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ORIGINAL RESEARCH

Household exposure factors, asthma, and school absenteeism in a predominantly Hispanic community

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The Passaic Asthma Reduction Effort (PARÉ) used an asthma symptom and household exposure factor questionnaire to screen 4634 elementary school children over a 4-year period in Passaic, New Jersey. During the first year, an additional 240 preschool children were also screened. Overall, 16% of the school children were reported by their parents to have been diagnosed with asthma. In all, 30% of responding families claimed to have at least one family member diagnosed with asthma and this was five times more likely if the target child had asthma. Exposures consistently associated with childhood asthma diagnosis included environmental tobacco smoke (ETS), presence of dampness/mold, roaches, and furry pets in the home. Diagnosis of asthma was primarily associated with all six symptoms used in the PARÉ questionnaire, and secondarily with environmental factors. Puerto Rican and black children had the highest asthma prevalence (26% and 33%), while Mexican children had the lowest (7%). Use of medications and school absenteeism among asthmatic children were associated with wheeze and night cough, but not with any specific environmental exposure. Increased school absenteeism by children undiagnosed with asthma was associated with ETS and dampness/mold in the home. Differences in asthma diagnosis and absenteeism in response to environmental factors were found across ethnic subgroups. Getting asthmatic children on medical management protocols and providing families with education about environmental risk reduction should aid in reducing morbidity in this ethnically complex population. Such coordinated efforts offer the promise of reducing school absenteeism.
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Introduction

Asthma prevalence is significantly higher in African- and Hispanic-American communities than in other populations (Beckett et al., 1996; Lieu et al., 2002). The disease has increased in both morbidity and mortality (Weiss et al., 1992). Asthma is also the major cause of school absenteeism in the US (Fowler et al., 1992; Altemeier, 1996). The Passaic Asthma Reduction Effort (PARÉ) was a 4-year screening program developed by Passaic Beth Israel Hospital in coordination with all public, private, and parochial schools in this predominantly Hispanic community (Freeman et al., 2002; Schneider et al., 2002). The objective of PARÉ was to screen all elementary school children (grades 2–5) for asthma and related respiratory problems over a 4-year period. The screening program was designed to be broad in scope, with both biomarker and survey components. The biomarker component (peak flow measures and spirometry) identified children in need of treatment for respiratory problems, including asthma. The survey component was to help physicians identify environmental triggers for children as they designed individualized asthma treatment plans. The need for this extensive screening program was prompted by increased school absenteeism because of asthma and respiratory illnesses, and asthma crises among children who had not previously been diagnosed with asthma. The study was designed so that no child would be screened more than once in the 4 years.

Passaic is a unique community in that it has a wide range of ethnic Hispanic groups coming from the Caribbean, Mexico, Central, and South America. This diversity provides an opportunity to compare asthma and exposure issues for a variety of ethnic groups within the same urban and predominantly poor community. The two end points of interest are asthma diagnosis (determined from both biomarker and parental survey data) and school absenteeism (determined from the parental survey data).

1. Abbreviations: CI, confidence intervals; df, Degrees of freedom; dx, diagnosis; ETS, environmental tobacco smoke; OR, odds ratio

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Methods

Each child screened was weighed and measured and given a peak-flow or spirometry test. During this procedure, the children were also asked five questions about whether anyone smoked at home and if so who, whether they had pets and if so what they were, and whether they had a rug or carpet in their bedroom. These questions were used to validate answers on the parental questionnaires.

A 25-item questionnaire was developed from existing instruments (Chilmoncyzk et al., 1993; American Institute of Research, 1991; Asher et al., 1995; New York City Health and Hospitals Corp., 1995; Beckett et al., 1996; Koren, 1997; Eskenazi et al., 1999; Joseph et al., 1999) and was designed to characterize symptoms, health practices, and environmental exposure factors that have been documented to be asthma triggers or suspected asthma triggers (Chilmoncyzk et al., 1993; Ingram et al., 1995; Stoddard and Miller, 1995; Beckett et al., 1996; Koren, 1997; Platts-Mills and Carter, 1997; Eskenazi et al., 1999). Parents were requested to complete the questions (in either Spanish or English) about their child's respiratory health (symptoms, diagnosis, and medications), family history of asthma, school absenteeism, potential environmental exposures in the home, insurance status, and race/ethnicity. The questionnaire data required mostly nominal (yes, no) or ordinal responses (e.g., categories of number of days absent). Six questions addressed symptoms: ''Does your child experience: Frequent coughs? Shortness of breath? Noise in the chest (sometimes called wheezing)? Trouble breathing? Tightness in the chest? Cough during the night or early morning?'' Positive responses were aggregated to produce an aggregate symptom score.

Environmental factors in the questionnaire included environmental tobacco smoke (ETS) exposure (number of smokers in the home; who smokes in the home; amount of ETS exposure the child has per day classified as none, less than a pack, a pack, more than a pack); mildew/mold in the bathroom, basement, closets, other areas of the home; carpeting in the child's bedroom; the presence of furry pets; pet access to the child's bedroom; use of feather pillows; presence of roaches; and the use of pesticides in the home.

Several derivative exposure factors were developed from these variables. An aggregate mold variable summed the number of places where parents reported dampness or mold. The aggregate mold variable was then used to develop two additional dichotomous variables: any mold and multiple mold. Any mold asks if there is mold anywhere in the home, while multiple mold addresses general household conditions under the assumption that mold in more than one area of the home reflects poor housing conditions. In addition to the aggregate mold variable, an aggregate exposure variable was developed based on the number of different types of exposure factors that the parent reported (e.g. any mold + furry pets + pesticide use = 3).

In year 1, children in two preschool programs and all third graders were screened. In year 2, the program targeted fifth graders. Third and fourth graders were screened in year 3, and second and third graders were screened in year 4.

Data were analyzed using SPSS, version 10.1 (2000) with Fisher's exact and χ^2 tests. Odds ratios (OR) with 95% confidence intervals (CI) were calculated on the χ^2 distributions to assess the relation between environmental exposure factors in the home and the outcome variables: asthma diagnosis and school absenteeism. Secondary predictor variables included symptoms, use of medications and family asthma. Variables significantly associated in bivariate analyses were introduced into a stepwise logistic regression with Hosmer and Lemeshow test for goodness of fit to identify independent factors contributing to asthma diagnosis and school absenteeism.

Analyses were performed for the entire study population and for major ethnic subsets. Student's *t*-test and analysis of variance were used to evaluate differences in age, aggregate symptoms, and aggregate exposure factors between and across groups.

Three Hispanic groups predominate in this community: Dominicans, Mexicans and Puerto Ricans. Most of the analyses were conducted on these three groups only, although additional analyses were conducted for black and Non-Hispanic White children, and the category ''other Hispanic.'' The ''other Hispanic'' group included individuals from 14 other Central and South American countries with the largest numbers of children originally from Colombia, Ecuador, and Peru.

Results

Of the potential 6480 elementary children to be screened, parental questionnaires were returned for 4634 children (72% response rate) and 77% of the returned questionnaires were fully completed by parents. The data presented here are from 64% of all elementary school Passaic children during the study period. A large proportion of questionnaires were completed in Spanish, indicating the strong Hispanic character of the Passaic community. In all, 57% percent of questionnaires returned by preschool parents were in Spanish, while 46% of questionnaires returned by elementary school parents were in Spanish. Among Hispanic groups, Puerto Rican parents were most likely to respond in English (76%), and Mexican parents most likely to respond in Spanish (88%).

From school rosters, we were able to ascertain that nonrespondents were similar to respondents in terms of age and gender, except during year 2 when it was found that fifth grade boys were slightly less likely to return questionnaires than fifth grade girls. We cannot make statements about the race and ethnicity of non-respondents, however, as these

variables were derived from the survey data. In order to determine if our sample was representative of the community as a whole in terms of race and ethnicity, we examined 2000 US Census data for the City of Passaic (US Department Commerce, 2002). In that year, 62.5% of the population and 68% of those aged less than 18 years of age were identified as Hispanic. The larger proportion of Hispanics in the younger age group demonstrates the young nature of the Hispanic community. Also in the year 2000, US Census data show black people as 13.8% and Asians as 5.5% of the Passaic population.

The overall questionnaire responses identified 75% of children as Hispanic, with 10.5% and 5% as black and Asian children, respectively. We conclude that our sample is likely a representative of the children of Passaic as a whole, but we cannot rule out the possibility that some non-Hispanics may be under-represented.

Table 1 lists the characteristics of children whose parents completed questionnaires by year of the screening program. The proportions of school aged children with an asthma diagnosis, on respiratory medications and missing school for respiratory problems once a month or more were significantly higher at the beginning of the study. In addition, preschoolers who were only sampled during the first year of the study had even higher rates of diagnosis, medication use, and school absenteeism than was reported for the older children.

Questionnaire responses about the characteristics of the children and the primary exposure factors are listed by ethnic group in Table 2. There were significant differences across groups for all variables except for gender distribution. Non-Hispanic white children were younger than children in the other ethnic groups, but there was no difference between the ages of the various Hispanic subgroups.

Asthma Diagnosis in School-age Children

The proportion of children diagnosed with asthma varied across ethnic groups. Puerto Rican and Black children had consistently high rates of asthma diagnosis (26% for the 4 years, range 22–28% for Puerto Ricans and 33% for the 4 years, range 30–42% for black children). Consistently lower rates of asthma diagnosis were observed for Dominican children (14%, range 12–17%) and Mexican children (7%, range 4–9%). Reporting of asthma for non-Hispanic white children was somewhat variable across the 4 years (14%, range 11–27%) (Table 2).

Among children diagnosed with asthma, medication use was low (Tables 1 and 2). Not reflected in these tables are the differences by ethnic group by year. For the first 3 years of the study, medication use was reported for less than half of the children diagnosed with asthma. Mexican and non-Hispanic white children (30% and 31%, respectively) were less likely to use medications than Dominican, black and Puerto Rican children (42%, 44%, and 47%, respectively) ($P<0.05$). In year 4, parents reported a significant increase in medication use compared to the previous years, to 48% for Mexican, 66% for non-Hispanic white, 62% for Dominican, 51% for black and 57% for Puerto Rican children.

Exposure Factors Related to Reported Diagnosis

Across all 4 years, the major household exposure factors associated with asthma diagnosis were ETS ($\chi^2=77.03$, $df=3$, $P<0.001$, 31% of asthmatics exposed compared to 17% of nonasthmatics) and dampness/mildew in the bathroom ($\chi^2=27.6$, $df=3$, $P<0.001$, 24% of asthmatics exposed compared to 15% of nonasthmatics). Two additional environmental factors were reported more frequently by parents of asthmatic children compared to

Table 1. Characteristics of children whose parents completed questionnaires (percentage calculated by excluding cases with missing data).

Year		1998	1999	2000	2001
Grade	Preschool	3	5	3–4	2–3
Hispanic country of origin (*N* %)					
Dominican Republic	96 (40)	201 (25)	129 (24)	320 (25)	294 (18)
Mexico	31 (13)	134 (17)	94 (17)	338 (26)	428 (26)
Puerto Rico	16 (7)	182 (23)	86 (16)	258 (20)	289 (18)
Other Hispanic[a]	84 (35)	84 (10)	90 (16)	61 (5)	192 (12)
Black	13 (5)	98 (12)	61 (11)	131 (10)	139 (9)
Non-Hispanic White	0 (0)	68 (8)	41 (7)	139 (11)	194 (12)
Non-Hispanic other (Asian)	0 (0)	41 (5)	47 (9)	51 (4)	80 (5)
Asthma dx (%)	24.4	20.2	12.3	14.0	12.3
Respiratory meds (%)	17.9	11.0	7.0	7.3	7.7
Absent >1/month (%)	15.5	10.1	4.3	5.7	5.9
Responses/total screening pool	240/350	1029/1300	548/790	1441/2087	1616/2303
Questionnaires returned (%)	69	79	69	69	70
Age of children (SD)	—	8.7 (0.7)	10.9 (0.7)	8.9 (0.8)	8.1 (0.9)

[a]Includes children from Argentina, Bolivia, Chile, Colombia, Costa Rica, Cuba, El Salvador, Guatemala, Honduras, Nicaragua, Peru, Ecuador, Uruguay, and Venezuela.

Table 2. Children's characteristics and household exposure factors by ethnic group.

Characteristics	Black	Non-Hispanic White	Mexican	Puerto rican	Dominican	Other Hispanic
N	489	479	979	765	939	349
Gender (% male)	48.3	46.9	47.1	44.3	46.2	42.5
Mean age (SD)	8.7 (1.2)	8.2 (1.0)	8.7 (1.1)	8.8 (1.1)	8.9 (1.2)	8.7 (1.1)
Asthma dx (%)*	33.1	14.6	6.5	25.8	13.5	15.1
Use meds (%)*	18.0	9.2	4.2	15.7	9.3	8.3
Absent >1/month (%)*	12.3	3.0	4.7	11.4	6.9	8.3
Family dx (%)*	57.6	28.1	12.1	64.3	30.4	28.1
Insured (%)*	90.9	93.1	55.5	84.9	72.1	72.5
Mean symptoms[a] (SD)**	1.7 (1.6)	0.7 (1.3)	0.6 (1.2)	1.4 (1.8)	1.0 (1.6)	1.1 (1.5)
Household Exposure Factor						
Smoking in home (%)*	45.8	12.7	10.3	35.5	10.8	16.4
Bathroom damp/mold (%)*	15.6	15.5	21.4	21.2	12.3	13.2
Carpet in child's room (%)*	63.7	79.2	40.1	60.2	50.3	56.9
Furry pets (%)*	24.0	19.8	9.1	31.1	13.9	24.7
Pets in child's room (%)*	33.8	35.5	12.9	37.7	13.7	18.9
Feather pillows (%)*	28.0	19.9	5.4	20.2	11.9	12.9
Roaches (%)*	21.8	6.0	28.6	28.9	23.2	21.2
Pesticide use (%)*	37.1	14.2	43.7	43.1	39.5	34.0
Mean factors (SD)**	2.2 (1.3)	1.6 (1.0)	1.5 (1.1)	2.1 (1.3)	1.5 (1.1)	1.6 (1.1)

[a]Derived from six survey questions: ''Does your child have: Frequent coughs? Shortness of breath? Noise in the chest (sometimes called wheezing)? Trouble breathing? Tightness in the chest? Cough during the night or early morning?''
*χ^2-test, **ANOVA $P<0.001$

Table 3. Odds ratios of household exposure factors and school-aged target child asthma diagnosis, medication use, and school absenteeism (with 95% CI).

Household exposure factors	dx	med use	absent
ETS (none/some)	2.27 (1.89, 2.74)***	1.66 (1.31, 2.10)***	2.29 (1.77, 2.98)***
Multiple mold sites (>1)	1.90 (1.35, 2.69)***	1.79 (1.18, 2.72)**	1.89 (1.17, 3.03)**
Any mold (none/some)	1.82 (1.49, 2.20)***	1.97 (1.56, 2.50)***	1.65 (1.25, 2.17)***
Damp bathroom (yes/no)	1.72 (1.40, 2.11)***	1.88 (1.47, 2.40)***	1.81 (1.35, 2.41)***
Furry pets (yes/no)	1.45 (1.16, 1.82)***	1.09 (0.83, 1.46) NS	1.26 (0.81, 1.74) NS
Roaches (yes/no)	1.40 (1.17, 1.69)***	1.36 (1.08, 1.71)**	2.26 (1.76, 2.90)***
Pets in bedroom (yes/no)	1.09 (0.91, 1.24) NS	1.23 (0.83, 1.82) NS	0.79 (0.49, 1.27) NS
Pesticide use (yes/no)	1.17 (0.99, 1.39) NS	1.01 (0.82, 1.25) NS	1.46 (1.15, 1.85)**
Feather pillow (yes/no)	0.95 (0.74, 1.22) NS	0.86 (0.62, 1.20) NS	1.19 (0.84, 1.69) NS
Carpet in room (yes/no)	0.91 (0.77, 1.07) NS	0.74 (0.60, 0.91)**	0.68 (0.53, 0.86) ***
Mean factors (SD)	2.0 (1.3) *versus* 1.7 (1.3)***	1.9(1.3) *versus* 1.7 (1.2)*	2.1 (1.3) *versus* 1.7 (1.1)***
N	4058	4107	4022

χ^2-tests: ***$P<$ 0.001, **$P<0.01$, *$P<0.05$, NS $P>0.05$.
t-Test mean factors: ***$P<0.001$, *$P<0.05$.

parents of nonasthmatic children: the presence of furry pets (predominantly dogs, 30% *versus* 22%, $P<0.001$) and the presence of roaches in the home (28% *versus* 22%, $P<0.001$).

Table 3 presents ORs for the major exposure factors for asthma diagnosis, use of medication for respiratory problems, and school absenteeism for the entire study population obtained from bivariate analyses. Significant differences in aggregate exposure were found between diagnosed and nondiagnosed children (2.0 exposure factors *versus* 1.7), between those using respiratory medications and those without (1.9 *versus* 1.7), and between children absent at least once a month and those less frequently absent (2.1 *versus* 1.7).

Nearly all the exposure factors had OR in the expected direction (Table 3). Several potential exposure factors were not associated with the outcome variables. Furry pets in the house were more associated with a diagnosis of asthma than was pet access to the child's bedroom. This is likely due to the fact that only a subset of furry pets are allowed access to the child's bedroom, whereas the pet is likely allowed near the television and kitchen, places where children spend a great deal of time. When dampness/mildew in individual areas of the home were used as independent variables, they were not

Table 4. Environmental factors associated with asthma diagnosis and school absenteeism by ethnic group.

Group	Factor	Asthma diagnosis		Absenteeism	
		Odds ratio (95% CI)	*P*-value*	Odds ratio (95% CI)	*P*-value
Mexican	Bathroom mold	1.55 (0.81–2.54)	0.181	2.49 (1.27–4.88)	0.006
$n=868$	Roaches	1.16 (0.65–2.07)	0.612	2.22 (1.20–4.10)	0.009
Puerto Rican	Bathroom mold	1.95 (1.33–2.87)	0.001	2.20 (1.30–3.71)	0.003
$n=721$	Roaches	1.45 (1.01–2.08)	0.042	1.87 (1.16–3.00)	0.003
	ETS	1.38 (0.98–1.95)	0.052	1.61 (1.01–2.56)	0.044
	Pesticide	1.27 (0.91–1.79)	0.157	1.57 (0.99–2.49)	0.054
Dominican	ETS	1.69 (0.98–2.91)	0.056	1.93 (0.97–3.85)	0.058
$n=885$	Bathroom mold	1.67 (0.99–2.85)	0.058	1.27 (0.59–2.78)	0.538
Black	Bathroom mold	2.17 (1.30–3.62)	0.003	1.67 (0.83–3.55)	0.150
$n=458$	Roaches	1.82 (1.16–2.86)	0.009	2.78 (1.54–5.03)	0.001
	ETS	1.60 (1.09–2.37)	0.017	1.27 (0.72–2.23)	0.406
Non-Hispanic White	ETS	2.22 (1.16–4.26)	0.014	13.17 (4.14–41.87)	0.001
$n=456$	Bathroom mold	2.27 (1.23–4.17)	0.007	1.51 (0.41–5.56)	0.406
	Roaches	1.38 (0.51–3.84)	0.513	8.00 (2.34–27.63)	0.001

*P-value for χ^2-test.

consistently associated with asthma diagnosis, except for bathroom dampness/and mildew. Although the ''any mold'' and ''multiple mold sites'' variables were statistically significant, they had little effect beyond what could be obtained using the variable ''damp bathroom'' by itself. The other exposure variables elicited in the questionnaire, feather pillows and carpeting in the child's room, had no statistical association with asthma diagnosis for the target children in this study. However, carpeting in the child's room was associated with lower rates of medication use and school absenteeism ($P<0.01$).

When the significant exposure variables were included in a stepwise logistic regression model, three exposure variables were found to contribute to diagnosis: ETS (OR 2.103, 95% CI 1.72–12.56, $P<0.001$), mold (OR 1.539, 95% CI 1.27–1.87, $P<0.001$), and the presence of furry pets (OR 1.371, 95% CI 1.12–1.67, $P=0.002$). However this model only explained 10% of asthma diagnosis. When symptoms were included in the model either as individual symptoms or aggregate symptoms, the explanatory value of the model increased to 47%, and mold dropped out of the model, leaving ETS and the presence of furry pets as the significant exposure factors.

For preschool children, damp bathrooms (OR 4.78, 95% CI 2.04–11.18, $P<0.001$) or the composite variable ''any mold'' (OR 3.30, 95% CI 1.57–6.97, $P=0.001$) were the only household exposures associated with asthma diagnosis in the target child.

Comparison of household exposure factors and target child asthma diagnosis for specific subgroups found that damp/moldy conditions were associated with diagnosis for Mexican and Puerto Rican children, but not for Dominican children (Table 4). ETS was associated with asthma diagnosis for all three Hispanic groups. ETS and damp/moldy conditions were associated with a target child asthma diagnosis for non-Hispanic White and black groups, while exposure to roaches

Table 5. Significant odds ratios of environmental factors and family asthma diagnosis (95% CI) by ethnic group.

Ethnic group	Environmental factors	Odds ratio (CI)
Mexican	Multiple mold sites	5.18 (2.49–10.81)***
	Bathroom damp/mold	2.27 (1.45–3.54)***
	Any mold	2.21 (1.41–3.45)***
	Roaches	1.83 (1.20–2.77)**
	Furry pets	1.76 (1.01–2.78)*
Puerto Rican	Multiple mold sites	4.16 (1.60–10.79)**
	Roaches	2.46 (1.69–3.58)***
	Any mold	2.07 (1.41–3.05)***
	ETS	1.98 (1.41–2.78)***
	Bathroom damp/mold	1.96 (1.30–2.95)*
	Pesticides	1.67 (1.21–2.30)**
	Furry pets	1.57 (1.07–2.31)*
Dominican	Any mold	2.09 (1.41–3.08)***
	Furry Pets	1.96 (1.24–3.10)*
	ETS	1.98 (1.29–3.04)**
	Roaches	1.86 (1.35–2.57)***
	Multiple mold sites	1.88 (1.35–2.62)*
	Bathroom damp/mold	1.78 (1.17–2.72)**
Other Hispanic	Any mold	2.75 =(1.49–5.09)***
	ETS	2.52 (1.37–4.63)**
Black	ETS	1.90 (1.30–2.77)***
	Roaches	1.76 (1.11–3.79)*
	Pesticides	1.56 (1.07–2.29)*
Non-Hispanic White	Any mold	1.95 (1.26–3.02)**

χ^2-tests, ***$P<0.001$, **$P<0.01$, *$P<0.05$.

in the home was associated with asthma diagnosis for black children. Mexican children who had low rates of asthma diagnosis showed significant associations between exposure to mold and roaches and school absenteeism, even though these were not associated with asthma diagnosis.

Non-exposure factors associated with school absenteeism included asthma diagnosis (OR 9.093, 95% CI 7.06–11.70, $P<0.001$) and use of medications for respiratory problems (OR 7.912, 95% CI 6.06–10.34, $P<0.001$) for all school-aged children, and significant factors for black and all Hispanic subgroups.

Familial Asthma

Asthma in members of the family other than the target child was reported by 33% of families and was more often reported by those families where the target child was asthmatic (OR 5.38, CI 4.52–6.42, $P<0.001$). Evaluation of environmental factors and family asthma found that the same variables that were found for the target school-age child (ETS, furry pets, roaches, and damp bathrooms) were significantly associated with family asthma diagnosis.

For families with preschool children, family asthma was associated with ETS (OR 5.21, 95% CI 2.29–11.87, $P<0.001$) and damp bathroom (OR 2.41, 95% CI 1.07–5.41, $P=0.03$).

For all Hispanic groups, damp/mold conditions were associated with family asthma. For Puerto Rican, Dominican, and other Hispanics, ETS was significantly associated with family asthma (Table 5). In contrast, ETS and presence of cockroaches were associated with family asthma for black groups. Any mold was implicated for non-Hispanic white families.

Household Exposure Factors Associated with Respiratory Symptoms

As previously reported in the literature, symptom reporting (aggregate symptom score) was associated with prior diagnosis of asthma (Asher et al., 1995). The mean number of symptoms reported for asthmatic children was 3.3 (SD 2.1, median 3) compared to 0.6 (SD 1.1, median 0) for children without diagnosed asthma ($P<0.001$). Among children with reported asthma, symptoms were more likely to be reported if the children were on medications than if they were not using medications (4.3 symptoms compared to 2.3 symptoms, $P<0.001$). At the same time, children without asthma showed a similar pattern, although with fewer symptoms. Nonasthmatic children on respiratory medications reported 1.6 symptoms compared to 0.6 for children not on medicines ($P<0.001$).

Symptoms were not only associated with asthma diagnosis but also, among school-aged children, with a variety of household exposures and the aggregate exposure factors. Aggregate symptom was significantly rank-correlated with aggregated exposure ($r=0.208$, $P<0.001$). In pairwise comparisons, exposure to ETS and presence of mold in the home were associated with a variety of symptoms in school-aged children. In contrast, no household exposure factors were associated with symptoms among preschool children in pair-wise comparisons.

For most of the ethnic subgroups, mold was the primary exposure factor associated with nearly all symptoms. The aggregated symptoms were significantly greater for all groups except black children when there was mold in the house. Only black children and non-Hispanic white children showed significant associations between ETS and specific symptoms ($P=0.043$ for wheeze and $P=0.007$ for trouble breathing, respectively).

Conditions in the Home associated with School Absenteeism

For preschool children, absenteeism was driven by symptoms and, in particular, cough at night or in the morning (cough pm/am). For this group, household exposure factors *per se* were not associated with school absenteeism.

This was not the case for school-age children. While the strongest associations were between symptoms and absenteeism, a number of household exposure factors were also associated with this outcome: ETS, dampness and mildew, and presence of roaches. Stepwise logistic regression analysis across all 4 years found that asthma diagnosis and symptoms were the driving forces behind absenteeism (asthma dx, OR 2.25, 95% CI 1.35–3.76, $P=0.002$, symptoms OR 1.54, 95% CI 1.38–1.72, $P=0.001$), followed by ETS (OR 1.67, 95% CI 1.12–2.49, $P=0.012$), and presence of roaches (OR 1.52, 95% CI 1.02–2.28, $P=0.042$). These four variables explained 25% of absenteeism. Replacing aggregate symptoms by each of the six symptoms in the stepwise analysis found that three symptoms contributed to the model: frequent cough, tightness in chest, and night cough. Replacing aggregate symptoms by the individual symptoms did not increase the explanatory value of the model.

Discussion

The significant environmental factors associated with asthma in this study have also been found in other studies (Rylander and Etzel, 1999; Lanphear et al., 2001; Finkelstein et al., 2002). Finkelstein et al. (2002) reported lower rates of household pests and smokers in their pool of 638 asthmatics than we found across all children in Passaic. In contrast, many more of their families had carpeting and pets. The differences may lie in SES differences between the study populations. The Finkelstien et al. study population contained 89% college-educated families. The possible protective influence of bedroom carpeting found in this study is contrary to findings in other studies. These were statistically weaker outcomes and may be the result of multiple analyses. However, since the direction was similar for asthma, medication use, and absenteeism, we cannot

exclude the possibility that carpeting in this community is indicative of some aspect of these families lives on which we did not collect information. We lacked direct information about family education and income, but US Census data for Passaic and the insurance coverage information we elicited from the survey data allow us to conclude that the Passaic population is a less affluent and less educated one than in the Finkelstein et al. study. The differences in exposure factors between these studies may reflect differences in SES between the study populations.

Subset ethnic analyses found that a variety of household exposure factors were associated with asthma diagnosis, and along with diagnosis and symptoms contribute to absenteeism. For Puerto Rican and 'Hispanic other' children the factors that were associated with asthma diagnosis were also associated with school absenteeism. In contrast, a number of environmental factors were associated with asthma diagnosis in black, non-Hispanic white, and Dominican children, but either fewer or different factors were associated with school absenteeism for these groups.

We documented that not only asthmatic children suffer from exposure to environmental triggers. Less than 20% of all families reported presence of dampness/mold in their homes, yet this household exposure factor was strongly associated with asthma diagnosis, absenteeism, and use of respiratory medications in children who were and were not diagnosed with asthma. We found that more than 63% of nonasthmatic children and 73% of asthmatic children had at least one exposure factor in the home, and 11% of nonasthmatic children and 20% of asthmatic children had at least three exposure factors that are known to be asthma triggers. These values are substantially greater than those found by Lanphear et al. (2001) and contribute to the morbidity of asthmatic and nonasthmatic children in Passaic.

The associations between symptoms and exposure factors differed across the years of the study. During 1999 when the least number of relations were observed, the children were the oldest, in fifth grade. It is possible that these older children were outgrowing respiratory symptoms, or that their parents were paying less attention to them. On the other hand, the proportion of children diagnosed with asthma declined between years 1 and 4 of the study, as did the proportion of children on asthma medications and the proportion missing more than one day of school per month due to respiratory symptoms. As children in years 1 and 4 were close in age, the argument that simply growing older reduces respiratory symptoms in school children cannot be used to explain this change in outcomes. One explanation is that the weather changed in this region, with high mold conditions at the beginning of the study followed by a series of dry years with decreased mold. As mold was a significant trigger for respiratory symptoms, this is quite plausible. Another explanation is that the PARÉ program worked, reducing children's exposure to ETS through an active health education campaign to get parents not to smoke inside the home or around their children. As ETS was another significant environmental trigger for respiratory symptoms, this is also plausible.

Ethnic differences were found in the prevalence of childhood asthma and in the types of household exposure factors that were associated with symptoms. Asthma was epidemic in Puerto Rican and black children. In contrast, Mexican children were less likely to have an asthma diagnosis and the rates for these children were nearly at the national norm. This finding is consistent with observations from other studies (Mendoza et al., 1991; Flores et al., 1999). Our study found that the Mexican children were reported to have both fewer symptoms and lower rates of ETS and pets than other groups. One of the most striking features was that while no environmental factors were associated with asthma diagnosis for Mexican children, both roaches and mold were associated with school absenteeism for this group. Environmental factors associated with asthma among the subgroups differed. Based on parental reports, Puerto Rican asthmatic children were exposed to more environmental triggers than were children in other Hispanic subgroups.

Absenteeism was associated with the number of respiratory symptoms reported. Absentee rates for children with three or more symptoms ranged from 23% to 35%, depending on ethnic group. Health-care coverage also varied across ethnic groups, with the newest immigrant group (Mexicans) less likely to have health insurance than others. Some of the differences in asthma diagnosis may be due to lack of access to health care.

In previous studies, a mix of ethnic groups have been lumped together as Hispanic. The differences observed in Hispanic subgroups in this community over a 4-year period suggest that treating these groups as homogeneous may not meet the health needs of the specific ethnically identified families. Yet the constant theme for most of the children in this study who are asthmatic or frequently absent from school because of respiratory problems was the presence of mold and tobacco smoke in the home. These triggers do not discriminate by ethnicity. ETS is a risk factor that can be managed with family education and cooperation. Mold in New Jersey is ubiquitous during much of the year and concerted efforts must be applied to reduce indoor sources such as water damage in bathrooms, basements, and from leaky roofs and gutters. Targeting these environmental triggers with a massive health education campaign holds promise for reducing school absenteeism from asthma and undiagnosed respiratory symptoms, regardless of ethnicity.

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