

Association of specific allergen sensitization with socioeconomic factors and allergic disease in a population of Boston women

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Background: Socioeconomic differences in allergic disease prevalence have been reported; asthma has been associated with poverty in the United States and hay fever and eczema with relative affluence elsewhere. It is not yet established to what degree such differences in disease prevalence reflect patterns of sensitization and specific allergen sensitivities.

Objective: We analyzed specific and total IgE measurements in a sample of 458 women, enriched for allergic disease, from the metropolitan Boston area to establish the relation of allergen sensitization to markers of socioeconomic status (SES) and to the prevalence and socioeconomic pattern of allergic disease in this community.

Methods: Total and specific IgE antibodies were measured with the UNICAP System; self-reported allergic disease, household income, education, and race-ethnicity were ascertained with a questionnaire; and a further marker of poverty (percentage living below the poverty level) in the women's area of residence was established on the basis of zip codes. Analysis was performed with SAS statistical software.

Results: Markers of low SES were univariately associated with increases in total IgE, number of allergen sensitizations, and levels of specific IgE. Socioeconomic differences in sensitization to cockroach (35% vs 6% in the highest and lowest poverty areas), animal (44% vs 26%), and ragweed (49% vs 23%) allergens were most marked. Sensitization primarily to indoor inhalant allergens (not ragweed or ryegrass) were associated with an increased risk of asthma, even after adjustment for SES.

Conclusion: We have demonstrated a socioeconomic gradient in sensitization that concurs with increased rates of asthma in less affluent communities in this population. (*J Allergy Clin Immunol* 2001;107:615-22.)

Key words: Sensitization, total IgE, socioeconomic status, asthma

Abbreviations used

NHANES: National Health and Nutrition Examination Survey
OR: Odds ratio
SES: Socioeconomic status

The prevalence of asthma and allergic disease is reported to vary markedly by socioeconomic status (SES) in several developed countries, and it is likely that this pattern is partly attributable to differential exposure and sensitization to allergens. Asthma was increased in relation to poverty in our Epidemiology of Home Allergens and Asthma Study cohort, which was composed of families within metropolitan Boston.¹ In contrast, hay fever, eczema, and asthma prevalence have been associated with relative affluence in Britain.²⁻⁴ Patterns of allergen sensitization also vary between populations^{5,6} and between socioeconomic strata within populations.⁷⁻⁹ It is widely assumed that this variation partly reflects the ecology of communities and the allergens to which the populace is exposed. In our cohort cockroach allergen levels were higher than dust mite allergen levels in less socioeconomically advantaged homes, but the converse was true in more affluent homes.¹⁰ Specific allergen sensitivities may also vary in their importance in different allergic phenotypes. Dust mite and cat allergen sensitivity have been strongly linked to asthma in some societies^{11,12}; sensitivity to pollen and other outdoor allergens may be relatively more important in hay fever and allergic rhinitis.¹³ More recently, cockroach allergen has been implicated in asthma morbidity.^{9,14-16} To what extent patterns of allergen sensitization explain the observed socioeconomic differences in the prevalence of asthma and other allergic disease has yet to be established. The relationship between SES; allergic disease, asthma, or both; and sensitization in women in their childbearing years is of great interest in that the prevalence of asthma in female subjects increases and catches up with that of male subjects during that period in the life cycle.¹⁷

We have therefore analyzed specific and total IgE levels in mothers in the Epidemiology of Home Allergen and Asthma Study to establish the pattern and burden of allergic sensitization according to markers of SES. We have assessed the relation of specific allergen sensitivi-

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Supported by the National Institutes of Health grants RO1 AI/EHS35786 and A1 20565 and the UK Medical Research Council (Fellowship, S. A. Lewis).

Received for publication May 12, 2000; revised December 4, 2000; accepted for publication December 5, 2000.

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0091-6749/2001 \$35.00 + 0 1/81/113523
doi:10.1067/mai.2001.113523

TABLE I. General characteristics of all 458 women with assessment of IgE to at least one allergen and the subset of 300 women with doctor-diagnosed allergic disease, asthma, or both

Characteristics	Whole sample		Subset with doctor-diagnosed allergic disease, asthma, or both	
	No.	%	No.	%
Age group (y)				
18-30	112	24.5	84	28.0
30-33	116	25.3	70	23.3
33-36	113	24.7	76	25.3
36-46	117	25.5	70	23.3
Race				
White	363	79.3	234	78.0
Black	51	11.1	34	11.3
Hispanic	24	5.2	19	6.3
Asian	16	3.5	9	3.0
Other	4	0.9	4	1.3
Area poverty (% below poverty line)				
<5%	180	39.3	112	37.3
5%-10%	130	28.4	83	27.7
10%-20%	105	22.9	74	24.7
>20%	43	9.4	31	10.3
Household income				
>\$50,000	319	69.7	202	67.3
\$30,000-\$50,000	83	18.1	63	21.0
<\$30,000	43	9.4	28	9.3
Unknown	13	2.8	7	2.3
Maternal education				
College or more	357	77.9	228	76.0
No college education	101	22.1	72	24.0
Total IgE (IU/mL)				
All	38.3*	12.8-118†	59.8*	23.0-169†
By area poverty				
<5%	31.6*	12.7-93.7†	51.0*	19.4-152†
5%-10%	34.5*	9.9-114†	57.8*	23.6-177†
10%-20%	47.5*	19.4-126†	66.6*	26.1-166†
>20%	69.1*	20.1-255†	90.0*	23.1-286†

*Geometric mean.

†Interquartile range.

ties to allergic phenotypes of asthma, eczema, and hay fever and compared our findings with the socioeconomic pattern of allergic disease in this community.

METHODS

Subjects

This study involves the mothers of children in the Epidemiology of Home Allergens and Asthma Study, an ongoing longitudinal birth and family cohort study, which has been described in detail elsewhere.^{1,10,18} In summary, all women met the following criteria: delivery of a child on a weekday between September 1994 and June 1996 at a hospital in Boston, Massachusetts; age of 18 years or older; ability to speak English or Spanish; and residence within Route 128 (the highway encircling the metropolitan Boston area). Women who gave birth to a child who was premature (<36 weeks), had major congenital abnormalities, or was hospitalized in the neonatal unit were excluded. These women completed a preliminary screening questionnaire that elicited details of allergy and allergic disease in the mother and the biologic father of the newborn. If either of these individuals had a doctor's diagnosis of asthma or hay fever or of allergy to house dust or house dust mites, cockroach, pollen, animals, or mold, the family was eligible for inclusion in the cohort study. The mothers therefore comprised a

population of women enriched for allergic disease. Maternal serum was collected from the blood just before the birth of the child. Four hundred ninety-nine mothers (and families) entered the longitudinal study; sera were not available for 41 mothers. We have analyzed data on the whole group (n = 458) and on the subset in which the mother (as opposed to just the child's father) was reported to have one or more of the diagnoses (defined as diagnosed allergic disease, asthma, or both). A complete set of specific IgE levels was available for 446 women.

IgE analysis

The serum sample was analyzed for total and specific IgE antibodies, as measured with the UNICAP System (Pharmacia, Uppsala, Sweden). For approximately 20 samples of low volume, IgE antibodies were measured with the CAP RAST FEIA System (Pharmacia), which requires less serum per assay. Specific IgE antibodies were assayed for mite, cat, cockroach, dog, ryegrass, ragweed, *Alternaria* species, and *Aspergillus* species allergens, with each allergen attached to a cellulose sponge (ImmunoCAP). Addition of patient serum (0.05 mL) allows specific IgE antibodies in the serum to bind to the allergen under conditions of antigen excess. After washing, the bound IgE is detected with purified antibody to IgE conjugated to an enzyme label. After further washing, a substrate is used to create a fluorescent signal, which

is a function of the quantity of specific IgE. The assay for measuring total IgE involves the same procedure with a sponge coated with antibody to IgE. The results are given as international units of IgE. In the CAP system CAP classes correspond to the following units: 0, 0 to less than 0.35 IU/mL; 1, 0.35 to less than 0.7 IU/mL; 2, 0.7 to less than 3.5 IU/mL; 3, 3.5 to less than 17.5 IU/mL; 4, 17.5 to less than 50 IU/mL; 5, 50 to less than 100 IU/mL; and 6, 100 IU/mL or greater.

We defined sensitivity to a specific allergen as CAP class level 1 or above (>0.35 IU/mL) and high specific IgE as CAP class 3 or above (>3.5 IU/mL). Sensitivity to cat or dog allergen was defined as animal allergy, ragweed or ryegrass as pollen allergy, and *Alternaria* or *Aspergillus* species as mold allergy. An individual was described as having "any allergen sensitivity" if he or she was sensitive to one or more specific allergens or had a total IgE level of 200 IU/mL or greater. Total IgE levels below the detection limit of 2 IU/mL were assigned a value of 2 for analysis.

Ascertainment of self-reported allergic disease and specific allergies

The interview-based screening questionnaire contained 3 separate questions asking the following: has a doctor ever said that you have (1) asthma, (2) hay fever, or (3) eczema? Positive responses were defined as doctor-diagnosed asthma, hay fever, and eczema, respectively. A further question asked the following: to which of the following has the doctor told you that you are allergic? House dust or house dust mites, cockroach, pollen, animals, and mold were then specifically prompted. If the women reported either doctor-diagnosed allergy to these inhalant allergens or doctor-diagnosed asthma, hay fever, or eczema, they were considered to be in the subpopulation with diagnosed allergic disease, asthma, or both.

Markers of race and SES

Race was determined by the woman's response to a question asking in which ethnic or racial group she would classify herself and categorized for analysis as white, black, Hispanic, or Asian, as previously shown.¹

Details of demographic and socioeconomic characteristics of the family were elicited by questionnaire at a home visit. Family income and personal educational level were categorized as less than \$30,000, \$30,000 to \$49,999, or greater than \$50,000 and high school or lower and college or above, respectively, for analysis. The women were also asked whether they currently smoked cigarettes (as of a month ago); those who responded positively were defined as current smokers.

A marker of poverty in the women's area of residence was established by zip code evaluated in terms of the proportion of the population in that zip code living below the poverty level (composite variable on the basis of family income and family size, according to 1990 US Census data) and categorized for analysis from less than 5%, 5% to 10%, 10% to 20%, or greater than 20% below the poverty level.

Statistical analysis

The prevalence of specific allergen sensitivities and combinations of sensitivities was compared with reported doctor-diagnosed allergic sensitivities by means of cross-tabulation. Associations of specific, any, and multiple allergen sensitivities and of allergic disease with markers of SES were analyzed by using the χ^2 test of independence (for race and education) or trend for ordinal variables (for area poverty and income). Adjustment for potential confounders, including age and race, was made by means of multiple logistic regression. We analyzed the relation of asthma, eczema, and hay fever with specific allergen sensitivity, controlling for age, markers of SES, and the presence or absence of any sensitivity by using multiple logistic regression.

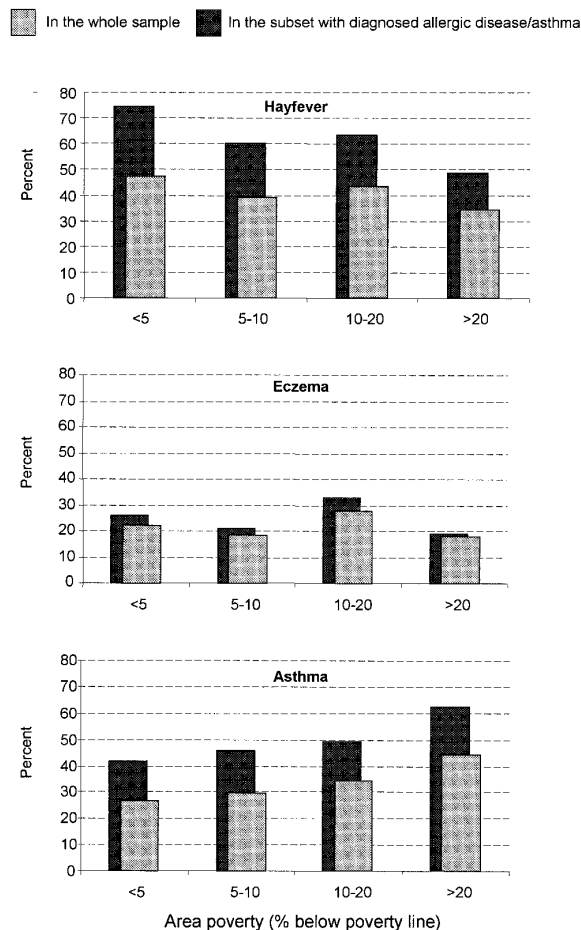


FIG 1. Hay fever, eczema, and asthma according to area poverty in the whole study population and the subset with diagnosed allergic disease, asthma, or both.

All univariate and multivariate analyses were done with SAS statistical software (SAS Institute, Inc, Cary, NC).

RESULTS

The characteristics of the 458 women for whom specific IgE levels were assessed are given in Table I. This study population was aged between 18 and 46 years; the majority were white (79%), educated to college level or beyond (78%), and living in a household where the income exceeded \$50,000 (70%). Few were current smokers (5%). In this group enriched for allergic disease, 31% reported doctor-diagnosed asthma, 43% reported hay fever, and 22% reported eczema. The subset with diagnosed allergic disease, asthma, or both was marginally younger but otherwise had similar characteristics. Contrary to the socioeconomic pattern of asthma previously documented for this cohort and presented in Fig 1 for comparison, hay fever tended to be more common in areas of relative affluence; this trend was significant when restricted to the women with diagnosed allergic disease, asthma, or both ($P = .007$). There was no relation of eczema with any markers of SES.

TABLE II. Relation of doctor-diagnosed allergy, allergic disease, or both to specific IgE levels

Reported allergy		No. (%)	IgE Cap class 1 or greater, No. (row %; measured allergen)
Cockroach	Yes	18 (4.2)	8 (44.4; cockroach)
	No	415 (95.8)	39 (9.4)
Animal	Yes	136 (30.3)	89 (65.4; cat or dog)
	No	313 (69.7)	53 (16.9)
Pollen	Yes	197 (43.7)	102 (51.8; ryegrass or ragweed)
	No	254 (56.3)	59 (23.2)
Dust-dust mite	Yes	158 (34.9)	80 (50.6; dust mite)
	No	295 (65.1)	82 (27.8)
Mold	Yes	97 (22.0)	18 (18.6; <i>Alternaria</i> or <i>Aspergillus</i> species)
	No	337 (77.6)	35 (10.4)
Asthma	Yes	141 (31.1)	107 (75.9; any of the above)
	No	313 (68.9)	165 (52.7)
Hay fever	Yes	192 (42.9)	159 (82.8; any of the above)
	No	255 (57.1)	108 (42.3)
Eczema	Yes	99 (22.0)	68 (68.7; any of the above)
	No	350 (78.0)	201 (57.4)
Doctor-diagnosed allergic disease, asthma, or both	Yes	300 (66.4)	231 (77.0; any of the above)
	No	152 (33.6)	40 (26.3)

Prevalence of specific allergen sensitivity

Sixty percent of this study population had any allergen sensitivity. Sensitization to mite allergen (IgE CAP class ≥ 1) was most common (36%), and sensitization to *Aspergillus* species was rare (4%). Multiple sensitivities were common; sensitivity to dog allergen was generally coexistent with sensitivity to cat allergen (98%), and sensitivity to *Aspergillus* species was generally coexistent with sensitivity to *Alternaria* species (85%). Eleven percent were sensitized to cockroach allergen, with the majority (94%) of these being sensitized to at least one of the other measured allergens, most commonly mite, ragweed, dog, or cat allergen. There was relatively little overlap between sensitization to the 2 pollens, ryegrass and ragweed. Only mite allergy occurred commonly in the absence of other sensitivities. High specific IgE (CAP class ≥ 3) levels were present in 3.5% (cockroach), 24% (mite), 13% (cat), 3% (dog), 12% (ryegrass), and 9% (ragweed) of the women.

Individuals with IgE to cockroach seldom reported doctor-diagnosed cockroach allergy; allergy to animals was most accurately reported (Table II).

Association of allergen sensitivity to socioeconomic indicators and race

Sensitivity to cockroach allergen was markedly increased in direct relation to area poverty ($P < .001$, Fig 2) and to all other markers of low SES and in ethnic minority groups, irrespective of whether all women or just the allergic subgroup were considered. SES, race, and age were closely associated in this population, and after controlling for race and age, the relation of cockroach sensitivity to poverty, low income, and lower educational level reached only borderline statistical signifi-

cance (all $P \leq .11$). The percentage of individuals with high ($\geq$ CAP class 3) IgE levels to cockroach allergen was also increased in the poorest area at 14%.

Cat and ragweed sensitivity were also significantly (both $P = 0.01$) more common, and sensitivity to dog allergen tended to be more common ($P = .06$) in women living in the highest poverty area; the proportion with high levels of specific IgE to both dog and ragweed allergen was also increased. Sensitivity to cat or dog allergen was unrelated to race or other SES variables; ragweed sensitivity tended to occur more frequently in those of nonwhite race but not after controlling for area poverty. Sensitivity to dust mite, *Alternaria* species, and *Aspergillus* species and high IgE levels to these allergens were equally common across all markers of SES. Ryegrass sensitization alone was more common in relation to some markers of high SES, especially when analysis was restricted to those with diagnosed allergy, but the trends were weak and nonsignificant.

Those living in areas of greatest poverty were consequently at the greatest risk of having any allergen sensitivity and of being sensitized to a number of different allergens (Fig 3, A); this was also apparent within those with diagnosed allergic disease, asthma, or both and within the subgroup with diagnosed asthma (Fig 3, B). There was a corresponding trend in mean total IgE levels across levels of area poverty ($P < .001$). The trend in allergen sensitivity with area poverty was most apparent where household income was greater than \$50,000. Allergen sensitivity was independently increased in those with a household income below \$50,000 (adjusted odds ratio [OR], 1.6; 95% CI, 1.0-2.7). The most common sensitivities among sensitized individuals in the highest poverty area and low income groups were cockroach, dust mite, cat, and ragweed, with the prevalence ranging from 50% to 70% for these allergens.

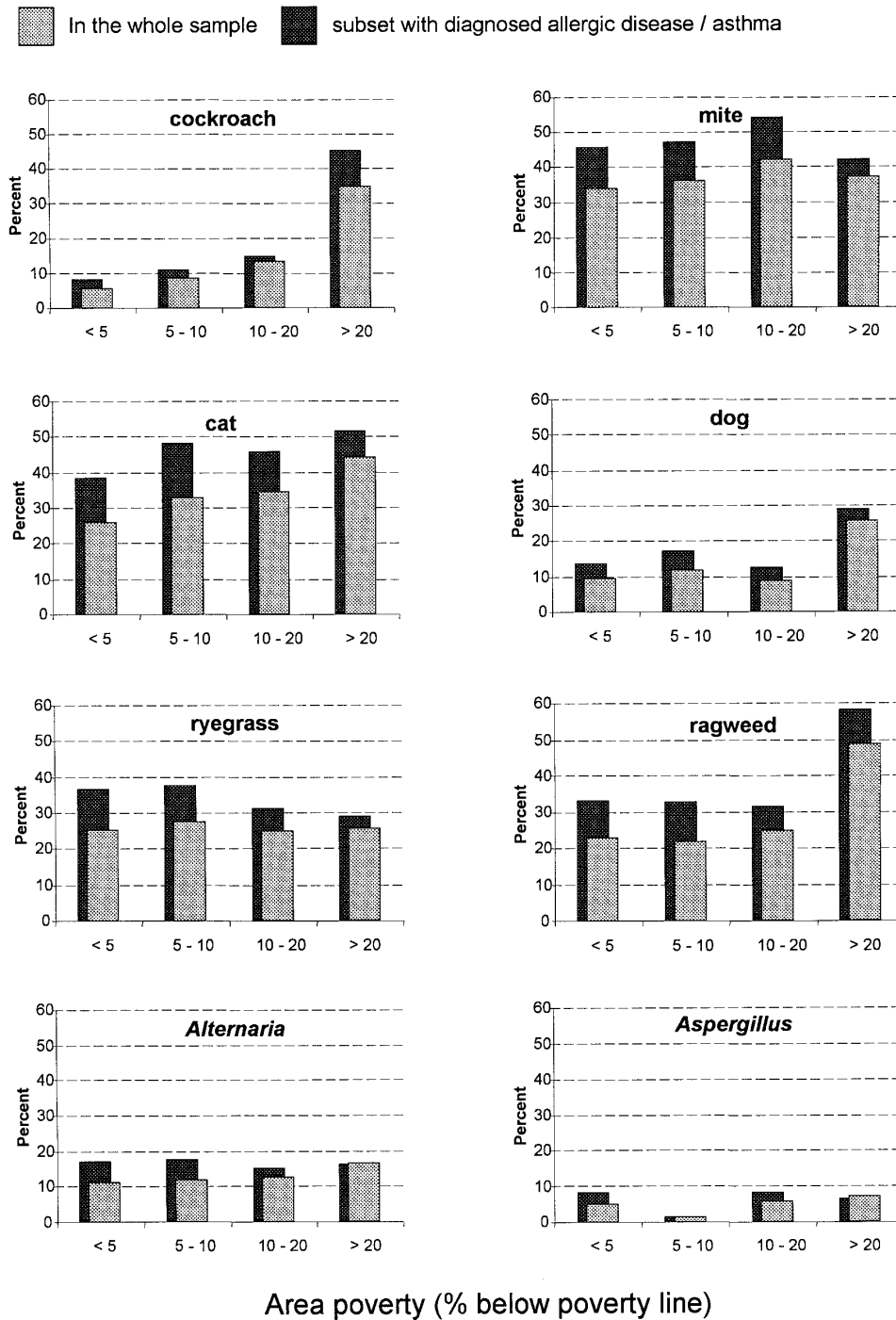


FIG 2. Sensitization (CAP class ≥ 1) to cockroach, mite, cat, dog, ryegrass, ragweed, *Alternaria* species, and *Aspergillus* species according to area poverty in the whole study population and the subset with diagnosed allergic disease, asthma, or both (unadjusted percentages).

Relation of asthma, hay fever, and eczema to specific allergen sensitivity

Doctor-diagnosed asthma was strongly associated with having any allergen sensitivity, most markedly with sensitization to cockroach (unadjusted OR, 5.4), animals

(cat OR, 4.0; dog OR, 5.9), and mite (OR, 3.0) allergen, even after controlling for age, SES indicators, race, and presence of any allergen sensitivity (Table III). The risk of diagnosed asthma increased with the level of IgE specific to each of these allergens, with the condition occurring in 81% of those with cockroach IgE at CAP class 3

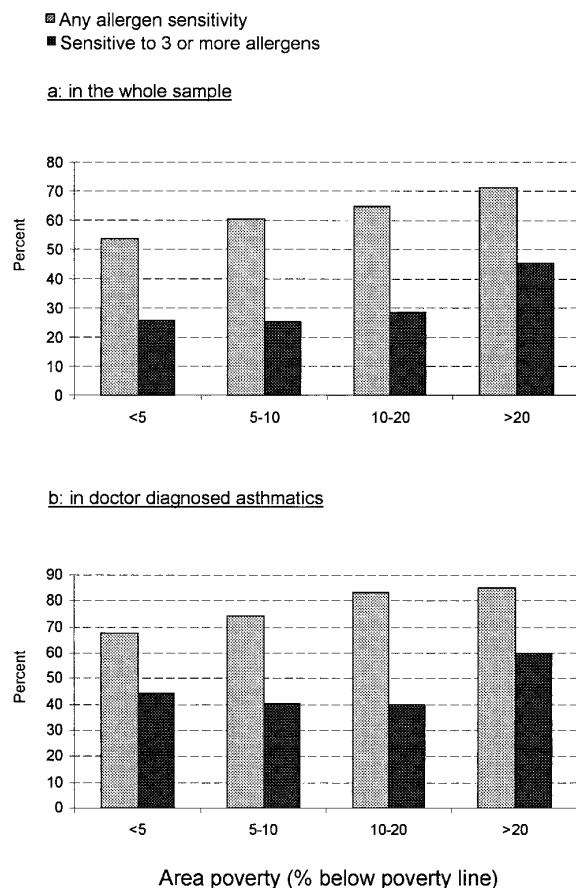


FIG 3. Any allergen sensitivity and multiple sensitivity (sensitivity to ≥ 3 allergens) according to area poverty in the whole study population and the subset with diagnosed asthma.

or greater and 68%, 86%, and 52%, respectively, of those with cat, dog, and mite IgE at this level. These findings contrasted with those for hay fever, which was associated with sensitivity to ryegrass (adjusted OR, 2.2) and ragweed pollen (OR, 1.7) in addition to cat (OR, 2.2) and relatively weakly related to the level of IgE to these allergens. Both conditions were more common in those with multiple sensitivities.

The occurrence of doctor-diagnosed eczema was significantly increased in those with any allergen sensitivity but more weakly related to sensitivity to individual specific allergens measured in this study than either asthma or hay fever. The strongest relation was with sensitivity to *Aspergillus* species, which reached borderline statistical significance ($P = .06$).

DISCUSSION

We previously reported that asthma was associated with low SES in this study of mothers from the greater Boston area. We have now demonstrated a socioeconomic gradient in sensitization, in which the poorest have increased total IgE levels, increased numbers of allergen

sensitizations, and increased levels of specific IgE to many of the allergens to which they are sensitized. Socioeconomic differences in sensitization to cockroach, household pets, and ragweed were most marked. Cockroach and animal sensitization were also associated with an increased risk of asthma, and higher levels of specific IgE were associated with an additional risk. Contrary to the socioeconomic pattern of asthma and to that of most specific allergen sensitivities, including ragweed pollen, doctor-diagnosed hay fever tended to be more common in the relatively affluent.

Although asthma rates were higher among poor and minority populations in the 1976 to 1980 National Health and Nutrition Examination Survey (NHANES II), perhaps paradoxically, reported rates of immediate hypersensitivity to skin tests of inhaled allergens were lower among the poor.¹⁹ Studies from Europe have also linked atopy with markers of high rather than low SES.^{20,21} At first evaluation, these findings contrast with ours. However, poverty represents diverse exposures in the United States and in other parts of the world. Urban poverty in the Northeast United States may represent a higher risk for sensitization than rural poverty in other areas of the United States. It is also possible that socioeconomic patterns in allergy have changed over the 20 years since the NHANES survey. Examination of the 1990 US Census data²² demonstrates that the racial-ethnic distribution of our population reflects that of the metropolitan Boston communities from which the population was drawn. Our findings are likely to be relevant to women in their child-bearing years from the wider community. These women were all pregnant, but there are no data to suggest that this would alter their specific or total IgE levels. However, our focus was on the relationships of allergy with disease and with socioeconomic factors internal to our population. It would be useful to test hypotheses generated by our analyses in more recent national data, separating out the situation of the urban and the rural poor.

Compared with the NHANES survey, our study population was not selected to represent a cross-section of the general population but such that either the woman herself or the child's father had a doctor-diagnosed allergic disease, asthmatic disease, or both. Although selection, reporting, or misclassification bias are potential limitations of the study, we did not find evidence that bias or other features of the sampling frame caused the socioeconomic differences in sensitization patterns that we observed. The relation of doctor-diagnosed allergy to the corresponding specific IgE level was equally strong across SES groups. When we repeated our analyses in the subset of self-reported allergic or asthmatic mothers (eliminating bias introduced by misclassifying allergies of the father), there were similarly higher rates of sensitization among the poor. Results were also unchanged by elimination from analyses of the 4 women with elevated IgE levels but no specific sensitization. Close correlation between measures of SES and power considerations did limit our potential to distinguish separate effects of area poverty, race, and income in predicting cockroach sensitization.

TABLE III. Doctor-diagnosed asthma, hay fever, and eczema according to sensitization to cockroach, mite, cat, ryegrass, ragweed, *Alternaria* species, and *Aspergillus* species

Allergen	Cap class ≥ 1	No.	Asthma		Hay fever		Eczema	
			%	Adjusted OR* (95% CI)	%	Adjusted OR* (95% CI)	%	Adjusted OR* (95% CI)
Cockroach	No	404	26.5	1	42.3	1	21.4	1
	Yes	50	66.0	3.0 (1.5-6.3)	44.0	0.9 (0.4-1.8)	26.0	1.3 (0.6-2.8)
Mite	No	292	21.9	1	33.5	1	18.4	1
	Yes	166	45.8	2.2 (1.3-3.9)	57.9	1.0 (0.6-1.7)	27.4	1.5 (0.8-2.8)
Cat	No	314	21.0	1	31.1	1	18.8	1
	Yes	144	51.4	3.8 (2.1-6.7)	66.9	2.2 (1.3-3.8)	28.0	1.5 (0.8-2.6)
Dog	No	401	25.9	1	40.6	1	21.8	1
	Yes	52	67.3	4.5 (2.2-9.0)	57.7	1.0 (0.5-2.0)	23.1	1.0 (0.5-2.0)
Ryegrass	No	337	27.9	1	32.9	1	21.0	1
	Yes	117	39.3	1.1 (0.6-1.8)	69.8	2.2 (1.3-3.8)	24.4	0.9 (0.5-1.6)
Ragweed	No	338	28.4	1	35.1	1	21.3	1
	Yes	116	37.9	0.8 (0.5-1.4)	64.0	1.7 (1.0-2.9)	23.7	0.8 (0.5-1.5)
<i>Alternaria</i> species	No	392	28.6	1	39.1	1	20.6	1
	Yes	55	47.3	1.9 (1.0-3.6)	66.7	1.3 (0.7-2.6)	32.1	1.4 (0.7-2.9)
<i>Aspergillus</i> species	No	427	29.3	1	42.0	1	21.0	1
	Yes	20	65.0	2.7 (1.0-7.4)	52.6	0.8 (0.3-2.3)	42.1	2.7 (1.0-7.4)
Number of the above	None	183	18.6	1	18.2	1	17.1	1
	1 or 2	139	30.2	1.9 (1.1-3.3)	54.1	5.6 (3.3-9.7)	24.6	1.6 (0.9-2.9)
	≥ 3	124	49.2	4.1 (2.4-7.2)	65.9	10.8 (6.0-19.4)	26.2	1.8 (1.0-3.2)

*ORs adjusted for age, race, area poverty, income, education, and any allergen sensitivity (specific allergens only).

Sensitization and allergic disease, although associated, are not the same, but in this study the majority of women who reported a personal history of doctor-diagnosed allergy were found to be allergic by means of IgE testing, and for most allergens, there was consistency between the specific allergen suspected and the presence of specific IgE. Animal sensitivities were most accurately reported, whereas 39 of 47 of those sensitized to cockroach allergen did not have a doctor's diagnosis of this allergy, which may reflect a diagnostic bias on the part of physicians in the community. Sensitization to alternative molds might explain some of the apparent overreporting of mold allergy. The absence of IgE in a proportion of those reporting pollen allergy or hay fever may be partly explained by variations in specific IgE to seasonal allergens,²³ or these individuals may be allergic to allergens not measured by this study. Personal smoking is reported to affect total serum IgE levels²⁴ and has inconsistent effects on specific IgE levels,²⁵ but smoking prevalence was very low in this group of young mothers and unlikely to be an important confounder in our analyses. Thus taking account of the potential for misclassification of specific IgE status, there was reasonable agreement between reported and measured allergic sensitization.

Asthma was associated with sensitivity to indoor rather than outdoor allergens in these analyses, and the risk of asthma increased with the number of indoor allergens to which individuals were sensitized and with the level of specific IgE, affecting the link between asthma and poverty in this community.¹ The inverse relationship between hay fever and poverty did not correspond to the socioeconomic patterns of immediate hypersensitivity to the 2 outdoor pollens ryegrass and ragweed. Either there is more

unmeasured hypersensitivity to other pollens in more affluent communities in our cohort, symptomatic pollen allergy is higher in the more affluent communities, or alternatively, hay fever is being underdiagnosed in the less affluent communities. Across the world, dust mite allergy has been most consistently implicated in asthma or in bronchial hyperresponsiveness.^{6,11,12} In places where mite allergy is rare, stronger associations have occurred with pet allergy^{6,26} or with cockroach allergy.^{9,15,16} In our analyses asthma was linked with sensitization to each one of these indoor allergens. The greater prevalence of cat and cockroach allergy in the poorest areas and in ethnic minority groups and the occurrence of dust mite allergy at levels similar to those of the rest of the study group, seem likely to play a role in the increased risk of asthma in this sector of the community. Moreover, there is evidence from other studies to suggest that these asthmatic individuals, through having multiple sensitivities, specifically cockroach sensitivity, may also experience greater ongoing morbidity from the condition.^{14,27-29} Although allergen types differ by SES in our cohort, there is no evidence that the absolute burden of allergens is higher in poor communities.¹⁰ These findings suggest that other exposures of poverty in addition to allergens are increasing the risk of multiple sensitivities and expression of asthma in poorer urban US communities.

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