

Connections among parent and child atopic illnesses

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This study investigated parent–child connections for the atopic illnesses of asthma, eczema, food allergies, and hay fever, in a sample of 325 families. Parents reported whether they or their children currently had each condition and rated the frequency and intensity of its episodes; these ratings were combined to estimate illness severity. The data revealed five main findings. First, chi-square parent–child concordance analyses indicated that children of parents with any of the atopic illnesses studied were significantly more likely to develop that same disease than were children of parents without the illness. Second, children were progressively more likely to have at least one atopic illness when the number of their parents who were atopic increased from zero to two. Third, the number of atopic illnesses in the children was associated with the number of atopic illnesses in the parents. These three findings augment the evidence for genetic factors in the development of atopic illnesses and suggest that the atopies of each parent may contribute to an aggregate, generalized risk for their children. Fourth, maternal atopy was more strongly related to the children's asthma and hay fever than paternal atopy. Fifth, the severity of the children's specific atopic illnesses was not affected by the number of their parents who had the same condition and was not strongly related to the severity of their parents' condition.

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Atopic illnesses – e.g. asthma, eczema, food allergies, and hay fever – are characterized by a pronounced reaction or sensitivity of the immune system, generally to specific environmental conditions. In the United States, these diseases result in enormous numbers of restricted activity days and physician visits, and asthma poses a substantial and growing risk of death (1). Epidemiological data indicate that the worldwide prevalence of atopic conditions has increased in the last 50 years (2). Although the causes of atopy are not fully known, studies have found high levels of concordance among parents and their children for the presence of particular atopic conditions, especially asthma, eczema, and hay fever (3–13). This connection is determined partly by heredity. In the case of asthma, for example, studies have found higher concordance rates for the condition among identical (monozygotic) than fraternal (dizygotic) twins (14–17) and higher prevalence rates of the condition among the relatives of children with

asthma than children without asthma (3,18,19). Evidence at the molecular level also supports the role of heredity in atopic conditions (2,20). In addition, two recent findings indicate that heredity can affect the severity of an illness one inherits. First, a study in twins found evidence for a role of genetic factors in asthma, not only for its presence but also in its severity (21). Second, genetic evidence suggests that the size of the genetic fragment causing a disease may be correlated with the severity of the condition and may become larger in subsequent generations (22).

Research has revealed three important features regarding the connections among parent and child atopic illnesses. First, a study (13) found that the prevalence of asthma among children who had neither, one, or both parents afflicted with the same illness increased with the number of asthmatic parents; a similar relationship was found for hay fever/eczema. These findings suggest that each parent having an atopic illness

may contribute to an aggregate risk of their child developing that illness. Second, studies have found parent-child links across atopic illnesses, such that having a parent with, say, asthma, increases the risk that the child will have another atopic illness, such as eczema (6, 10–12, 23, 24). However, these risks to the child's health across atopic illnesses appear to be less strong and less consistent than for parent-child connections within the same illness. Third, the mother's atopic status appears to play a greater role than the father's status in the development of atopy in their children (25, but see recent inconsistent findings: 3,5,8–11).

The present study constitutes part of a larger investigation, the Family Health Project, which examined a variety of biopsychosocial factors in the development and characteristics of several childhood illnesses, particularly asthma. This study was conducted to extend the findings of other researchers regarding connections among parent and child atopic illnesses by using measures of the presence and severity of four diseases: asthma, eczema, food allergies, and hay fever. Virtually all prior studies linking parent and child atopy have assessed the presence, but not the severity, of these diseases. Five hypotheses were made.

- (a) Children of parents who have a particular atopic illness would be more likely to have that same illness than children whose parents do not have that disease.
- (b) The number of atopic conditions of the parents and of their children would be correlated.
- (c) Children who are atopic would be more likely to have atopic mothers than atopic fathers.
- (d) For parent-child pairs who are concordant for an atopic disease, severity ratings for that illness would be correlated.
- (e) The likelihood of children being atopic would increase as the number of their parents who are atopic increased.

It was also speculated that if the number of parents with an illness influences the presence of that disease, it might also influence the severity of the illness.

Subjects and methods

Subjects

Families ($n=325$) who participated in the Family Health Project were recruited through the National Organization of Mothers of Twins Clubs in the United States. Although these

families contained twin children, the present study did not compare twins. The mean ages for the full sample were 8.30 ± 7.07 years for the children and 38.57 ± 7.70 years for the parents. When recruiting participants, the clubs were asked to encourage all members to participate, especially those with family histories of asthma.

Methods

Parents (typically the mother) provided the data by completing an extensive survey that requested demographic information, biopsychosocial data, and illness histories regarding the biological parents and the children. The survey was approved by an Institutional Review Board, the cover letter clearly stated that individuals were free to choose not to participate, and procedures to ensure anonymity were described and maintained for all data collected. The respondents returned the surveys to the researcher either directly by mail or through the club after collection at a meeting.

The present analyses focused on illness history questions pertaining to four atopic conditions: asthma, eczema, food allergies, and hay fever. For each atopic illness, the respondent provided data on severity of illness in each parent and child by estimating on five-point rating scales the frequency (0=never, 1=rarely, 2=occasionally, 3=fairly often, and 4=very often) and intensity (0=never experience, 1=mild, 2=moderate, 3=fairly severe, and 4=very severe) of illness episodes the person would probably experience if he or she discontinued using relevant medication for 1 year, except when an episode was life-threatening. Scores ≥ 1 on both ratings signified the presence of an illness. Illness severity was defined as the product of the frequency and intensity ratings – an approach similar to that used to assess the severity of various illnesses with other instruments, such as the Psychosomatic Symptoms Checklist (26).

When parents reported data on their children, they arbitrarily designated a first and second twin, who will be referred to here as Child 1 and Child 2, respectively. Except as stated below, age restrictions were introduced to reduce false negatives in assessing the eventual development of these diseases in children. For analyses focusing on asthma, only data for families with children between 2 and 20 years of age were included. Although some children develop asthma in infancy, distinguishing between asthma and respiratory infections is difficult in children younger than 2 years of age and most individuals who will become afflicted do not

experience the onset until after 2 or 3 years of age (27,28). Wheezing during viral infections in the first 3 years of age is not a reliable predictor of later asthma (29). Restricting the children's ages to between 2 and 20 years retained data for 266 families; the children had a mean age of 7.72 ± 4.64 years, and 148 (55.6%) were male. For analyses focusing on the three other atopic illnesses, the families with children under 6 months or over 20 years of age were excluded. This age restriction left data for 294 families; these children had a mean age of 6.99 ± 4.81 years, and 164 (55.8%) were male. An spss statistical package for Windows was used in performing all data analyses.

To enhance data validity and reliability, respondents were prominently instructed to 'fill out the questions and pages in their presented order and answer each question as carefully and objectively as you can' and 'when answering questions about each individual, do not compare your answers to those you gave for other family members.' Questions regarding the parents and each child were on separate pages. The respondents were asked to complete the survey at a Mothers of Twins Club meeting or at home. Parents who completed the survey at home were asked to consult their children aged 10 years or older in answering questions about the children's illnesses.

The reliability of the parents' ratings was tested by applying Chronbach's alpha statistic on the frequency and intensity data for the four atopic illnesses of the children with asthma. These analyses were performed separately for Child 1 and Child 2 data and revealed substantial internal consistency of the ratings, with alphas 0.81 and 0.83, respectively. Two lines of evidence can be stated for the construct validity of the present approach in measuring illness severity. First, previous studies on asthma in which parents used the same rating scales have found that asthma severity in children is influenced by heredity (21) and is significantly correlated with the frequencies of early and recent respiratory infections and with the impact of respiratory infection as a trigger of asthma episodes (30). Second, other research has shown that parent reports regarding their children's episodic illnesses, such as headache and asthma, are reliable and valid (31,32).

Results

Given that the present study was not designed to compare members of twin pairs, some statistical tests reported below were conducted separately for Child 1 and Child 2, treating each pair of

analyses as if one analysis represented a replication study of the other. Separate analyses were performed on illness presence and severity data. In children, gender comparisons in the presence and severity of the illnesses revealed few differences. Eight of 10 2×2 chi-square tests performed on data for the presence of each atopic illness (asthma, hay fever, eczema, food allergy) and atopy of any type for Child 1 and Child 2 data, separately yielded no significant differences ($p > 0.14$; the two significant comparisons were for Child 1 asthma [$p = 0.009$] and atopy [$p = 0.048$]). All eight *t*-tests comparing severity data for each illness yielded no gender differences (all $p > 0.13$) for the Child 1 and Child 2 data. Although a possible reason for these non-significant findings is that some gender analyses involved very few children, all asthma and hay fever comparisons had a minimum of 67 cases.

To examine connections in the presence of parent and child atopic illnesses, three sets of analyses were performed. First, 2×2 chi-square tests were conducted for each atopic illness to determine whether children of parents who have a specific atopic illness are more likely to develop that illness than are children whose parents do not have the disease. Table 1 presents the outcomes of these tests, along with the proportion of children having each illness as a function of the presence of the illness in their parents. These analyses clearly show that the presence of each illness in one or both parents is a risk factor for that illness in their children. Because the number of families in which both parents had the same atopic illness was very small ($n < 9$) for three of the diseases (asthma, eczema, and food allergies), the influence of one vs. both parents was not assessed in performing these analyses. Each of the comparisons presented in Table 1 was also performed with the data separated by gender. All of these 16 analyses except one (Child 1 females for eczema) revealed statistically significant ($p < 0.04$) outcomes in the same direction found with the genders combined.

Second, parent-child connections in the presence of atopy – i.e. having one or more atopic illness – was examined by testing whether the likelihood of children being atopic increases with the number of atopic parents they have. Because these analyses did not focus only on asthma, data from all 322 families whose twins were at least 6 months of age were included. Of the 644 children, 299 were atopic. The percentages of children who were atopic if none, one, or both of their parents were atopic were, respectively: 33.33%, 48.41%, and 64.56% for Child 1; 28.21%, 50.00%, and 65.82% for Child 2. Both

Table 1. Child prevalence rates of asthma, eczema, food allergy, and hay fever as a function of illness status of the parents

Parent illness status	Prevalence rates of designated illnesses	
	Child 1	Child 2
Parental asthma		
Neither parent	68/235 (29%)	52/235 (22%)
One/both parents	29/53 (55%)	25/53 (47%)
Chi-square (d.f.=1)	12.868*	13.845*
Parental eczema		
Neither	23/241 (9.5%)	18/241 (7%)
One/both parents	22/81 (27%)	29/81 (36%)
Chi-square (d.f.=1)	15.650*	39.042*
Parental food allergy		
Neither	14/267 (5%)	15/267 (6%)
One/both parents	13/55 (24%)	15/55 (27%)
Chi-square (d.f.=1)	20.084*	25.312*
Parental hay fever		
Neither	20/151 (13%)	19/151 (13%)
One/both parents	68/171 (40%)	70/171 (41%)
Chi-square (d.f.=1)	28.400*	32.231*

*p < 0.001.

of these progressions were highly significant: for Child 1, chi-square = 18.65 (d.f.=2), p=0.000; for Child 2, chi-square = 28.23 (d.f.=2), p=0.000. Third, because many atopic individuals had more than one atopic disease, the data for all 236 families that had at least one atopic member were examined for the number of atopic diseases that the parents and children (ages 6 months to 20 years) had. Significant Pearson correlations [all d.f.=234] were found in the number of atopic diseases for the parents and Child 1 ($r=0.18$, $p=0.006$), for the parents and Child 2 ($r=0.20$, $p=0.002$), and between Child 1 and Child 2 ($r=0.36$, $p=0.000$).

The relative impact was examined of atopy in the mother and father on the development of their children's atopic conditions. Comparisons were made among child participants with each atopic illness for the frequencies of the presence of the same illness and of atopy, in general, in the mother only, the father only, or in both parents. The mother-only frequencies were numerically greater than the father-only frequencies in all comparisons except one (they were equal in a food allergy comparison). The frequency data for each illness were subjected to separate one-sample (one-way) chi-square tests. Table 2 presents the frequency data and the outcomes of these analyses for the Child 1 and Child 2 illnesses of asthma and hay fever. These results indicate that the presence of the same illness or of atopy in general in the mother is more strongly associated with development of asthma and hay fever in the child than the presence of these conditions in the father. The statistical outcomes for eczema and food allergy were mostly non-significant, perhaps

because of the low frequencies of these illnesses in this sample.

Two sets of analyses were carried out to assess parent-child connections in the severity of their atopic illnesses. First, Pearson correlations were computed between parent and child illness severity data for each illness. These analyses included only data from those families in which at least one parent and one child had the same illness and the children met the age restrictions, described above, for each illness. With these restrictions, 38 families were included in the analysis for asthma, 33 families for eczema, 15 families for food allergies, and 78 families for hay fever. In cases where both parents or both children were afflicted, the mean severity score for the illness of the parents or the children was used. All correlations of parent and child illness severity data were non-significant ($p>0.17$), except for eczema ($r=0.39$ [d.f.=32], $p=0.026$). Second, to test whether the severity of an atopic condition developed by a child was influenced by the number of parents they had with that illness, data from all 325 families were used. In cases where both children were afflicted, the mean severity score was used. The number of families showing illness concordance in a child and both parents was substantial for hay fever ($n=36$), but not for the three other diseases. Consequently, for hay fever a one-way analysis of variance was performed, comparing illness severity data of children with neither, one, or both parents afflicted; for asthma, eczema, and food allergies, t -tests compared illness severity data in children with neither vs. one or both parents afflicted. All analyses failed to show any significant differences ($p>0.30$), despite analyzing 21–89 subjects in each group.

Discussion

The results of the present study support and extend those of previous investigations regarding connections among parent and child atopic illnesses. These data confirm the previous findings (described above) that children are more likely to develop asthma, eczema, food allergies, or hay fever if their parents are afflicted with the specific illness than if their parents are not. The current data also support the possibility that atopic illnesses in children are affected more by maternal factors than paternal factors, at least for asthma and hay fever.

In addition, this study found few gender differences in the presence and severity of the atopic conditions of the children in this sample. Moreover, the data also revealed great consis-

Table 2. Frequencies and chi-square analyses of maternal and paternal atopic conditions in relation to their children's atopic illnesses

Illness	Parental frequency of same illness*						Parental frequency of atopy*					
	MO	FO	Both	Total	Chi-square	p	MO	FO	Both	Total	Chi-square	p
Asthma												
Child 1	15	17	4	26	7.46	0.024	24	8	32	64	14.00	0.001
Child 2	12	6	5	23	3.74	0.154	23	5	21	49	11.92	0.003
Hay fever												
Child 1	25	8	29	62	12.03	0.002	23	7	37	67	20.18	0.000
Child 2	29	8	31	68	14.32	0.001	28	7	38	73	20.57	0.000

*FO, father only; MO, mother only.

tendency in the heightened risks for both boys and girls for developing the same atopic condition as their parents – that is, the connection with parental affliction was unchanged in analyses when these data were separated by gender. This high level of consistency contrasts with the outcomes of other studies. For example, one study (24) reported that the presence of asthma in the parents posed a risk for boys, but not for girls, but the presence of eczema in the parents presented a risk for both boys and girls. Another study (12) found that parental asthma posed a greater risk of the development of asthma in girls than in boys. The reason for these contradictory findings on gender risks is unclear.

Two current findings extend our knowledge regarding connections among parent and child atopic illnesses. First, an association was found between the number of atopic illnesses in children and their parents. Second, the data revealed that the risk of a child becoming atopic – i.e. developing any of the four atopic illnesses examined – increases progressively with the number of their parents who are atopic. These outcomes are consistent with four previous findings:

- Children's risks for asthma and for hay fever/eczema increase as the number of parents with the same illness increases (13).
- Children have an especially high risk of developing a specific allergy if they have more than one relative with the same allergy (6).
- Parents and children who are concordant for having allergic rhinitis (hay fever) often do not share the same specific allergies (33).
- As described above, several studies have found that having a parent with an atopic illness increases the risk of a child developing a different atopic condition.

The present results indicate that an atopic illness in each parent may contribute to an aggregate risk of their child being atopic and,

together with previous findings, suggest that a component of the connection between parent and child atopic illness may involve a generalized tendency towards becoming atopic.

In contrast to the research hypothesis and speculation, almost no connection was found between the severity of atopic illness in children and either the severity of their parents' illnesses or the number of their parents who were atopic. Four explanations may be considered for this outcome. First, in the present research, the number of subjects in some analyses may not have been sufficiently large to demonstrate significant relationships between parent and child illness severities. However, the correlation coefficient was low (0.16) for parent-child hay fever severity with 78 pairs. Second, previous research has found weaker atopic correspondence between parents and children than between siblings (34). Third, it is very difficult for parents and physicians to determine the source of a specific allergy episode. Fourth, the clinical course of a reaction to allergens changes with maturation. For instance, food allergies diagnosed in a child's first year are likely to disappear by the third year (35). Although parent-child atopic illness severities may simply be weakly related, another possibility is that their relationship would be stronger if assessed at comparable developmental periods. This would require comparisons of parent and child pediatric records, which might only be possible in societies that have national health records.

The relationships between parent and child atopic illnesses in this study are provocative but should be interpreted cautiously for at least two reasons. First, data collected through questionnaires are always subject to concern regarding their validity and reliability with respect to the potential for biased reporting and the accuracy of the knowledge and memories of the respondents, particularly when providing information on individuals other than themselves. Second, the current data relied on ratings collected from one

respondent (virtually always the mother) without confirmation from other sources. Independent corroboration might have provided additional evidence for the validity of the present data, but no practical or reliable source was available. These psychometric issues can be addressed in five ways. First, evidence for the reliability and validity of the current ratings was given above. Second, as researchers have noted, survey methodology is common in research on atopic illnesses because symptoms occur episodically, thereby making medical diagnoses of the presence and severity of these conditions more difficult than for many other diseases (6,36,37). Third, the finding that parent-child illness severities were correlated for eczema, but not for the other diseases, suggests that the respondents tried to be accurate and to not compare the ratings they gave for different family members. Fourth, having one person report on all members of the family may have promoted internal consistency in the way the parents interpreted the questions and used the rating scales. Fifth, a previous study comparing data on children's illnesses (e.g. asthma and bronchitis) from parent reports and pediatric records found very high levels of agreement (32).

In conclusion, the present data confirm and extend prior findings regarding the role of heredity in atopic illness. The results indicate that children are at heightened risk for developing a specific atopic illness if their parents have that illness, and provide preliminary evidence for the view that atopy in each parent may contribute to an aggregate, generalized risk of their child becoming atopic. However, the severity of specific atopic conditions in children does not seem to be affected by the number of their parents who have the same condition or by the severity of their parents' condition.

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