

Association of allergic symptoms in children with those in their parents

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This study investigated the association of asthma, allergic rhinitis, and eczema in United Arab Emirates (UAE) schoolchildren with allergic conditions in their parents. A cross-sectional, population-based study among schoolchildren aged 6–14 years was conducted in Al-Ain City, UAE. The field survey was conducted from October 1992 to May 1993. A questionnaire was distributed to 850 UAE government school students from representative, randomly selected schools with a majority of UAE nationals. The student and both or either of the parents were present during the interview. A detailed clinical history of asthma and wheezing in the target children and a history of asthma and allergic rhinitis in their parents and siblings were obtained. It was found that 13.1% of asthmatic children had mothers with asthma (relative risk (RR) = 2.67; 95% confidence intervals (CI) = 1.65–4.35), and 15.2% had fathers who were asthmatic (RR = 2.85; 95% CI = 1.81–4.49). This contrasted with 4.4% of nonasthmatic children who had fathers with asthma, and 4.1% who had mothers with asthma. A similar pattern was seen with symptoms of allergic rhinitis when it was found that 34.3% of children who had asthma had mothers with allergic rhinitis (RR: 2.74; 95% CI: 1.90–3.94). The corresponding figure for fathers was 12.7% (RR: 0.92; 95% CI: 0.5–1.7). The frequency of either parent of the asthmatic children having allergic rhinitis was 28.6%; for both parents, it was 14.5%. It was also found that asthmatic children had 12.5% of their fathers, 32.8% of their mothers, 26.4% of either of their parents, and 33.3% of both their parents suffering from allergic rhinitis. Siblings of the asthmatic children were also studied to establish the relationship between allergic conditions in the siblings and asthma in the study sample. It was found that in the asthmatic study population the frequency of siblings having asthma was 31.9%; of those having allergic rhinitis, 21.3%; and of those having eczema, 16.1%. Twenty-nine percent of either of the parents of the children with eczema had the same condition, and the corresponding figure for allergic rhinitis was 36.5%. The prevalence rate of asthma in the schoolchildren studied increased dramatically to 22% when wheeze, asthma, or nocturnal cough were grouped together. When eczema and allergic rhinitis were also considered together along with the above, the rate increased to 31%. The size of the family did not seem to affect the parent/child association of allergic symptoms. Our findings indicate that there is a strong association between respiratory allergies and eczema in parents and in their asthmatic children, thereby indicating a strong genetic basis for the occurrence of asthma in particular and atopy in general.

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The prevalence rate of asthma in developed countries is reported to be 1.2–6.2% (16) and rising (25), increasing by 29% in 1980–7 in the USA (31). Possible causes of asthma have been the focus of several studies, genetic factors (30) being seen as playing an important part. It is difficult to find a cause-

and-effect relationship between asthma and the environmental and genetic causes ascribed to it. Many workers, using questionnaires, have measured associations of various risk factors for asthma on the basis of samples from birth cohorts (4), schoolchildren (7), general practices (23), clinics (10), etc.

Figures for the prevalence of asthma, allergic rhinitis, and wheezing vary from one country to another. It has been speculated that much of this variation is due to different factors; e.g., pollution, presence of allergens, socioeconomic factors, environmental influences, study design, and method of diagnosis. The United Arab Emirates (UAE) has a total area of 78 000 sq. km, a population of approximately 2 million, and most major cities and towns located on the coast. Al-Ain is an oasis town in the interior, and it therefore has a drier environment than other major towns. There are fewer industries, fewer cars, and a smaller population in Al-Ain than Dubai and Abu Dhabi, the two biggest cities in the UAE. On the other hand, it is greener, with more trees, shrubs, and plants.

The strong association of asthma, allergic rhinitis, wheezing, and eczema has been reported by several authors (1, 6, 9, 36). It is reasonably well documented from family and twin studies that asthma has a hereditary basis (5, 13, 24, 34). Although some work has been done on populations in neighboring countries (5), there has been little population-based work on asthma in the UAE studying its particular environment and the genetic makeup of its population. This study was therefore initiated to investigate the association of asthma, allergic rhinitis, and eczema in UAE schoolchildren aged 6–14 years and their parents.

Material and methods

The schoolchildren studied were the subjects of a cross-sectional population study conducted in both urban and rural areas of Al-Ain region in the UAE. The survey was done to study the prevalence of asthma among UAE schoolchildren aged 6–14 years, between October 1992 and May 1993.

The methods selected included a self-administered questionnaire for parents. We adopted, with modifications, Peat et al.'s (23) and Bener et al.'s (5) standardized questionnaires to determine the prevalence and severity of asthma. A multistage sampling method was used, and the schoolchildren were selected randomly. Stratification allowed both urban and rural areas to be proportionally represented. The list of names of government schools was obtained from the Director of General Education in the Ministry of Education. Government schools in Al-Ain are segregated by sex. There are 25 schools each for boys and girls located in 10 different districts. Of these 25 schools, 15 each of boys' and girls' schools have a majority of UAE nationals as students and are located in five districts. In the first stage, one school from each of these five districts was selected randomly, thus overcoming the so-called cluster effect. That could have occurred if the 15 schools were

put in one pool and names randomly selected, possibly resulting in schools in only one area of the town being represented. In the rural area, there are five primary schools (three for boys and two for girls), and one school each for boys and girls was selected randomly. Similarly, the classrooms and schoolchildren were selected in the second and third stages by the same simple random-sampling method, resulting in the selection of 850 students (determined sample size) who proportionally represented the study population.

The questionnaires with letters of explanation were distributed to the parents of those children who were UAE nationals, and who lived in either urban or rural areas of Al-Ain region. The questionnaires and administration team were the same for both urban and rural areas. The data we obtained were based on the information provided by the parents of these children. Both or either of the parents of each child was interviewed by senior medical students under the supervision of the physician. For most children, both parents were present, and in a few cases when parents were widowers or widows, one parent was present (fathers of five asthmatic and 14 nonasthmatic children and mothers of three asthmatic and 12 nonasthmatic children were dead at the time of study). All were biologic parents. Although the sample population included only children aged 6–14 years, when parents were asked about siblings in the family with an allergic condition, no age limit was imposed. In the analysis, the siblings were included only in the family studies and not in the calculation of the prevalence rates.

Before the studies, the repeatability of the questionnaire was determined in a separate study of children in grades 1–6 in primary schools in Al-Ain. Of 110 respondents to the first questionnaire, 93, who were the same parents who completed the first questionnaire, completed the questionnaire a second time, 5 weeks later. When the first questionnaire was administered, parents were not told of the second questionnaire. No alteration was made to the questionnaire before its use in the main study sample. To test for selection bias, peak expiratory flow measurements were made on 200 schoolchildren, selected by simple random sampling from 729 children, half of whom were asthmatic.

The self-administered questionnaire was completed by the parents and returned to the school. Wheezing was defined as an affirmative answer to the question, "Has the child at any time suffered from attacks of wheezy breathing, exercise wheeze, or night cough?" The questions concerning the diagnosis of asthma were, "Has the child at any time in his life suffered from an attack of asthma?", "What was the age at which asthma was first diagnosed?", and "Has the child ever needed treatment or hospi-

tal admission for asthma?" The question on allergy was, "Were you ever told that the frequent upper respiratory symptoms are due to allergy (allergic rhinitis)?" The question for eczema was, "Were you ever told by a physician that your child has eczema?"

The questionnaires were coded, entered, and processed on the IBM computer in the Department of Community Medicine of the Faculty of Medicine and Health Sciences at the UAE University (Al-Ain, UAE). The statistical package program SPSSx (27) was used in the chi-square analysis to ascertain the association between two or more categoric variables. Student's *t*-test was used to determine the significance of difference between two continuous variables. In 2×2 tables, the Fisher exact test was used instead of chi-square analysis, especially when the sample size was small. The relative risk (RR) and confidence intervals (CI) were obtained with the EPI 5 package (14). The level $P < 0.05$ was considered to be the cutoff value for significance.

Approval for the study was obtained from the Medical Ethics Committee of the Faculty of Medicine and Health Sciences of the UAE University, and the Director of General Education of the Ministry of Education. A signed consent form was obtained from the parents of each child after the explanation of aims and the nature of the study.

Results

Questionnaires with a letter of explanation were distributed to the parents of 850 children living in urban and rural areas. Parents of 729 children (85.8%) consented to the study. The age range of the children studied was 6–14 years, with a mean of 9.36 years and standard deviation of 2.11 years; 53% were girls, and 47% were boys. The measurements of repeatability used to assess the degree of reproducibility of the questionnaire were kappa values, average correct classification rates, and the proportion in agreement. Responses to the questionnaire, administered on two occasions by the same people, showed a high degree of repeatability between the first and second samples. The questions concerning diagnosed asthma (90%), wheeze (97%), and allergic rhinitis (85%) showed excellent agreement.

The sample of the asthmatic group of 100 students included five who were found to have completed the form incorrectly when questionnaires were reviewed. Similarly, seven asthmatic students were found to have completed the questionnaires wrongly as non-asthmatic. Biased or erroneous reporting could therefore be in the range of 5–7% of the total number of questionnaires completed.

The overall prevalence rate of asthma in this population was found to be 12.21%, the rate in the urban area (15.6%) being higher than in the rural area

(9.6%). Sixty-five boys and 34 girls had asthma or wheeze, giving a sex ratio of 1.9:1 (the sex ratio of the total population studied was 0.88:1). When asthma, wheeze, and nocturnal cough were taken together, 161/729 (giving a prevalence rate of 22.1%) children studied gave a positive history of at least one of these conditions. In 89 of these children, either the father or mother was affected (55.3%), relative risk 2.04 (95% CI = 1.32–2.45; $P < 0.0001$). When we considered either asthma, wheeze, cough, eczema, or allergic rhinitis in the children, we found 287/729 children had at least one of the above conditions. Of these 287 children, 195 had at least one parent (67.9%) suffering from any one of these conditions, and 142 nonasthmatic children had a parent with at least one of the above conditions (relative risk 2.4 (95% CI = 1.6–2.8; $P < 0.0001$).

Whereas the prevalence of asthma in fathers of nonasthmatic children was 4.4%, it reached 15.2% among asthmatic children (relative risk 2.85 (95% CI = 1.81–4.49). Similar values were observed for asthma in mothers (Table 1). It was found that 28.3% of asthmatic children had one parent with the above condition; this contrasted with 8.6% of nonasthmatic children who had one parent with asthma, the difference being statistically significant ($P < 0.0001$). A similar pattern was seen when the parent-child association of allergic rhinitis symptoms was investigated; 10.1% and 34.3% of wheezy children had fathers and mothers with allergic rhinitis, respectively. It was also found that 28.6% of wheezy children had one parent with allergic rhinitis, and 14.3% of wheezy children had both parents with allergic rhinitis. The prevalence rates of eczema in fathers, mothers, one parent, and both parents of children who were wheezy were 8.1%, 21.2%, 29.3%, and 5.1%, respectively. There were 167 children who had allergic rhinitis and 100 with eczema.

Table 1. Relationship of parental asthma, allergic rhinitis, and eczema to children's asthma¹

Allergic condition	Fathers		Mothers		Either parent	
	a	b	a	b	a	b
Asthma	15, (15.2%)	28	13, (13.1%)	26	28 (28.3%)	
	2.85 (1.81–4.49)*		2.67 (1.65–4.35)**		3.11 (2.14–4.51)*	
Allergic rhinitis	10, 10.1%	89	34, 34.3%	65	44 44.4%	
	0.92 (0.5–1.7) NS		2.74 (1.9–3.94)*		2.18 (1.52–3.12)*	
Eczema	8, 8.1%	68	21, 21.2%	43	29, 29.3%	106
	0.76 (0.38–1.49) NS		2.8 (0.186–4.21)*		1.58 (1.08–2.31)**	

¹ Prevalence, relative risk, and 95% CI are placed below figures.

a = no. of asthmatic children; b = no. of nonasthmatic children.

*($P < 0.0001$); **($P < 0.02$).

NS = not significant.

Table 2. Prevalence of allergic conditions in 729 children studied and occurrence of same condition in parents¹

Allergic condition	Children	Fathers	Mothers	Either parent
Asthma	99	15 2.85 (1.8–4.49)*	13 2.67 (1.65–4.35)**	28 3.11 (2.14–4.51)*
Eczema	100	22 2.42 (0.161–3.65)*	17 2.13 (1.35–3.35)**	29 8.14 (4.48–14.78)*
Allergic rhinitis	167	33 2.03 (0.160–2.74)*	49 2.17 (1.66–2.84)*	61 3.0 (2.36–3.85) NS
Asthma, wheeze, or cough	161	76 1.85 (1.7–2.55)*	85 2.03 (1.32–2.45)*	89 2 (1.50–2.40)*
Asthma, wheeze, cough, allergic rhinitis, or eczema	287	128 2.20 (1.87–2.60)*	156 3.26 (2.77–3.84)*	195 1.47 (1.39–1.67)*

¹ Prevalence, relative risk, and 95% CI are placed below figures.

* $P < 0.0001$; ** $P < 0.02$.

NS = not significant.

The frequencies of occurrence of the conditions in the children and their parents are presented in Table 2.

Prevalence rates for asthma or wheeze, allergic rhinitis, eczema, and cough are presented in Fig. 1.

Families were divided according to the numbers of children (Table 3). It was found that 25% of either fathers or mothers had asthma if more than one child in a family were affected, whereas 23% of either fathers or mothers had asthma in those families in which only one child was affected. This difference was not statistically significant. In 108 families with only one child, 18 had a child with asthma. In three of these families, either the mother or the father had asthma (16.7%). In 621 families with more than one child (ranging from two to eight), 60 families (9.7%) had one child affected, and 21 families had more than one child affected (3.4%; 25.9% of the total number of families with more than one child at least one of whom was affected). In five families (four families with two children, and one family with three), all children were affected (8.3% of affected families with more than one child).

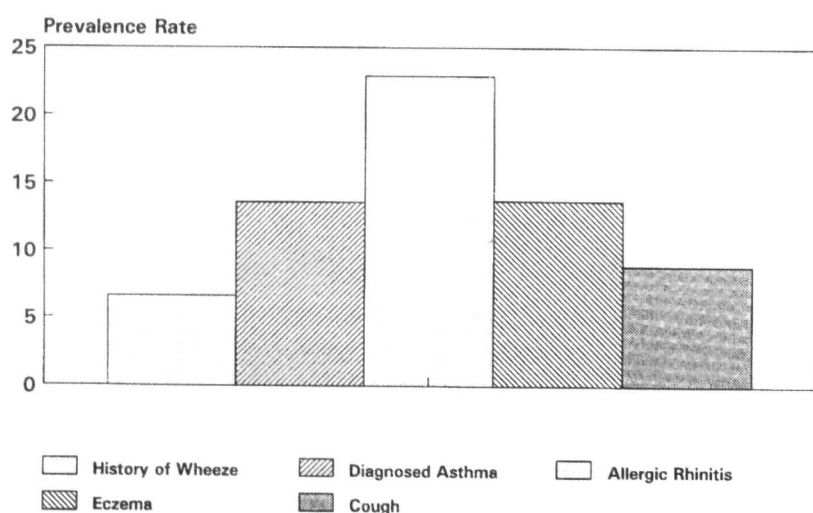


Fig. 1. Prevalence of asthma, wheeze, allergic rhinitis, and eczema in UAE.

Discussion

Our finding of a higher prevalence of asthma among offspring of parents with allergic respiratory diseases strongly supports the hypothesis that asthma is inherited, as reported previously (5, 13, 24). The finding of this study of the occurrence of asthma, allergic rhinitis, and eczema in the parents and asthma in the children suggests that these diseases involve a common genetic defect. The association of asthma, allergic rhinitis and eczema in the same patient has been reported in other studies (1, 21, 24, 33, 34, 36).

We have found a significant relationship between parental history of asthma, allergic rhinitis and eczema, and asthma in children. However, although we tried to exclude bias from the study, the possibility that biased reporting of the disorder by the family could have taken place cannot be ruled out. Reporting may depend on whether the parents had relatives with an allergic condition and therefore would have been more likely to recognize the condition in their offspring than those who did not have such relatives. Thus, the actual prevalence rates could be higher than our figures show. Moreover, when asthma, wheeze, and nocturnal cough were taken together to represent asthma, the prevalence rate obtained was significantly higher (22%, as compared with 12.2%) than those in the studies referred to earlier. This may be due to environmental factors such as an increase in respirable and ingestional allergens (19) that occurred with the rapid growth of the city, as reflected in the high prevalence rate of atopic conditions (31%) occurring in the study population. This high rate reported may mean either that the claims were exaggerated, or, more likely, that they were real. If this is an accurate representation of the actual rate, then an important factor that might affect it is the high rate of consanguinity among the local population (19). The repeatability and validity of the questionnaire were tested, showing that very

Table 3. Affected children divided according to size of family (number of children) and number of children affected in each family

Family size	No. of families with at least one affected child		No. of families with one child affected and status in parents		No. of families with more than one child affected and status in parents	
	No asthma	Asthma	Child	Parent	Child	Parent
1	90	18	18	3	0	0
2	128	24	20	6	4	2
3	123	13	10	3	3	0
4	113	7	5	2	2	0
5	78	19	16	5	3	1
6	52	10	7	4	3	1
7	14	4	1	0	3	1
8	7	4	1	0	3	2
> 8	25	0	0	0	0	0
Total	630	99	78	23	21	7

little bias had occurred and that it did not appear to affect the result significantly.

Other family studies have shown that their parents' history of allergic diseases clearly influences the presence or absence of children's symptoms (19, 20). Familial propensity to the condition has been reported in other studies. An odds ratio (OR) of 4.9 (33) was found in a study done in general practice when 17% of those diagnosed as asthmatic had asthmatic parents, as compared with 4% of controls. In an Australian study (18), an OR of 7.8 with 99% CI (5.2–11.8) was found for identical twins, and an OR of 2.1 for nonidentical twin pairs. A shared environment which is constant for families gives strong support to the general acceptance by workers in the field of the genetic basis of the association between parents' and children's respiratory allergies.

However, twin studies are necessary to distinguish between genetic and environmental effects. One large study of twins (30) showed a greater incidence of concordance in monozygotic (19%) than dizygotic twins (4.8%). A larger study conducted in Tasmania, Australia (19), on 8585 children found an OR of 2.63 (2.08–3.31) and 2.52 (1.99–3.19) in 7-year-old children with a history of asthma associated with their mother's or father's having a history of asthma, respectively. This association was found to be independent of sex of either parent and the atopic condition of the child. In the 133 children in whom both parents were asthmatic, 65 (49%) had a history of asthma. This was considered to be consistent with a genetic causation of asthma.

Our study has shown a definite link, as others have, between the occurrence of allergic conditions in the parents and in their children, with statistically significant differences in prevalence rates between wheezy children with asthmatic parents and non-wheezy children with asthmatic parents. In this study, an interesting feature was that asthma, eczema, and allergic rhinitis in mothers gave compa-

table OR (Table 1), but did not do so for these features in the fathers, in whom the asthma OR was higher. There is no plausible explanation for this occurrence, except that sex may influence the atopic condition, where maternal modification of developing immune responses occurs (11).

A study of 344 families (29) showed that the risk of developing asthma was 6.5% in children of parents who were not asthmatic. This risk increased to 19.7% if one parent was affected, and to 63.6% if both were affected. In our study, there is a similar increase in risk not only in children of parents with asthma but also in those with allergic rhinitis and eczema. An interesting finding in our study was that children with asthma were more likely to have mothers with allergic rhinitis and eczema than fathers with allergic rhinitis and eczema. Why this is so cannot be explained adequately. It could be speculated that it is related to genomic imprinting (17) wherein the differential expression of genetic material, at either a chromosomal or allelic level, depends on whether the genetic material has come from the father or the mother. There was no perceived sex difference in the heredity of either eczema or asthma, but a definite significant increase in the frequency of allergic rhinitis existed in the maternal line. Cookson et al. (11) showed that 62% of sibling pairs affected by atopy shared the maternal 11q13 allele, while only 46% shared the paternally derived alleles. The shared maternal allele differed significantly ($P = 0.001$) from the expected distribution, while paternally derived alleles were not significantly different from the expected ratio. Savilahti et al. (28) found that heredity was the only significant predictor of atopy. Many theories exist about how atopy is inherited: that it is inherited as a simple mendelian dominant character (12), that it is a simple recessive trait (2), that it is carried by a single autosomal dominant gene with reduced penetrance (32), and that it is a multifactorial inheritance (21).

The problem with comparing studies of this type

is that differences in definition, age groups studied, and sampling methods complicate the issues. A sampling method recently described using prescriptions was found to be very effective in identifying asthmatic patients in the community (26). The studies that we have quoted for comparison with our results come closest to agreeing with the criteria we used to define our population. Most of the family studies show that asthma has a large genetic component (24, 29). Moreover, there is much evidence that the occurrence of asthma in first-degree relatives of asthmatic patients is significantly higher than in the relatives of normal controls (21). However, the mode of inheritance has yet to be determined. Some classic examples of closed communities where prevalence of asthma is in the region of 20–30% imply strongly that genetic factors are important. At the same time, studies on migrating populations have shown a rise of prevalence of asthma in the same community which migrates from a low to a high prevalence area. This suggests also that environmental factors have a major role. These factors are yet to be determined. Even the sodium content of diet has been incriminated as one factor (8).

Ambient levels of air-quality indicators such as sulfur dioxide (SO₂), ozone, carbon monoxide, nitrogen dioxide (NO₂), lead, and suspended particulates have been measured in Dubai, UAE (35). All objectives (based on reviews from the USA) were met from the measured air quality, except for the respirable particulates (pm10). Fine dust pm10 levels exceeded accepted air-quality standards from May to December. Studies on asthma done in Melbourne, Australia (35) showed strong relations between high pm10 values and admissions of asthmatic children to hospital. The pm10 values in Melbourne were much lower than in Dubai. However, the nature of the particulate matter in Melbourne air was shown to be predominantly organic, whereas, in Dubai, it is predominantly inorganic (salt, sand). Another study presented the response in subjects to gaseous air-pollution levels, weather, and medicine intake. It was found that low relative humidity and increased levels of SO₂ and NO₂ corresponded to decreased peak flow rate in nonallergic asthmatic patients (22).

Al-Khayat & Habibullah (3), also reporting from Dubai, found that admissions of children with asthma increased between October and February, the cooler months of the year, during which time they were highest. They related that to low temperature and humidity. The maximum relative humidity occurs from September to March. Al-Ain has a higher temperature but a lower relative humidity than Dubai. It also has more pollen and other plant-based allergens, but the effect of these substances on incidence of asthma has not been studied in Al-Ain.

The UAE has one of the highest rates of consanguinity in the world; 31% of marriages are between first cousins, and 30% between those related less closely (15). Whether this has any bearing on the prevalence of asthma depends on the mode of inheritance of the trait. Therefore, in conclusion, although the cause of asthma is most probably multifactorial, the present study has shown that it is very likely that a genetic component is an important factor, because there is a greater risk that a child will develop asthma if either of his parents or any sibling has asthma or other allergies than if no relative has these disorders. The genetic expression of the disease may depend on the sex of the affected parent.

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