

ORIGINAL PAPER

Asthma in young south Asian women living in the United Kingdom: the importance of early life

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Summary

Background Studies of immigrants suggest that the environment during fetal life and duration of residence in the host country might influence the development of asthma. Little is known about the importance of the timing of the exposure in the host country and whether migrants might be especially vulnerable in certain age windows.

Objective We compared the reported prevalence of asthma between young white and south Asian women in the United Kingdom, and investigated associations with country of birth and age at immigration.

Methods A questionnaire on atopic disorders was posted to 2380 south Asian and 5796 white young mothers randomly sampled in Leicestershire. Data on ethnicity were also available from maternity records. Data were analysed using multivariable logistic regression and a propensity score approach.

Results The reported prevalence of asthma was 10.9% in south Asian and 21.8% in white women. South Asian women who migrated to the United Kingdom aged 5 years or older reported less asthma (6.5%) than those born in the United Kingdom or who migrated before age 5 (16.0%), with an adjusted odds ratio of 0.38 [95% Confidence Interval 0.23–0.64, $P < 0.001$]. For those who migrated aged over 5 years, the prevalence did not alter with the duration of residence in the United Kingdom. Current exposure to common environmental risk factors had relatively little effect on prevalence estimates.

Conclusion These data from a large population-based study support the hypothesis that early life environmental factors influence the risk of adult asthma.

Keywords asthma, environment, epidemiology, ethnic groups, risk factors

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Introduction

The prevalence of asthma in the white population of the United Kingdom is among the highest in the world, much higher for instance than in the south Asian countries India, Pakistan and Bangladesh [1]. In adult south Asians who were born in or migrated to the United Kingdom, asthma prevalence is thought to be lower than in the white population [2]. This contrasts with the increased prevalence of other diseases associated with a western lifestyle such as cardiovascular disease, diabetes and obesity [3].

Research from Australia, Sweden and the United States suggests that susceptibility to asthma in migrants might

be due to factors associated with the fetal environment as well as the duration of residence in the host country [4–12]. Without knowing the age at immigration, it is impossible to differentiate the effects of early life exposures and of continued later exposures on the development of asthma. The effect of age at immigration on the development of asthma in migrants has not been reported in detail.

The objectives of this study were to describe the prevalence of asthma in young south Asian and white women in a population-based study, and to examine associations with country of birth, age at immigration and current environmental and socio-demographic risk factors.

Materials and methods

Setting and study population

We used the Leicestershire Health Authority Child Health Database to select a random sample of white and south Asian families (mother self-identified as Indian, Pakistani or Bangladeshi) with a pre-school child [13–17]. For women, further information on age, country of birth, self-reported ethnic origin, religion and language was available from maternity records. As this information was lacking for men, this paper only reports results for women.

Questionnaires

In 1998, we mailed a questionnaire for self-completion to 2380 south Asian and 5796 white families [13]. We asked whether parents had ever experienced asthma, wheezing or bronchitis. For this paper, we combined positive responses to questions about asthma and wheeze and defined this as asthma, as asthma is by far the most common cause for wheeze in young adults. Understanding of the term 'wheeze' was also evaluated [17]. Those women who accepted the definition 'whistling or squeaking noise from the chest' were considered to have a correct understanding of the term. We asked about household language and ethnic group using a tick list of categories. The questionnaire included questions on environmental and household exposures such as air pollutants (tobacco smoke, cooking and heating devices), pets, size of the house and number of household members. We measured socio-economic status at the individual level (duration of education, number of people per room and single-parent family) and at local area level by Townsend score (based on 1991 census data about household overcrowding, unemployment, car ownership and house ownership). In a further questionnaire in 2003, we also asked whether and when family members had migrated to the United Kingdom and whether the family diet was 'entirely English', 'mostly English with Asian' or 'mostly/entirely Asian'.

All questionnaires were printed in English, but included a slip written in Gujarati, Punjabi, Bengali and Urdu, offering a telephone interview in an Asian language. Four families accepted this offer. The questionnaires were deliberately not translated, as we decided that answers would be more comparable in English, the language used by the women when talking to their doctor. In contrast, we were not sure that after translation, the term 'wheeze' would retain the same meaning in several Asian languages. We tested the repeatability of questionnaire answers by sending the same 1998 questionnaire to a random sample of 600 white (336 responses) and 200 south Asian (77 responses) families after an interval of 3 months.

The Leicestershire Health Authority Research Ethics Committee approved the study.

Statistical analysis

Analyses were performed with Stata, version 8.0 for Windows (Stata Corporation, Austin, TX, USA). First, we compared the lifetime prevalence of asthma or bronchitis between south Asian and white women using logistic regression models to estimate crude and adjusted odds ratios [OR; with 95% confidence intervals, (CI)]. Models were adjusted *a priori* for the following covariates: person completing the questionnaire (self or proxy), age, Townsend deprivation score, education, passive and active smoking, cooking and heating facilities and household pets. Second, we investigated factors associated with asthma prevalence in south Asian women. All variables associated with the outcomes ($P < 0.05$, using likelihood ratio tests) in univariable analysis were entered into multivariable models.

The following sensitivity analyses were performed for all final models to test the robustness of the findings: including only persons who had completed the questionnaire themselves; including only those who correctly defined wheeze as 'whistling or squeaking noise from the chest'; including only the more homogeneous Gujarati-speaking subgroup; and including a clustering variable for Townsend score. Because of the large number of correlated risk factors, we also used a propensity score approach [18], by modelling age at immigration as the dependent variable and the potential confounders as independent variables. Then, the sample was split into blocks to test the hypothesis that the average propensity scores did not differ between exposed and unexposed. Lastly, we performed a conditional logistic regression matching by propensity score block. This approach, akin to randomization in clinical trials, assures a balance of measured confounders between exposed and unexposed groups.

Results

Response rates and population characteristics

In 1998, questionnaires were returned by 1716/2380 (72%) families where the woman was south Asian and 4855/5796 (84%) families where the woman was white. Of these, 859 (50%) south Asian and 2900 white women (60%) also returned the 2003 questionnaire, with additional information on age at immigration and diet. After excluding questionnaires completed by spouses not living in the same household, we had data on symptoms and risk factors for 1712 south Asian and 4848 white women who replied in 1998, among whom 857 and 2896 south Asian and white women, respectively, also replied in 2003 (Fig. 1). Age was similar in south Asian (mean 30.9 years,

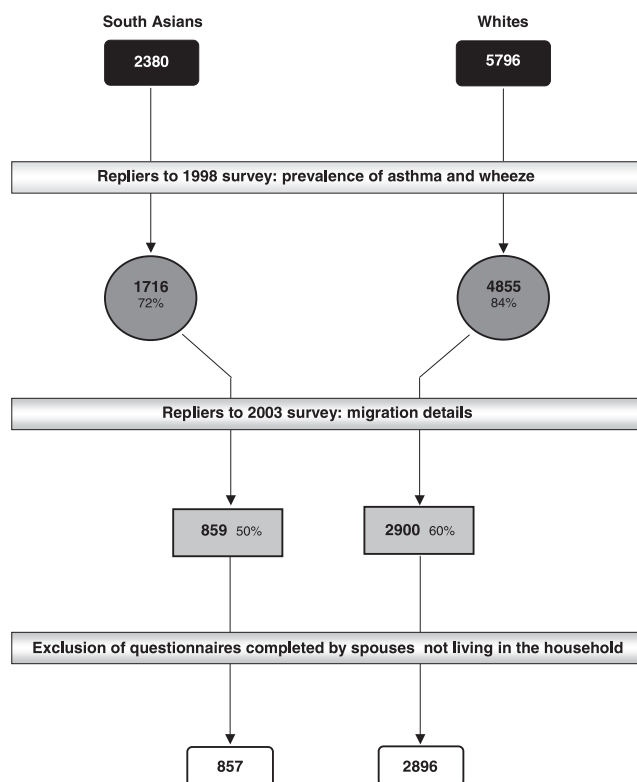


Fig. 1. Flow diagram showing derivation of data from women responding to 1998 and 2003 questionnaires.

SE 5.0) and white women (mean 31.2 years, SE 5.4). The repeatability of the question on asthma was excellent, with a Cohen's κ of 0.82 (0.74–0.89), with no ethnic differences, while 577/857 (67%) south Asian and 2523/2896 white women (87%) correctly defined wheeze as a 'whistling or squeaking noise from the chest'.

Among south Asians, 424 women (25%) were born in the United Kingdom, 439 (26%) in Africa and 737 (43%) in the Indian subcontinent (601 from India, 67 from Bangladesh and 69 from Pakistan). The largest subgroup (819) was Gujarati-speakers born in India (374), Africa (270) or the United Kingdom (155). The next largest consisted of Punjabi-speaking families (197), most of them born in the United Kingdom (90) or in India (99). A more detailed breakdown of women's characteristics by country of birth, language and religion can be obtained from the corresponding author.

Women who replied both in 1998 and 2003 did not differ by country of birth, household language, Townsend score, education, diet or prevalence of asthma. Moreover, associations between asthma and the tested risk factors in 1998 were similar in responders and non-responders in 2003.

Reported prevalence of asthma in south Asian and white women

The reported crude prevalence of asthma was 10.9% (95% CI 9.4–12.4) in south Asian women and 21.8% (20.6–22.9)

in white women ($P < 0.001$), with an unadjusted OR of 0.44 (0.37–0.52; Table 1). After adjustment, the OR increased slightly to 0.52 (0.38–0.73). When including only women who correctly defined wheeze, the unadjusted and adjusted OR changed only slightly to 0.46 (0.35–0.61) and 0.51 (0.34–0.79), respectively. Differences in the reported prevalence of asthma were not due to the preferential use of the alternative term 'bronchitis', as bronchitis was reported even less often in south Asian (3.6%) than in white women (14%). Nine percent (346/3793) of white women not reporting wheeze complained of 'bronchitis'; this proportion was only 2% (24/1525) among south Asian non-asthmatics.

Factors associated with asthma in south Asian women

In univariable analysis (Table 2), factors associated with an increased prevalence of asthma among south Asian women included being born in the United Kingdom or having migrated before age five, speaking English, eating mostly an English instead of an Asian diet and active smoking. Several indicators of low socio-economic background were associated with a lower prevalence, including limited education, overcrowding, lack of electricity for cooking and lack of central heating, while the association with the Townsend deprivation score was marginal (not all data are shown). Age, religion, exposure to pets and environmental tobacco smoke were not related to asthma. Most socio-demographic and lifestyle factors were closely associated with age at immigration, including current deprivation measures, household language and type of diet.

In multivariable models, age at immigration (being born in the United Kingdom or having immigrated at age < 5 years; Fig. 2a and Table 1) or, alternatively, duration of residence in the United Kingdom (Fig. 2b), were the strongest predictors of reported asthma. There was a stepwise decline in prevalence from 15.2% in women born in the United Kingdom or migrating < 5 years, to 6.1% in women who had migrated to the United Kingdom beyond their fifth year of life (Fig. 2a). After adjustment, those who had migrated to the United Kingdom after the age of 5 years were less than half as likely to report asthma than those who had been born in the United Kingdom or had migrated < 5 years old (OR 0.38; 95% CI 0.23–0.64, $P < 0.001$, Table 1). For those who migrated aged over 5 years, the prevalence did not alter with duration of residence in the United Kingdom (5.1%, 8.0% and 6.2% in those living 1–10, 11–25 and > 25 years in the United Kingdom, $P = 0.47$). This was confirmed in adjusted models. Owing to the close correlation between age at immigration and duration of residence, these two variables could not be included in the same statistical model and therefore their effects could not be disentangled. After controlling for age at immigration, no other demographic,

Table 1. Prevalence of self-reported lifetime asthma in young white and south Asian women

	N*	Unadjusted data			Adjusted† data		
		%	OR	(95 CI)	%	OR†	(95 CI)
All women							
White women	4848	21.8	1		21.3	1	
South Asian women	1712	10.9	0.44	(0.37–0.52)	10.4	0.52	(0.38–0.73)
Among south Asian women							
Born in the UK or immigrated before 5 years of age	349	16.0	1		15.2	1	
Immigrated aged 5 years or older	477	6.5	0.36	(0.23–0.58)	6.1	0.38	(0.23–0.64)

*N, number of subjects with available data

†Adjusted for age, respondent to questionnaire, active smoking, cooking with electricity, Townsend score and type of diet

Table 2. Demographic characteristics, socio-economic conditions and environmental factors associated with asthma in south Asian women (N = 1712)

	N	n	%	(95 CI)	OR	(95 CI)	P
Respondent to questionnaire							
Other (usually spouse)	578	31	5.4	(3.5–7.2)	1.00		
Self	1134	156	13.8	(11.7–15.8)	2.81	(1.89–4.20)	< 0.001
Country of birth							
United Kingdom	424	75	17.7	(14.0–21.3)	1.00		< 0.001
Indian subcontinent*	737	49	6.6	(4.8–8.5)	0.33	(0.23–0.49)	
Africa	439	49	11.2	(8.2–14.1)	0.58	(0.40–0.86)	
Other/missing	112	14	12.5	(6.3–18.7)	0.66	(0.36–1.23)	
Household language							
English	266	44	16.5	(12.0–21.0)	1.00		0.001
Gujarati	898	73	8.1	(6.3–9.9)	0.45	(0.30–0.67)	
Other Indian language	479	62	12.9	(9.9–16.0)	0.75	(0.49–1.14)	
Other non-Indian/missing	69	8	11.6	(3.8–19.3)	0.66	(0.30–1.48)	
No. of years since immigration†							
Born in the United Kingdom	260	42	16.2	(11.7–20.7)	1.00		0.001
> 25	139	17	12.2	(6.7–17.7)	0.72	(0.39–1.33)	
11–25	229	18	7.9	(4.3–11.4)	0.44	(0.25–0.79)	
1–10	199	10	5.0	(2.0–8.1)	0.27	(0.13–0.56)	
Age at immigration (years)†							
Born in the United Kingdom	260	42	16.2	(11.7–20.7)	1.00		< 0.001
0–4	89	14	15.7	(8.0–23.4)	0.97	(0.50–1.87)	
5–14	135	8	5.9	(1.9–10.0)	0.33	(0.15–0.72)	
> 15	342	23	6.7	(4.1–9.4)	0.37	(0.22–0.64)	
Type of diet‡							
Mostly/entirely Asian	508	42	8.3	(5.9–10.7)	1.00		0.044
Mostly English with Asian	662	76	11.5	(9.0–13.9)	1.44	(0.97–2.14)	
Entirely English	22	5	22.7	(3.7–41.7)	3.26	(1.15–9.29)	
Active smoking							
No	1683	180	10.7	(9.2–12.2)	1.00		
Yes	29	7	24.1	(7.6–40.7)	2.66	(1.12–6.31)	0.042

No associations were found for age, religion and Townsend deprivation score.

*India, Pakistan or Bangladesh

N, total number of women in this category; n, those women with reported asthma

†N = 826

‡N = 1192

socio-economic and environmental exposure remained independently associated with asthma.

All sensitivity analyses gave results very similar to the main analysis (Table 3). When we included only the 577

women with a correct definition of wheeze, the adjusted OR comparing those who migrated to the United Kingdom after the age of 5 years with those who had been born in the United Kingdom or had migrated < 5 years old changed

from 0.38 to 0.36 (0.19–0.68, $P=0.002$). The analysis using the propensity score method also gave similar results, with an adjusted OR of 0.38 (0.22–0.64, $P < 0.001$).

Discussion

This large population-based survey found that the self-reported lifetime prevalence of asthma in young south Asian women was about half that in white women. Age at immigration was the factor most strongly associated with prevalence. Those who had been born in the United Kingdom or migrated before age 5 reported the highest prevalence of asthma, with a stepwise decline in the

incidence for those who migrated after age 5. Associations with all other current (adult) socio-economic, environmental and lifestyle exposures were explained by confounding with immigration status.

Comparison with other studies and interpretation of ethnic differences

We are aware of only one other survey in adults in the United Kingdom examining associations between asthma, country of birth and duration of residence [19]. Prevalence rates of diagnosed asthma in 1783 south Asians were similar to published data for whites but there was no association with immigration status after adjustment for age and sex. These findings contrast with ours, but there are significant differences in study design. In the study by Ormerod et al. [19], questionnaires were administered by community nurses in a primary care setting, the sample included a wide age-range, there were few immigrants and there was no concurrent white reference group. However, the results of the fourth National Survey of Health in Britain's ethnic minorities (which included 1861 adults from south Asian backgrounds) were consistent with our study, showing a lower prevalence of wheeze in all groups of south Asians compared with whites [3]. This pattern contrasts with other chronic diseases, such as diabetes and coronary heart disease, which are more common in south Asians [3]. Studies among a variety of populations in the United States [7–9], Australia [4, 20] and Europe [6, 10–12] have also found a lower prevalence in people born abroad and a time-dependent increase after immigration. Two large surveys including adults [7] and children [9] of Mexican American ethnicity found a strong association between asthma and wheeze and place of birth. Prevalence data are supported by studies showing a parallel increase in atopic sensitization [9, 21, 22].

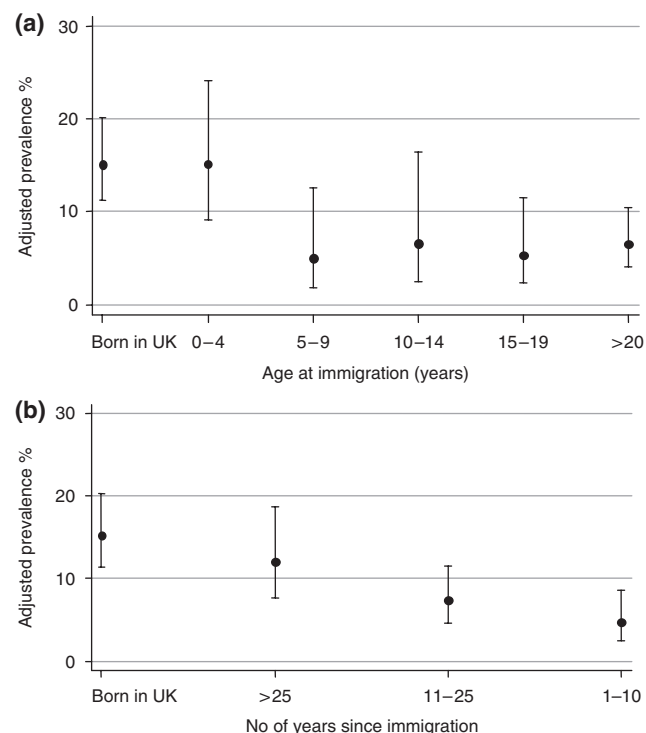


Fig. 2. Adjusted lifetime prevalence of asthma in south Asian women, (a) by age at immigration or (b) duration of residence in the United Kingdom.* Values are point estimate and 95% confidence interval. *Adjusted for age, respondent to questionnaire, Townsend score, type of diet, active smoking and cooking with electricity ($N=826$).

Explaining the link between age at immigration and asthma

Pre-natal and early life environmental exposures [9], and social and psychological factors associated with

Table 3. Association between self-reported lifetime prevalence of asthma among south Asian adult women and age at immigration (having immigrated after the age of 5 years vs. being born in the UK or having immigrated aged < 5 years): main results and sensitivity analyses using different statistical approaches

	N	OR*	(95 CI)	P
Main result, based on multivariable logistic regression	826	0.38	(0.23–0.64)	< 0.001
Subgroup results, including only those:				
With a correct definition of wheeze (as whistling or squeaking noise from the chest)	577	0.36	(0.19–0.68)	0.002
Speaking Gujarati	442	0.28	(0.12–0.65)	0.003
Women having completed the questionnaire themselves	556	0.38	(0.21–0.68)	0.001
Main result, based on propensity score model	826	0.38	(0.22–0.64)	< 0.001

N, number of subjects with available data.

*Adjusted for age, respondent to questionnaire, active smoking, cooking with electricity, Townsend score and type of diet.

increasing acculturation have been proposed as explanations for the association between atopic disorders and migration [7, 8, 23]. Among the former, exposures related to the hygiene hypothesis [24, 25] and to diet might predominate. We did not have individual information on early childhood environment of people born in south Asia. However, in general, United Kingdom immigrants from the Indian subcontinent, especially from Pakistan and Bangladesh, came mostly from a rural environment, while those from Africa were usually from business or professional backgrounds. The higher prevalence of atopic disorders in immigrants from Africa as compared with those from the Indian subcontinent would be consistent with the hygiene hypothesis [24].

The striking stepwise change in the association between age at immigration and asthma (Fig. 2a) suggests an increased risk to those born in the United Kingdom or who migrated before age 5. The fact that there was no difference in the prevalence of asthma between those born in the United Kingdom and those who migrated before age 5 years implies that all of the effect might be post-natal, with no additional effect of pre-natal exposures within the United Kingdom. There was a striking lack of any relationship between asthma and age at migration for those who migrated beyond age 5.

A number of environmental and cultural factors are related to self-reported ethnicity, country of birth and duration of stay in a host country [26–28]. We showed a strong association with several proxy measures of socio-economic status, indoor air pollutants such as cooking fuel, cigarette smoking and type of diet. We did not, however, measure some exposures that change with increasing acculturation to a host country such as separation from the extended family and neighbourhood support networks that protect against stress, changing views of health and illness, symptom perception and reporting behaviour [23, 28, 29]. Interestingly, exposure to known environmental risk factors for respiratory disease at the time of the survey (use of gas for cooking, pets and exposure to environmental tobacco smoke) only explained a small proportion of the variation in prevalence.

Methodological considerations

The strengths of this study include its population-based sampling strategy, large sample size and good response rate. We could validate participants' reports of self-defined ethnic group and detailed information about language, religion, country of birth, age at immigration and duration of residence in the United Kingdom with independent data from women's maternity records. Our results were robust to sensitivity analyses and should be generalizable to south Asian women with young children in the United Kingdom, particularly for the largest sub-

group: Gujarati speakers of Indian origin. One should be cautious in extrapolating these results to other age groups. Data on asthma status came from the large majority of the population, but the analysis by age at immigration was only possible for a subgroup of women representing 36% of the original population. Although the association between asthma and other risk factors in this subgroup was similar to the rest of the population, we cannot totally exclude bias.

A limitation of the dataset was that we assessed only the lifetime prevalence of asthma and did not have information on the age of onset. This limitation also applies to most other studies [7, 9]. Retrospective assessment of age at onset of asthma is unreliable. Ideally, longitudinal studies following up immigrants from birth to adulthood should be conducted to study this question. This kind of study is, however, logistically very difficult, as immigrants would ideally need to be identified and enrolled immediately before immigration, and then followed up at regular intervals. We also had no objective measurements of associated traits, such as atopy, bronchial responsiveness or lung function.

Because all questionnaires were in English, there might have been some degree of misunderstanding by recent immigrants, or a difference in perception or reporting of symptoms between ethnic groups or by duration of stay in the United Kingdom. However, completeness, internal consistency and repeatability of questionnaire replies were good in both ethnic groups and sensitivity analyses, including those correctly defining wheeze as a whistling sound, showed similar results. Arguably, such a validation of answers on wheeze might be at least as valid as a reported doctor's diagnosis of asthma. Also, if there had been a difference in adults' questionnaire comprehension, symptom perception or reporting, we would expect a similar effect of parental duration of stay on reported asthma prevalence in their children. This was not the case (unreported observations).

In summary, we found that the prevalence of atopic disorders was lower in young south Asian than white women in the United Kingdom. Asthma was strongly associated with age at immigration, with an increased prevalence in those who had been born in the United Kingdom or migrated aged below 5 years. Environmental exposures at the time of the questionnaire survey were not closely associated with disease prevalence. The complex association between age at immigration or duration of residence and many socio-economic, environmental and lifestyle exposures underlines the need for longitudinal study designs in future, so that exposures, symptomatic outcomes and physiological features can be studied prospectively at several points in time. Our findings, if confirmed, suggest that exposures that occur very early in life, especially during the pre-school years, are likely to be important in the aetiology of asthma.

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Competing interest: There are no competing interests.

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