

The Effect of Lifestyle on Wheeze, Atopy, and Bronchial Hyperreactivity in Asian and White Children

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There is increasing evidence linking Western culture to increasing prevalence of asthma. We have measured the prevalence of symptoms of asthma, bronchial hyperreactivity, and atopy in a sample of white and Asian inner city schoolchildren aged 8–11 yr in the U.K. and assessed the influence of certain aspects of western culture on these variables. Bronchial reactivity was measured by methacholine challenge, atopy by allergen skin prick tests, and symptoms of asthma and aspects of lifestyle by questionnaire. Degree of Westernization was assessed from dietary habit categorized as exclusively Asian, mostly Asian, mixed, or exclusively English. The questionnaire was completed by 92% of children. The 308 white and 539 Asian children were of similar age (mean 9.3 yr versus 9.4 yr) with slightly more girls in the Asian group (52.6% versus 47.4%). The white children reported more wheeze within the past year (14.2% versus 8.8%, $p = 0.01$) but less were atopic (29.5% versus 38.4%, $p = 0.01$) with no significant difference in the prevalence of hyperreactivity (31.5% versus 29.6%, $p = 0.57$). Most Asians (97%) included Asian food in their diet; 35% ate a mostly Asian diet, 45% ate a mixed English and Asian diet, and 17% ate an exclusively Asian diet. After controlling for confounding factors whites were at higher risk of hyperreactivity and lower risk of atopy, and the risk of hyperreactivity and to a lesser extent atopy among Asian children was related to diet in a dose response fashion. The relative odds for hyperreactivity with an exclusively Asian, mostly Asian, or a mixed diet relative to an English diet were 0.31 (95% CI 0.15 to 0.62), 0.88 (0.56 to 1.37), and 0.99 (0.65 to 1.49), and for atopy were 1.22 (0.72 to 2.06), 1.47 (0.99 to 2.19), and 1.78 (1.23 to 2.58). These results suggest that diet or other closely related factors associated with Westernization are involved in the etiology of atopy and hyperreactivity. **Carey OJ, Cookson JB, Britton J, Tattersfield AE. The effect of lifestyle on wheeze, atopy, and bronchial hyperreactivity in Asian and white children.**

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Studies in economically developing countries and in migrant populations suggest that the prevalence of asthma is strongly dependent on environmental factors and may be increased by Western cultural influences (1–3). Comparison of populations living in the same area but differing in certain aspects of culture may therefore help to assess the effects of lifestyle, identify relevant factors, and guide strategies for the prevention of asthma.

Estimates of asthma prevalence in Asian children living in Britain (4) suggest that the disease is more frequent than in comparable children living in India (5), and there is evidence that recent Asian immigrants have a lower prevalence of asthma (2.8%) than those living in Britain for a longer period (4.2%) (6). The prevalence of asthma was lower in Asian than in European children in both these surveys (4, 6). This evidence there-

fore suggests that the prevalence of asthma among Asian children living in Britain may be strongly influenced by environmental factors associated with integration into a Western lifestyle.

The City of Leicester has a substantial proportion of citizens from the Indian subcontinent, and their lifestyle differs from that of the white population. This study was designed to compare the prevalence of asthma symptoms, bronchial hyperreactivity, and atopy in Asian and white Leicester schoolchildren, and the extent to which these variables may be influenced by adoption of a Western lifestyle. We have used dietary habit that could be graded by the relative amounts of Asian and English foods consumed as an indicator of Western cultural integration.

METHODS

All children aged 8–11 yr in four inner city schools were asked to take part in the study. The schools were chosen to provide a good mix of Asian and white children. The study was approved by the Department of Education, the local hospital ethics committee, and head teachers of the schools. Informed written consent for bronchial challenge and skin tests was obtained from parents.

Questionnaire

Parents were asked to complete a questionnaire sent via the children and

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available in English, Gujarati, and Punjabi. Accuracy of translation of the questionnaire into Asian languages was checked by back translation by independent translators. The questionnaire requested information on wheeze in the last year; diagnosis of asthma; school absenteeism due to wheezing illness; type of diet categorized as entirely English, Asian, mostly Asian, or mixed Asian and English; and other lifestyle variables including parental smoking and domestic pets. Children were interviewed after return of questionnaires and asked about respiratory symptoms. Their responses were compared with answers given by parents.

Methacholine Challenge and Skin Tests

Methacholine challenge (from 0.048 μmol to a maximum of 12.2 μmol) was carried out using the method of Yan and coworkers (7) on children who had a forced expiratory volume in one second (FEV_1) greater than 60% predicted (8). Children receiving asthma medication were asked to avoid antihistamines and oral bronchodilators for 24 h and aerosol bronchodilators for at least 6 h before challenge if possible and were only challenged if able to do so. FEV_1 and forced vital capacity (FVC) were measured by dry wedge spirometer (Vitalograph, Buckingham, UK).

Skin prick tests were performed using cat fur, dog hair, grass pollen, house dust mite, and saline control solutions (Bencard, Brentford, UK). Weal diameter was measured after 10 min as the mean of the largest diameter and that perpendicular to it (excluding pseudopodia).

Analysis

Ethnic origin was based on assessment by the teachers and/or school records. Answers to questions on respiratory symptoms given by children and their parents were compared and symptoms taken to be present if either responded in the affirmative. FEV_1 was plotted against log dose methacholine and the dose provoking a 20% fall in FEV_1 (PD_{20}) obtained by linear interpolation. Hyperreactivity was defined as a PD_{20} of less than 12.2 μmol . Children were regarded as atopic if any allergen produced a skin weal 1 mm larger than the saline control. Categorical data on respiratory symptoms, family history of atopy, skin prick response, and presence of bronchial hyperreactivity for Asian and white children were compared by chi-square tests using the Statistical Package for Social Science (9) (SPSS-PC).

Regression slopes and odds ratios for the association of age, sex, ethnic origin, parental smoking, domestic pets, religion, vegetarianism, duration of residence in the United Kingdom, and diet with history of wheeze in the past year, bronchial reactivity, and skin prick tests were obtained by multiple logistic regression using the EGRET program (10). Lifestyle variables found not to exert significant influences on outcome variables were dropped from the analytical model. Because ethnic origin and dietary habit were almost completely confounded, in that almost all white children ate an exclusively Western diet, the effects of diet were analyzed with and without including a term for ethnic origin.

The relative effects of atopy and other predictor variables on the odds of wheezing or airway hyperreactivity were compared between racial groups by including a multiplicative interaction term in the final regression models with $p < 0.05$ taken to be significant.

RESULTS

Of the 922 children approached, questionnaires were completed and returned for 847 (92%). The response rates were 90% (308) for white and 93% (539) for Asian children. Mean age and height were similar for white and Asian children. White children showed a slight male predominance compared with Asians and had higher lung function measurements (Table 1).

Symptoms, Asthma Diagnosis, School Absence, and Diet

Wheeze in the past year was reported more frequently by white children (14.2%) than Asian children, (8.8%; $p = 0.01$). A diagnosis of asthma had been given to 10% of white children and 9% of Asians ($p > 0.5$). School absence because of wheezing in the previous year was similar for both Asian and white children (7%) with 3% of both groups losing more than 10 school days because of wheezing in the previous year. Of the children with a history of wheeze in the last year, 52% of white and 71% of Asian children reported a diagnosis of asthma. Wheezing

TABLE 1
GROUP CHARACTERISTICS

	White	Asian
Number	308	539
Age, yr*	9.3 $\pm$ 1.1	9.4 $\pm$ 1.1
Sex, % male	52.6	47.4
Height, cm	129 $\pm$ 7.6	130 $\pm$ 8.4
FEV_1 , L	1.93 $\pm$ 0.3	1.77 $\pm$ 0.4
FVC, L	2.08 $\pm$ 0.37	1.89 $\pm$ 0.39

* Values are mean $\pm$ SD.

reported by children said to be asymptomatic by parents was less common in white than Asian children (of symptoms reported by children 4.3% were not reported by white parents compared with 6.7% not reported by Asian parents, $p = 0.19$). Symptoms reported by parents but not by the children were rare.

Almost all (99%) white children ate an exclusively English diet, whereas an exclusively Asian diet was taken by one English child and 90 (16.6%) Asian children. The majority of Asian children consumed mostly Asian food (35%) or a mixed diet of Asian and English food (45%); only 17 (3.4%) Asian children ate an exclusively English diet.

Measures of Bronchial Responsiveness and Atopy

Of the 847 children who returned the questionnaire, 795 (94%) underwent bronchial challenge tests (501 [93%] Asians, 294 [95%] whites). Bronchial challenge was not performed on 52 children (38 Asian) because of low initial FEV_1 or the use of asthma medication prior to testing (nine children), because permission for challenge was refused (20), or children were absent from school at the time of the study (23). Of those challenged with methacholine, 31% had a PD_{20} of 12.2 μmol or less, with no significant difference between Asian (31.5%) and white children (29.6%, $p = 0.57$). Skin prick tests were performed on 814 children (515 Asian) including all who attended for bronchial challenge. Of the 33 not tested, seven reported a history of wheeze (two Asian). Positive skin tests occurred in 35% of children, significantly more in Asian (38%) than in white children (30%, $p < 0.05$).

Independent Effects of Diet and Ethnic Origin

Effect of ethnic origin. There was an association between ethnic origin and wheeze, bronchial hyperreactivity, and atopy. After adjustment for age, sex, and atopic status, white children were at greater risk than Asian children for wheeze (odds ratio [OR] 2.04; 95% confidence interval [CI] 1.24 to 7.35) and for hyperreactivity after controlling for FEV_1 (OR 1.32; 95% CI 0.92 to 1.89); without correcting for FEV_1 white children had a slightly lower though nonsignificant risk of bronchial hyperreactivity (OR 0.89). White children were at significantly lower risk of atopy than Asian after adjustment for age and sex (OR 0.63; 95% CI 0.46 to 0.87). There was no evidence of interaction between the effects of atopy and race in any of the analyses.

Effects of diet. Children on an exclusively Asian diet had the lowest prevalence of wheeze although this was not statistically significant (OR 0.45; 95% CI 0.18 to 1.15; Table 2). They also had the lowest risk of hyperreactivity (OR 0.31; 95% CI 0.15 to 0.62; Table 3). There was a statistically significant dose response relation between the risk of hyperreactivity and the degree of Westernization of diet (Asian < mostly Asian < mixed < English; Table 3). The risk of atopy in Asian children also showed evidence of a dose response relation to the first three categories of diet (Table 4) with children on a mixed diet being most atopic and children on an exclusively Asian diet being least atopic (English 41%, mixed English and Asian 42%, mostly Asian 37%, and Asian 32%). Though the odds ratio was lowest in Asians

TABLE 2
INDEPENDENT ODDS RATIOS, CONFIDENCE INTERVALS,
AND P VALUE FOR THE EFFECTS OF AGE, SEX,
ATOPY, AND DIET ON WHEEZE*

	Odds Ratio	95% CI	p Value
Constant	0.06	0.01–0.53	0.011
Age, per yr	0.99	0.79–1.25	0.971
Female sex	0.61	0.37–1.03	0.066
Atopy	9.11	5.13–16.16	< 0.001
Diet			
Asian	0.45	0.18–1.15	0.108
Mostly Asian	0.58	0.30–1.12	
Mixed	0.55	0.30–1.00	

* The odds are relative to a nonatopic male child, 8 yr of age, on an English diet.

on an exclusively English diet, the number on an English diet was insufficient for the analysis. Because only one white child had an Asian diet and only 17 Asian children had an exclusively English diet, an analysis of the separate effects of diet and ethnicity on atopy was not feasible.

Other factors associated with Westernization. There was no significant effect of dogs and cats at home, parental smoking, vegetarianism, religion, or duration of residence in the U.K. on wheeze, atopy, or hyperreactivity after adjusting for the effects of diet.

DISCUSSION

Within-survey comparisons of the prevalence of asthma between Asian and white children have shown a consistent trend for higher prevalence rates in white children. In surveys of Birmingham schoolchildren, both diagnosed asthma and current wheeze were higher among white children than Asians in 1968 (4) (5.5% versus 3.4%) and 1974 (6) (6.32% versus 4.2%). In a more recent study in Southampton 19.6% of European schoolchildren reported current wheeze compared with 11.9% of Asian children (11).

When Asian children living in the U.K. are divided into those born in the U.K. and those born abroad, the latter group tends to report less asthma. A diagnosis of asthma and current wheeze was reported for 4.2% of U.K.-born Asians compared with 2.8% of Asians born outside the U.K. (6) in Birmingham in 1974 though the proportion was similar (3.4%) in the two groups in an earlier survey (1968) (4). A national survey of inner city children in 1988 (12) showed that Asians born in Asia reported less wheeze (1.7%) than Asians born in the U.K. (2.3%) or in Kenya (2.6%). It is likely that the Kenyan Asians in this study had been exposed to a Westernized culture before moving to the U.K.

Studies in Africa have shown that asthma prevalence increases

TABLE 3
ODDS RATIOS, CONFIDENCE INTERVALS, AND P VALUE
FOR THE INDEPENDENT EFFECTS OF AGE, SEX, ATOPY, FEV₁,
AND DIET ON BRONCHIAL HYPERREACTIVITY*

	Odds Ratio	95% CI	p Value
Constant	3.36	0.75–15.10	0.013
Age, per yr	1.02	0.85–1.22	0.865
Female sex	0.74	0.52–1.04	0.085
Atopy	5.31	3.75–7.53	< 0.001
FEV ₁ , per L	0.24	0.13–0.44	< 0.001
Diet			
Asian	0.31	0.15–0.62	0.003
Mostly Asian	0.88	0.56–1.37	
Mixed	0.99	0.65–1.49	

* The odds are relative to a nonatopic male child, 8 yr of age, on an English diet.

TABLE 4
ODDS RATIOS, CONFIDENCE INTERVALS, AND
P VALUE FOR THE INDEPENDENT EFFECTS OF AGE,
SEX, AND DIET ON ATOPY*

	Odds Ratio	Atopy 95% CI	p Value
Constant	0.17	0.05–0.64	0.009
Age, per yr	1.15	1.00–1.32	0.046
Female sex	0.38	0.28–0.52	< 0.001
Diet			
Asian	1.22	0.72–2.06	< 0.025
Mostly Asian	1.47	0.99–2.19	
Mixed	1.78	1.23–2.58	

* The odds are relative to a nonatopic 8-yr-old male child on an English diet.

as indigenous populations move to the cities from rural communities. For example, in a study in Zimbabwe the prevalence of reversible airways obstruction was similar in black and white children in the most affluent areas of Harare (5.9% and 5.3%, respectively), lower in black children living in a less affluent area of Harare (3.1%), and only 0.1% in children from peasant families in a rural area (3). These data are therefore consistent with a dose response relation between degree of affluence and asthma. The most likely explanation is the influence of Western cultural environmental factors.

Evidence that changes in culture *per se* can affect asthma prevalence comes from surveys of populations as they adopt a more Western lifestyle while remaining in their usual geographic area. In such populations, genetic factors are constant and climatic and other general environmental conditions are unlikely to have changed. Studies in Papua New Guinea have revealed a substantial increase in the prevalence of asthma in adults from 0.28% in 1974 (13) to 7.3% in 1980 (14) at a time of increasing Western influence.

Our study was designed to investigate the influence of certain aspects of Western culture on the prevalence of atopy, bronchial reactivity, and current wheeze in Asian and white schoolchildren in the U.K. We found that current wheeze was reported more commonly in white (14.2%) than Asian (8.8%) children, and the difference was significant after controlling for age, sex, and atopic status. The unadjusted prevalence of hyperreactivity in our study was similar in the two groups of children, but after adjustment for differences in prevalence of atopy and baseline FEV₁, the risk of hyperreactivity was higher in white children. However, white children were significantly less likely to be atopic in keeping with data from Birmingham schoolchildren (15). Observed differences in atopy (response to one or more of cat, dog, grass, or house dust mite allergen) were unlikely to be due to differences in allergen exposure as all the children went to the same schools, were living in similar housing in the same districts, and had similar levels of pet ownership. There was no significant difference in reported parental smoking between ethnic groups overall, but we have no information about maternal smoking during pregnancy or according to sex of parent. There may however be cultural bias in the reporting of smoking, which could make smoking estimates unreliable, particularly in Asian women because of peer group pressures.

The difference in reported wheeze between the two ethnic groups was not explained by differences in atopy or hyperreactivity, nor was it consistent with the reporting of diagnosed asthma and school absence due to wheezing illness, which were similar for the two groups. The effect of atopy on all outcomes was the same in Asian and white children. Together with the finding that substantially more Asian children reported wheeze that was not reported by their parents, these results are consistent with some

reporting bias, such that parents of white children were more likely to report wheeze in their children than Asian parents.

We assessed the influence of degree of Westernization in explaining the observed differences in atopy and hyperreactivity by using diet as a marker of Western integration. We found that the risks of atopy and hyperreactivity in Asian children were related to diet, such that the more exclusively Asian the diet, the lower the risk of hyperreactivity and, with the exception of Asians on an exclusively English diet, also atopy. It was not possible in our analyses to separate the effects of ethnic origin and diet completely as they were closely associated, and independent effects of type of diet were not statistically significant, but the dose response relationships were not altered qualitatively by control for ethnic group in the analyses. Only Asians had mixed diets, so the observed dose response effects were not contributed to by white children and therefore only applied to Asian children.

If we assume that diet is a reasonable index of cultural integration, our results indicate that risks for atopy, hyperreactivity, and possibly wheeze increase in relation to diet or a closely related factor of Western culture. Vegetarianism showed no influence on outcome variables, which suggests that if diet was directly responsible it is likely to be more complex than the amounts of meat and vegetables consumed. Other aspects of diet were not assessed.

Whether dietary factors influence reactivity, atopy, and wheeze directly is not clear. There is evidence of genetic inheritance for atopy (16, 17), but environmental factors are also likely to be involved since we know, for example, that atopy can be potentiated by cigarette smoking (18–20). Although our finding of a strong association between diet and both atopy and bronchial reactivity does not prove causation, evidence that diet can influence asthma exists for food additives (21), food allergy (22), dietary salt consumption (23, 24), magnesium (25), and other trace elements (26).

An alternative explanation for our findings is that diet was a marker of some other Western exposure relevant to asthma or atopy. We considered factors such as household pets and parental smoking. The proportion of Asian households with a smoker and/or dog or cat was slightly higher for those taking an exclusively Asian diet compared with those taking other diets. Controlling for household pets and parental smoking in the analyses did not change the relation between diet and wheeze, atopy, and reactivity significantly.

The relation between diet and wheeze, atopy, and hyperreactivity was not influenced by religious following, which may be a marker for genetic variation within the Asian group, duration of residence in the U.K. or country of birth, although few Asian children in our sample were born outside the U.K. It seems unlikely therefore that diet was acting as a marker for environmental effects determined by place of birth.

Several studies have suggested that the prevalence of atopic disease tends to be higher among higher socioeconomic groups, and a recent study has shown an association between socioeconomic status and allergen skin sensitization (27). Our study population was unlikely to include wide variations in socioeconomic status. However, this is a possibility. There must be a causal explanation for the associations described between the prevalence of atopic diseases and the degree of Westernization, affluence, or socioeconomic status.

Although we cannot be certain whether diet was responsible for our observations or was simply acting as a marker for other causally related cultural factors, our results support the view that environmental factors associated with Western affluence exert important influences on asthma. Further studies of culturally diverse communities should help to determine which environmental factors are important and thus provide a basis for considering means of modifying the main risk factors.

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