern Europe	1567	0.96 (0.61–1.52)	1.18 (0.96–1.44)
Western Europe, etc.	5806	1.05 (0.82–1.36)	0.97 (0.83–1.13)
Sweden	192 036	0.91 (0.88–0.94)	1.09 (1.07–1.11)

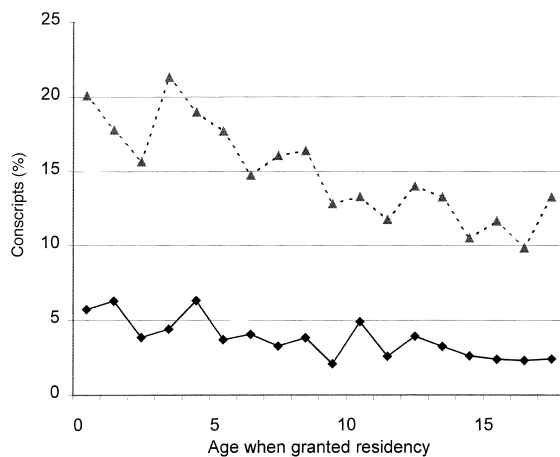


Fig. 2. The prevalence of asthma (◆) and allergic rhinitis (▲) in relation to age when granted residency in Sweden among the foreign-born conscripts ($n = 6015$).

RR for asthma was 1.49 (1.14–1.95) and that for allergic rhinitis was 1.49 (1.29–1.72) when compared to those were granted residency at a later age.

An analysis of ethnicity and atopic disorder among the Swedish-born conscripts is presented in Table 4. The analysis is divided into two socio-economic groups since the results presented above indicated diverging socio-economic gradients in the different ethnic groups. Conscripts with mothers born in Latin America, Asia and Africa had the highest risk for asthma (RR 2.63) and allergic rhinitis (RR 1.97) among the conscripts with high socio-economic status, and also had a significantly increased risk in the lower socio-economic group for allergic rhinitis (RR 1.38). Conscripts with mothers from the Western countries had an elevated risk for allergic rhinitis

in both socio-economic groups (RR low 1.30 and high 1.27). The conscripts with mothers born in the Mediterranean with low socio-economic status had the lowest risk for asthma (RR 0.43) and allergic rhinitis (RR 0.84), whereas the conscripts with mothers born in the Mediterranean with high socio-economic status had similar risks for asthma and allergic rhinitis as the Swedish-born conscripts with Swedish-born parents.

Discussion

Estimates of the prevalence of atopic disorder tend to differ substantially between different methods (16). A previous study by Åberg (2) compared the prevalences of asthma and allergic rhinitis found routinely in the military examination with those found by a trained allergist. A lower rate was found in the routine examination, particularly with regard to allergic rhinitis where 20% of the cases were missed.

Half of the foreign-born young men and 69% of the Swedish-born young men with foreign parents entered military conscription, compared to 92% of the Swedish-born young men with Swedish-born parents. This difference is probably explained by the law that excludes foreign citizens from the duty of military service. There is a certain risk that foreign-born young men with asthma, because of an affected physical fitness, volunteer less often for military service. Unpublished data from the exercise tests, however, demonstrate that conscripts who are born outside Sweden have a mean working capacity that is approximately 10% lower than those born in Sweden. Thus it does not seem very probable

Table 4. Risk ratio (RR) in stratified analysis of ethnicity for atopic disorder in Swedish-born conscripts

Risk factor	n*	Asthma RR (95% CI)	Allergic rhinitis RR (95% CI)
High socio-economic status (maternal education: 12 years or more, $n = 130\ 367$)			
Living in a big city	18 049	0.84 (0.78–0.91)	1.00 (0.96–1.05)
Living in northern Sweden	7703	1.22 (1.12–1.34)	0.99 (0.94–1.05)
Born in 1976–1977	27 799	1.39 (1.31–1.48)	1.21 (1.17–1.25)
Mother born in Western Europe, Scandinavia, USA, Australia	963	1.26 (0.99–1.59)	1.27 (1.13–1.44)
Mother born in Eastern Europe	491	1.15 (0.81–1.63)	1.34 (1.08–1.66)
Mother born in the Middle East or Southern Europe	355	1.19 (0.79–1.78)	0.99 (0.94–1.05)
Mother born in Africa, Asia or Latin America	128	2.63 (1.71–4.01)	1.97 (1.52–2.56)
Low socio-economic status (maternal education = 0–11 years, $n = 70\ 415$)			
Living in a big city	22 134	0.81 (0.76–0.87)	0.98 (0.95–1.01)
Lives in northern Sweden	14 720	1.21 (1.14–1.29)	1.04 (1.00–1.08)
Born in 1976–1977	47 141	1.28 (1.22–1.33)	1.19 (1.15–1.22)
Mother born in Western Europe, Scandinavia, USA, Australia	3703	1.12 (0.99–1.26)	1.30 (1.22–1.38)
Mother born in Eastern Europe	317	0.87 (0.54–1.40)	1.34 (1.08–1.67)
Mother born in the Middle East or Southern Europe	2272	0.43 (0.34–0.56)	0.84 (0.76–0.93)
Mother born in Africa, Asia or Latin America	217	1.12 (0.99–1.26)	1.38 (1.07–1.77)

*Number of individuals exposed to risk variable.

that physical fitness is a major selection criteria for volunteering military service in this group. Another methodological problem in the present study is if the method used for identifying atopic disorder is biased by the ethnicity and time of residency of the conscript. The questionnaire sent to all conscripts and the medical interview during the medical examination are both in Swedish. It is possible that foreign-born conscripts with limited knowledge of Swedish might be less easily identified as having an atopic disorder compared to the rest of the population. It cannot be excluded that such a language-barrier factor did contribute to the apparent low prevalence of atopic disorder in the conscripts who had settled in Sweden shortly before the military conscription examination.

The present study clearly demonstrates the increasing time trend of atopic disorder in the general Swedish population in later years. There is no indication that the influx of migrants has affected the pace of the increase in the general population in any major way, since the time trends are similar in conscripts with Swedish- and foreign-born parents. Studies of asthma in conscripts in Israel (17) and Belgium (18) in recent years have demonstrated similar prevalences to that reported in the present study; 5.9% and 7.2%, respectively. The Belgian study also noted a rapid increase in the prevalence of asthma that was confirmed with objective evidence of airway hyper-responsiveness.

In the conscripts with Swedish-born parents, the differences in risk for atopic disorder between the two socio-economic groups are quite marginal, although statistically significant in such a large sample. It is quite possible that these differences are explained by factors related to the geographic and urban/rural distribution of the different socio-economic groups that have only been partially adjusted for in this study (19,20). Among the conscripts born in Sweden with mothers from Latin America, Asia and Africa and the Mediterranean, asthma is significantly more common in the higher socio-economic group, and in the Mediterranean group this is true also for allergic rhinitis. Family size might explain some of these differences, since there are considerable socio-economic differences in family size in minorities from Latin America, Asia, Africa and the Mediterranean in Sweden; families with low socio-economic status have larger families. A recent study has demonstrated that atopic disorders are less common among Swedish conscripts with large families (21).

The low socio-economic group from the Mediterranean has the lowest risk for atopic

disorder of the sub-populations in the study. The immigrants from the Mediterranean who gave birth in Sweden in the mid-1970s were dominated by poorly educated workers from the countryside of east Turkey who kept strong ties with their home villages. Children in these families often spent considerable time in the countries of birth of their parents during early childhood, and during such stays the children were exposed to infections that often stunted their growth temporarily (22). Comparative studies of children in Sweden and Estonia have suggested that a change in the intestinal microflora is an important cause for the increasing prevalence of atopic disorder in Sweden (23). Thus it is possible that children in low-status families from the Mediterranean were protected from the development of atopic disorder by the establishment of an intestinal microflora similar to that of the children in their parents' home villages.

Sensitization to allergens in early childhood and *in utero* has been cited as an important step in the establishment of an allergy that may lead to a disorder later in life (24). The present study did not indicate that this early sensitization is of particular importance in the development of atopic disorder, since the prevalence of atopic disorder among the foreign-born conscripts is more or less directly proportional to the time of exposure to the allergens in the environment in Sweden.

In a number of studies in different ethnic groups, it has been demonstrated that susceptibility to atopy and atopic disorders is to a certain degree inherited and thus genetically determined (12,25). The low prevalence of atopic disorder in children with low socio-economic status in families from the Mediterranean, which has been observed in the Netherlands as well (26), can probably be explained by environmental factors as noted above. The high risk for allergic rhinitis and asthma in Swedish-born conscripts with mothers born in Asia, Africa and Latin America with high socio-economic status is more difficult to explain based on known environmental risk factors. Although this small sub-sample is much too heterogeneous to allow for any far-reaching conclusions, genetic differences in susceptibility for atopy may have to be considered on a population level as well. Studies of Australian-born South-east Asians, American-born Chinese and Swedish-adopted East Asian boys have identified East Asians as an immigrant group with particular risk for atopic disorder (11,13,27). Maybe Africans and Latin Americans should be added to the list of immigrant populations with a susceptibility for atopy?

Much is, however, yet to be learnt about the factors responsible for the rapid increase of atopic disorders in the industrialized world. It is quite possible that hitherto unknown lifestyle factors with relation to ethnicity and atopy are waiting to be identified. Further studies of children with different ethnic backgrounds raised in the same physical environment are needed to better understand the interaction between genetic and lifestyle factors in the development of allergy.

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