

Building-related health symptoms and classroom indoor air quality: a survey of school teachers in New York State

Abstract Most previous research on indoor environments and health has studied school children or occupants in non-school settings. This investigation assessed building-related health symptoms and classroom characteristics via telephone survey of New York State school teachers. Participants were asked about 14 building-related symptoms and 23 classroom characteristics potentially related to poor indoor air quality (IAQ). Poisson regression analysis was used to assess the relationship between these symptoms and each classroom characteristic, controlling for potential confounders. About 500 teachers completed the survey. The most frequently reported classroom characteristics included open shelving (70.7%), food eaten in class (65.5%), dust (59.1%), and carpeting (46.9%). The most commonly reported symptoms included sinus problems (16.8%), headache (15.0%), allergies/congestion (14.8%), and throat irritation (14.6%). Experiencing one or more symptoms was associated most strongly with reported dust (relative risk (RR) = 3.67; 95% confidence interval (CI): 2.62–5.13), dust reservoirs (RR = 2.13; 95% CI: 1.72–2.65), paint odors (RR = 1.73; 95% CI: 1.40–2.13), mold (RR = 1.71; 95% CI: 1.39–2.11), and moldy odors (RR = 1.65 95% CI: 1.30–2.10). Stronger associations were found with increasing numbers of reported IAQ-related classroom characteristics. Similar results were found with having any building-related allergic/respiratory symptom. This research adds to the body of evidence underscoring the importance to occupant health of school IAQ.

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Practical Implications

Teachers play an important role in educating children, and teacher well-being is important to this role. Health symptoms among New York teachers while at work are common and appear to be associated with numerous characteristics related to poor classroom IAQ. Improving school Indoor Air Quality may reduce sickness and absenteeism and improve teacher performance.

Introduction

Teaching is a profession with many members, making the physical environment in which they work important in terms of its potential public health impact. A poor environment may lead to health problems, adversely affect performance, and negatively impact retention. Teacher well-being is also important because of the central role they play in the education and future economic success of children.

Like other buildings, schools are subject to a variety of conditions that can affect indoor air quality (IAQ). Students, teachers, and other staff spend much of their day in this setting, where they may be exposed to allergens and chemical irritants. These include mold from unresolved moisture problems; allergens from dust-mites, cockroaches, rodents, and pets; diesel

exhaust; and volatile organic chemicals (VOCs) from cleaning products, art supplies, paint, and other sources, and many of these contaminants are found in settled dust on floors and other dust reservoirs such as furniture, carpeting, and shelving as well as in the air (Chew et al., 2005; Daisey et al., 2003; Instanes et al., 2005; New York State Department of Health, 2008; Ramachandran et al., 2005; Smedje and Norback, 2001; Tortolero et al., 2002; Tranter, 2005). Inadequate ventilation, which concentrates existing indoor pollutants, is also found in many classrooms (Daisey et al., 2003; Tortolero et al., 2002). In the United States, 18% of schools rate their IAQ as unsatisfactory and 26% rate their ventilation as unsatisfactory (U.S. Department of Education, 2000), with higher proportions in New York State (NYS) reporting unsatisfactory IAQ (24%), and ventilation (36%) (U.S.

General Accounting Office, 1996). More recently, in NYS excluding New York City (NYC), about 40% of schools were assessed by inspectors as having moisture problems, based on the NYS Education Department (NYSED) Building Condition Survey (BCS), and various ventilation-related problems were identified (New York State Department of Health, 2009). Outside of NYS, a majority of teachers surveyed in two large city school districts reported fair to poor IAQ (Schneider, 2003). Despite these problems, adoption by states, school districts, and schools of policies and programmes designed to maintain good IAQ is variable (Jones et al., 2007; Lin et al., 2012).

Numerous studies have reported associations between ventilation, building-related health symptoms, perceived IAQ, sick leave, and productivity in adults (Seppanen et al., 1999; Sundell et al., 2011; Wargocki et al., 2002), but these have primarily studied office workers. Other studies of the effects of the indoor environment on health or performance have been conducted in the school setting, but have focused either on children (Meklin et al., 2002; Mendell and Heath, 2005; Meyer et al., 2004; Myhrvold et al., 1996; Simons et al., 2010; Smedje et al., 1997) or on staff in general (Norback and Torgen, 1987; Norback et al., 1990; Smedje et al., 1996). The only studies specifically focusing on teachers have investigated building-related symptoms and mold (Ebbehoj et al., 2005), health symptoms and poorly rated IAQ (Schneider, 2003), and teacher sick leave in relation to student ratings of school IAQ (Ervasti et al., 2012). While these studies are informative, they either focused on one aspect of IAQ or considered it as a whole. No study to date has examined a series of teacher health symptoms in relation to a comprehensive array of IAQ-related classroom characteristics. The current study examined the relationship between classroom characteristics potentially related to poor IAQ and building-related health symptoms, controlling for demographics and home environmental exposures, among teachers in NYS primary and secondary public schools.

Methods

Population and study design

This cross-sectional study, conducted in December of 2009, consisted of a survey of elementary and secondary public school teachers in NYS schools, excluding NYC.

Survey procedures and survey

The NYS Department of Health (NYSDOH) worked with NYS United Teachers (NYSUT) to design and conduct a telephone survey of public school teachers. NYSUT represents virtually all teachers in the state

and operates a call center for polling members. The quality of interviews at the call center is good because call center operators are paid on a per-hour rather than a completion basis, and NYSUT call center staff monitor operator quality by flagging operators that consistently make calls shorter than the expected time and by listening in on calls.

The survey was drafted by NYSDOH and reviewed for content and programming issues by a member of the NYSUT research staff and the call center programmer, respectively. NYSUT then developed, and NYSDOH reviewed, a script and detailed protocol of survey administration procedures for call center interviewers to follow. NYSDOH randomly selected schools from a list of schools who had completed the 2005 BCS, a survey mandated by the NYSED to be conducted every 5 years by schools, and which assesses the school environment. Because the NYC BCS was not available, we included only non-NYC schools. This list of schools was matched to the NYSUT membership database. For each school on the list, one teacher was chosen to be surveyed, based on random number assignments. If the first teacher chosen was not reachable after three attempts, another teacher was chosen from that school until a completed interview was obtained. A pilot study of 25 teachers was conducted to estimate the time it would take to administer the survey and to identify time-consuming, unclear, or awkwardly worded questions. As no problems were identified in this phase, the pilot study surveys were included in the final database.

The first section of the survey contained questions about teacher demographics (age, gender), employment characteristics (number of years teaching, grades taught, number of hours spent in the school setting, number of classrooms taught in), and non-school-based environmental factors potentially related to health outcomes (tobacco exposure, proximity to busy highways, furred or feathered pets). Teachers were also asked about the presence of 14 potentially building-related health symptoms experienced during the workday during the 2009–2010 school year (sneezing, throat irritation, eye irritation, skin irritation, headache, allergies/congestion wheezing, coughing without cold, sinus problems, frequent colds/flu, fatigue, difficulty in concentrating, nausea, and asthma attacks). For each symptom, teachers were asked about its pattern (worsening during the workday or workweek, improvement when not at work) and impact on their attendance and ability to teach. Teachers were also asked whether they had been diagnosed with asthma and if they currently have asthma. Finally, teachers were asked about aspects of their classroom environment potentially related to poor IAQ, including the presence of mold; moisture problems; dust; dust reservoirs (blinds, curtains, pillows, upholstered furniture, stuffed animals, chalkboards); construction during school hours; pets; vermin; environmental tobacco smoke; odors from

mold, diesel fumes, pesticides, arts & crafts or markers, air fresheners or perfumes, paint, construction/renovation and cleaners; fresh air adequacy; and classroom housekeeping issues, including objects blocking fresh air intakes, storage type and adequacy, food eaten in the classroom, and type and condition of flooring.

Data analysis

Data cleaning and analysis was conducted using SAS (v. 9.3). Descriptive analyses of teacher characteristics, teacher symptoms, and IAQ-related classroom characteristics were conducted. Building-related health symptoms were defined as symptoms occurring during the workday that (i) worsened during the workday or workweek or (ii) improved overnight, on weekends or when on vacation. Two summary symptom measures were developed for use in multivariable analysis of the association between classroom characteristics and teacher health: (i) having one or more building-related symptoms and (ii) having one or more building-related allergic or respiratory symptoms (allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds or flu, cough without cold, asthma attacks). Having current asthma was also evaluated. Separate regression models using a Poisson distribution to estimate relative risk (RR) were run for each classroom characteristic adjusting for the following: age ≥ 50 versus < 50 , sex, school size (above or below the median of 37 full time teachers in non-NYC NYS), district economic need (high versus average or low need as measured by district ability to meet the needs of its students using local resources) (New York State Education Department, 2011), years worked at school (above or below the median of 10 years), teaching elementary vs. middle/high school grades, overtime work (working more than 40 h per week), exposure to environmental tobacco smoke, having furred or feathered pets at home and living within 300 yards of busy roadways. Finally, the effect of increasing numbers of IAQ-related classroom characteristics on health outcomes was assessed. For each of the two summary health symptom measures, a scale was created from classroom characteristics associated with that measure at $P < 0.10$ in multivariable analysis. Adjusted risk ratios and 95% confidence intervals were then calculated for exposure to 2–3 classroom conditions, and to >3 classroom conditions, respectively, using exposure to one or no classroom conditions as a reference.

Results

Study population characteristics

The sample of schools chosen for participation in this survey was compared to the parent database of non-NYC schools in 637 districts and was found to be

similar with regard to school size and district economic need. A total of 501 teachers working in 428 schools across NYS participated in this survey. For a few schools, more than one teacher was interviewed due to queuing overlap within the call center. The overall participation rate was 86%. In comparisons of survey participant sex and age with those of the general NYSUT membership, a greater proportion of survey respondents (approximately 81%) were female, compared to 75% among NYSUT members ($P < 0.0036$), and fewer (about 54%) were younger than age 50, compared to about 62% among the NYSUT membership ($P < 0.0002$). The median years of teaching experience among participants was 17, ranging from 0 to 42, and the median years of experience within the current school was 10, ranging from 0 to 39. Table 1 summarizes additional respondent characteristics, employment characteristics, and non-school environmental factors. A majority of respondents were between the ages of 40 and 59, and over 80% were female. Almost 30% worked in a high-need district. Almost half worked more than 40 h per week, most taught in one classroom only, and most taught one or more of grades pre-K through grade 6. About 10% either smoked within the past month or were exposed to second-hand smoke, about half reported living within 300 yards of busy roadways, and a majority reported having one or more furred or feathered pets.

Classroom characteristics

Information about teacher impressions of classroom IAQ relating to allergens and irritants, odors and fumes, and other classroom parameters is summarized in Figure 1. The allergens and irritants most commonly reported in the classroom included dust and dust reservoirs. Moisture problems, construction during school hours, and roaches or rodents were each

Table 1 Participant characteristics

	N	%
Age group		
<30	42	8.4
30–39	98	19.6
40–49	132	26.4
50–59	190	37.9
60+	33	6.6
Unknown	6	1.2
Female sex	404	80.6
In high-need district ^a	143	28.5
Work ≥ 40 h/week	237	47.3
Teach in one classroom	355	70.9
Teach grades pre-K-6	365	72.9
Smoke or exposed to second-hand smoke	48	9.6
Live with 300 yards of busy road	254	50.7
Furred or feathered pets in residence	321	64.1

^aDistrict has limited ability to meet needs of students with local resources.

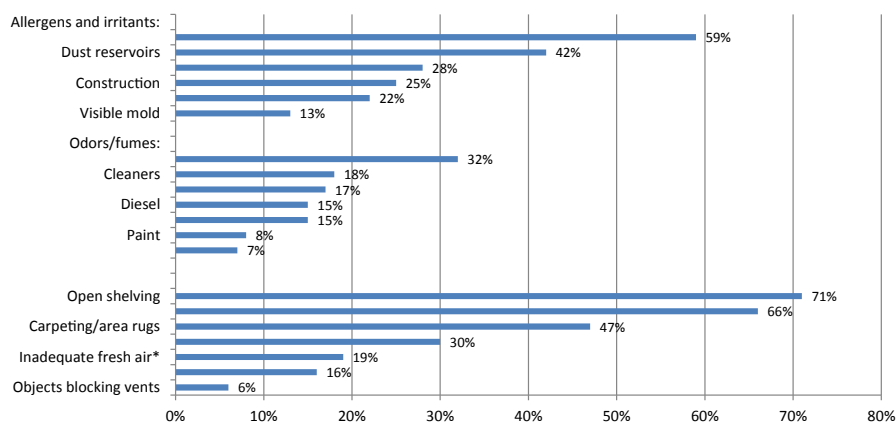


Fig. 1 Reported classroom characteristics, teacher survey, NYS, 2009 ($N = 501$ teachers). *Adequate fresh air some of the time, rarely or never

reported by over 20% of teachers, and the least commonly reported allergens/irritants (<10%) were pets in the classroom and tobacco smoke. The most commonly reported odor was from art supplies, and odors/fumes from cleaners, scented products, diesel exhaust and construction were each reported by over 10% of teachers. Fewer reported odors/fumes from paint, mold, and pesticides. Almost one-fifth reported inadequate fresh air, and less than 10% reported objects blocking air vents. Commonly reported housekeeping-related measures included open shelving for storage, food eaten frequently in the classroom, and inadequate storage. Carpeting or area rugs were reported by almost half of teachers, and less than 20% reported poor flooring condition.

Teacher health and performance

About 12.2% of teachers reported a diagnosis of asthma, and 9.6% reported that they currently have asthma. The prevalence of 14 building-related health symptoms is shown in Table 2. The most common were sinus problems, headache, allergies/congestion, and throat irritation. Other symptoms reported by over 10% of teachers include fatigue/drowsiness, sneezing, and eye irritation. For most symptoms, the prevalence was greater among females than males (data not shown). Substantial proportions of respondents reported that having these symptoms affects their teaching ability or attendance; this ranged from 16.7% for wheezing to 46.4% for sinus problems.

About 42% of respondents reported having one or more building-related symptoms. Among those, the number of symptoms ranged from 1 to 10, with about 59% reporting 1–2 symptoms and about 23% reporting 3–4 symptoms. About 32% reported one or more of eight building-related allergic/respiratory symptoms. Among these, 69% reported 1–2 symptoms and the rest reported 3–6 symptoms. Female teachers were

Table 2 Prevalence and patterns of self-reported health symptoms, non-NYC NYC public school teachers, 2009 ($N = 501$)

Building-Related Symptom ^a	Prevalence		% with symptom whose attendance or ability to teach is affected
	<i>N</i>	% ^b	
Sinus problems	84	16.8	46.4
Headache	75	15.0	37.3
Allergies/congestion	74	14.8	33.8
Throat irritation	73	14.6	38.4
Fatigue or drowsiness	60	12.0	18.3
Sneezing	56	11.2	26.8
Eye irritation	53	10.6	18.9
Cough without cold	26	5.2	34.6
Frequent colds	25	5.0	68.0
Skin irritation	20	4.0	10.0
Inability to focus	17	3.4	47.1
Wheezing	12	2.4	16.7
Nausea	8	1.6	37.5
Asthma attacks	4	0.8	50.0

^aSymptom worsens during workday or workweek, or improves when away from work.

^bPercent out of total of 501 surveyed.

more likely than male teachers to report one or more symptoms (48.9% vs. 29.0%, $P \leq 0.0006$) and one or more allergic/respiratory symptoms (43.2% vs. 19.5%, $P < 0.0001$).

Classroom characteristics and health symptoms among teachers

Current asthma was associated with the following classroom characteristics: moldy odors (RR = 2.34; 95% CI: 1.09–5.02), visible mold (RR = 2.10; 95% CI: 1.10–4.03), moisture damage (RR = 1.92; 95% CI: 1.13–3.24), dust (RR = 2.14; 95% CI: 1.08–4.23), and odors from perfumes/air fresheners (RR = 1.98; 95% CI: 1.12–3.50) after controlling for teacher and employment characteristics and non-school-based exposures. Table 3 summarizes the multivariable analysis of the relationship between building-related symptom summary measures and classroom characteristics, controlling for teacher and employment

characteristics and non-school-based exposures. Most classroom characteristics were significantly associated with an increased risk of having one or more building-related health symptoms, with the strongest associations found for dust (RR = 3.67; 95% CI: 2.62–5.13), dust reservoirs (RR = 2.13; 95% CI: 1.72–2.65), paint odors (RR = 1.73; 95% CI: 1.40–2.13), visible mold (RR = 1.71; 95% CI: 1.39–2.11), and moldy odors (RR = 1.65; 95% CI: 1.30–2.10). A similar pattern of results with generally stronger associations was found with having one or more building-related allergic/respiratory symptoms. Environmental tobacco smoke, open storage, food eaten often in the classroom, and having carpets or area rugs were not significantly associated with either symptom measure at $P < 0.05$.

The greater the number of unfavorable IAQ-related classroom characteristics reported by teachers, the stronger the association with having one or more building-related symptoms (Table 4). Compared to those reporting one or no such characteristics, the RR among those reporting 2–3 characteristics was 3.14 (95% CI: 1.49–6.62), and the RR among those reporting 4 or more characteristics was 6.15 (95% CI: 3.03–12.48). A similar dose–response pattern was found for having one or more allergic/respiratory symptoms.

The multivariable analysis was also stratified by teacher sex and age group (age 20–39, 40–49, ≥ 50). Significant direct associations were seen with blocked air vents among male but not female teachers (Table S1a, b; p for interaction = 0.015 for any building-related symptom and 0.004 for any allergic/respiratory building-related symptom). Blocked air vents also showed differential associations with the outcome measures by age group (Table S2a–c), with significant risk associations among teachers age 20–39, elevated but non-significant risk associations among teachers age 40–49, and null point estimates among teachers age 50+ (p for interaction = 0.086 for any building-related symptom and 0.072 for any allergic/respiratory building-related symptom). Age- and sex-stratified dose–response patterns were similar to those of the main analysis (data not shown).

Discussion

Classroom characteristics

Over half of respondents reported open shelving, food eaten in classroom, and dust, with significant proportions reporting carpeting, dust reservoirs, odors from

Table 3 Multivariable analysis of classroom characteristics and building-related symptoms

Classroom characteristics	Any symptom			Any allergic/respiratory symptom ^a		
	N ^c	%	RR ^b (95% CI)	N ^c	%	RR ^b (95% CI)
Visible allergens/Irritants						
Mold	42	71.2	1.71 (1.39–2.11)	34	66.7	1.90 (1.49–2.43)
Moisture damage	81	62.3	1.56 (1.29–1.90)	64	56.6	1.69 (1.34–2.13)
Dust	178	64.5	3.67 (2.62–5.13)	141	59.0	4.77 (3.10–7.34)
Dust reservoirs	130	65.0	2.13 (1.72–2.65)	103	59.5	2.37 (1.83–3.08)
Construction	62	52.1	1.21 (0.98–1.51)	53	48.2	1.39 (1.08–1.78)
Pets	14	60.9	1.43 (1.04–1.96)	13	59.1	1.76 (1.24–2.50)
Roaches or rodents	60	58.3	1.34 (1.09–1.64)	49	53.3	1.51 (1.19–1.92)
Environmental tobacco smoke	7	53.9	1.24 (0.73–2.11)	6	50.0	1.29 (0.73–2.29)
Odors or fumes						
Mold	25	75.8	1.65 (1.30–2.10)	22	73.3	1.84 (1.40–2.42)
Diesel	45	62.5	1.42 (1.13–1.78)	34	55.7	1.45 (1.10–1.91)
Construction or renovation	42	59.2	1.31 (1.04–1.64)	36	55.4	1.46 (1.13–1.88)
Art supplies/whiteboard markers	81	54.4	1.33 (1.09–1.63)	60	46.9	1.36 (1.07–1.74)
Perfumes/air fresheners	46	58.2	1.39 (1.11–1.74)	37	52.9	1.51 (1.14–1.99)
Cleaning chemicals	50	59.5	1.43 (1.17–1.75)	40	54.1	1.52 (1.19–1.93)
Paint	29	76.3	1.73 (1.40–2.13)	25	73.5	1.98 (1.56–2.50)
Pesticides	6	75.0	1.52 (0.96–2.39)	6	75.0	1.73 (1.10–2.70)
Other IAQ-related conditions						
Open storage	151	45.6	1.02 (0.81–1.28)	116	39.2	1.01 (0.77–1.33)
Inadequate storage	80	57.1	1.41 (1.15–1.72)	60	50.0	1.44 (1.13–1.83)
Food eaten often	150	49.0	1.25 (0.99–1.58)	112	41.8	1.18 (0.90–1.55)
Carpets or area rugs	108	48.9	1.07 (0.85–1.33)	82	42.1	1.09 (0.84–1.42)
Poor floor condition	46	61.3	1.42 (1.14–1.77)	38	56.7	1.55 (1.19–2.00)
Inadequate fresh air	54	60.0	1.44 (1.17–1.77)	40	52.6	1.49 (1.16–1.92)
Objects blocking air vents	19	61.3	1.47 (1.08–2.01)	15	55.6	1.67 (1.13–2.47)

^aDefined as having one or more of the following symptoms: allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds/flu, cough without cold, asthma attacks.

^bRR: relative risk adjusted for age ≥ 50 vs. < 50 , sex, years worked at current location, overtime work, school size, high vs. average/low district economic need, elementary vs. middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence.

^cExposed cases.

Bolded estimates indicate significant associations at $P < 0.05$.

Table 4 Multivariable analysis of number of classroom characteristics and building-related symptoms

Number of reported adverse classroom conditions	Any symptom			Any allergic/Respiratory symptom ^a		
	N ^c	%	RR ^b (95% CI)	N ^c	%	RR ^b (95% CI)
Visible allergens/Irritants						
≥4 Conditions	162	62.3	6.15 (3.03–12.48)	110	61.1	4.96 (2.93–8.39)
2–3 Conditions	41	30.8	3.14 (1.49–6.62)	38	30.2	2.67 (1.51–4.73)
0–1 Conditions (reference)	7	9.5	1.00	14	12.4	1.00

^aDefined as having one or more of the following symptoms: allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds/flu, cough without cold, asthma attacks.

^bRR: relative risk adjusted for age ≥ 50 vs. < 50, sex, years worked at current location, overtime work, school size, high vs. average/low district economic need, elementary vs. middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence.

^cExposed cases.

Bolded estimates indicate significant associations at $P < 0.05$.

art supplies, inadequate storage, moisture problems, construction, and vermin. The prevalence of reporting inadequate fresh air in the current survey was less than in national (Allermann et al., 2003; U.S. Department of Education, 2000) and NYS school surveys (New York State Department of Health, 2008; U. S. General Accounting Office, 1996), but similar to the 2010 Building Condition Survey (BCS), which covers the same population of schools (NYSDOH, unpublished data). However, classroom moisture problems and roaches or rodents were more frequently reported by teachers than on the BCS. These differences may reflect the fact that, compared with inspectors, who assess conditions over a short period of time, problems are more likely to be noticed by teachers due to their continued presence throughout the school year. In a study measuring IAQ-related conditions in eastern Texas classrooms (Tortolero et al., 2002), art supply irritants, dust, cleaning supply irritants, water damage, moldy/musty odors, and inadequate ventilation were much more frequently reported than on the current survey. This could be due to the fact that the Texas data were based on inspections conducted in a warm, humid climate.

Building-related symptoms

Substantial minorities of teachers reported experiencing one or more building-related symptoms in the current study. The most prevalent symptoms were sinus problems and headaches, each reported by 15% or more of respondents, and almost 10 percent reported current asthma. For many symptoms, substantial proportions reported adverse impacts on their attendance or teaching ability. In another survey that addressed teacher health (Schneider, 2003) one-third of teachers in Washington, D.C., and one-quarter of teachers in Chicago reported health problems that were potentially related to school IAQ; however, information about specific types of health problems was available only from the Chicago cohort, where the most commonly reported included asthma and respiratory symptoms (25%), with 16% reporting other symptoms, including sinus problems. Another cross-sectional

study assessed the prevalence of a number of individual building-related symptoms among teachers (Ebbehøj et al., 2005). Reported prevalence was roughly similar to that of the current analysis for throat irritation, concentration problems, fatigue, eye irritation, and headache, but comparability is hampered by the fact that the symptom measures reported by Ebbehøj et al. did not specifically represent building-related outcomes. Similar to Ebbehøj et al., symptom prevalence was higher among female than male teachers.

Associations between classroom characteristics and building-related symptoms

In the current study, having one or more building-related symptoms was associated with most IAQ-related classroom characteristics after controlling for potential confounders, with the strongest associations found for dust, dust reservoirs, paint odors, visible mold, and moldy odors. The risk for having symptoms was greater with increasing numbers of reported adverse classroom characteristics. Current asthma was also positively associated with mold and moisture problems, dust and chemical fragrances. Stratified analysis showed associations between blocked air vents, a possible indicator of inadequate ventilation, and teacher symptoms in males but not females and among younger but not older teachers. Conclusions based on these results are tentative due to small numbers in the strata and absence of any compelling biological explanation.

The findings of this study are consistent with what is known about the impacts of allergens and irritants in indoor environments upon occupant health symptoms (National Research Council, 2006). In general, these results are consistent with findings from a survey of teachers in the Washington, D.C., and Chicago school districts (Schneider, 2003) in which many respondents reported health problems they thought were caused by the school environment.

The significant associations found in this study between dust and teacher health are especially important because of the high prevalence of reporting dust in

this and other studies (New York State Department of Health, 2008; Tortolero et al., 2002). Accumulated dust harbors allergens and irritants from molds, pet dander, dust-mites, cockroaches, mice, and VOCs (Chew et al., 2005; Gyntelberg et al., 1994; Instanes et al., 2005; Munir et al., 1993; Ramachandran et al., 2005; Smedje and Norback, 2001; Tortolero et al., 2002; Tranter, 2005). These allergens and irritants can exacerbate or cause asthma or allergies (Institute of Medicine, 2000). Upholstered furniture, carpets, window treatments, and stuffed animals act as reservoirs for this dust (Custovic et al., 1996; Smedje and Norback, 2001; Tortolero et al., 2002). The quality of classroom housekeeping can also be associated with exposure to allergens and irritants. Inadequate storage can lead to clutter, which acts as a dust reservoir and shelter for roaches and mice. Flooring that is in poor condition is likely to be more difficult to clean, thereby harboring more symptom-causing allergens and irritants. Our findings with respect to dust are supported by other studies, several of which incorporated objective measures of dust and its constituents. In a study of adults in various occupational settings, Gyntelberg et al. (1994) found significant correlations between various building-related symptoms and the presence in dust of bacteria, particles, VOCs, and allergenic material. Another study (Allermann et al., 2003) found that the inflammatory potential of school dust samples from schools with a high prevalence of building-related symptoms (eye irritation, nose irritation, nose congestion, throat irritation, itching/flushing facial skin, headache, fatigue, and concentration difficulties) was significantly higher than in schools with a low symptom prevalence. Norback et al. (1990) found an association between new onset eye irritation and respirable dust in elementary school employees.

Mold and excess moisture is known to be associated with building-related health symptoms, (Bornehag et al., 2001), and inadequate moisture management promotes mold as well as dust-mites, both of which are allergenic (Institute of Medicine, 2000, 2004). Our findings were consistent with other studies that measured mold levels in school settings. Ebbehøj et al. (2005) found a relationship between mold levels measured in floor dust and building-related symptoms among female school teachers after controlling for confounders. Associated symptoms included headache and concentration problems, and these showed a dose-response relationship with mold levels. A study of measured floor dust mold and building-related symptoms in school children (Meklin et al., 2002; Meyer et al., 2004) also found associations with eye irritation, throat irritation, headache, and problems in concentrating. Additionally, relationships between mold concentrations and asthma were found in a study of 1410 school employees in 38 schools (Smedje et al., 1996) as well as in a study of school children (Smedje et al., 1997). Our

results for asthma in relation to mold and moisture and dust are also consistent with those of a study of work-related asthma in the educational setting (Mazurek et al., 2008). This study used NIOSH surveillance data from four states representing a population of affected educational service workers, over half of which were teachers or teacher's aides. Based on interview and information from physicians and administrative records, that investigation found that the most frequently reported agents among teachers and teacher's aides in elementary and secondary schools were indoor air pollution (including inadequate ventilation), mold, and dust.

Paints, art supplies and whiteboard markers, perfumes, air fresheners, cleaning chemicals, and pesticides often contain VOCs, which can build up in the indoor environment and which can have adverse health effects (U.S. Environmental Protection Agency, 2012a). Findings of other studies with regard to these substances are consistent with those of the current study. Norback et al. (1990) found associations between measured VOC concentrations in schools and chronic building-related symptoms in school staff, including airway irritation, congestion, headache, fatigue, and eye irritation, and Smedje et al. (1997) found associations between exposure to VOCs and current asthma in secondary school students. Diesel exhaust contains a complex mixture of pollutants that can affect health. It is linked to respiratory dysfunction, including asthma, and to allergies (Brunekreef et al., 1997; Northridge et al., 1999). Construction and renovations often occur when the building is occupied, and if not performed with proper safeguards can expose building occupants to fumes, dust, and hazardous contaminants including lead and asbestos, and can also interfere with the ventilation system (U.S. Environmental Protection Agency, 2012b).

The findings of the current study regarding ventilation inadequacy and teacher health symptoms are important because ventilation problems are common in schools (Daisey et al., 2003; Tortolero et al., 2002; United States General Accounting Office, 1996; U.S. Department of Education, 2000) and because lower ventilation rates are associated with higher levels of indoor air pollutants (Institute of Medicine, 2000). Our results with respect to inadequate fresh air are consistent with a pilot study of ten NYS schools which found that teachers reporting upper respiratory and neurophysiologic symptoms were more likely to work in classrooms with higher CO₂ concentrations (an indicator of inadequate ventilation) (Muscatiello et al., 2014). A study conducted in the school setting involving students found high CO₂ concentrations to be associated with headaches, dizziness, tiredness, difficulty in concentrating, and upper airway irritation (Myhrvold et al., 1996), and another study (Smedje et al., 1996) found that school children in schools receiving new

ventilation systems were less likely to report one or more asthma symptoms than children in other schools. Most other studies have examined ventilation and occupant health in office settings. Several reviews of this literature covering numerous studies with diverse epidemiologic designs (Seppanen et al., 1999; Sundell et al., 2011; Wargocki et al., 2002) as well as a large case-referent study (Stenberg et al., 1994) found lower ventilation rates and higher CO₂ levels to be associated with building-related symptoms, asthma and allergy, discomfort, poorer perceived air quality and reduced performance and productivity. Even though most of these studies were conducted in a non-school environment, we would expect similar mechanisms of exposure and response to occur in the school setting. Our results for asthma, however, which indicated a borderline significant inverse relationship, (data not shown) are inconsistent with these previous findings.

We did not find associations between teacher health symptoms and eating food in the classroom, environmental tobacco smoke, or open shelving. Improperly managed food has the potential to attract allergenic pests such as mice and cockroaches, tobacco smoke can exacerbate asthma (Institute of Medicine, 2000), and open shelving can act as a dust reservoir and has been associated with pet allergens in settled dust and higher levels of formaldehyde, a respiratory irritant (Smedje and Norback, 2001). We also did not find associations for carpeting or area rugs and teacher symptoms, nor did we find any relationship for poor carpeting condition (data not shown). This is surprising in light of the fact that carpeting acts as a reservoir for allergens (Dybendal and Elsayed, 1992; Tortolero et al., 2002; Tranter, 2005), and a higher prevalence of health complaints have been reported in carpeted relative to uncarpeted classrooms (Norback and Torgen, 1987).

Strengths and limitations

This study is unique in that it jointly assessed a comprehensive array of school classroom characteristics related to Indoor Air Quality and a variety of building-related health symptoms in teachers. This information was obtained via telephone survey in collaboration with the NYS United Teachers Call Center. This strategy allowed the selection of participants from a broad, representative base of NYSUT members, and also resulted in a very high response rate of 86%. The call center also employed a standardized protocol to be followed by interviewers for consistent administration of the survey. The center also pays by the hour rather than by number of interviews completed and has quality control measures in place to assure high quality interviews. Additionally, our sample size of 501 teachers enabled us to conduct multivariable analysis controlling for a variety of potential confounders. NYC

teachers were not included in this survey; therefore, these results are not necessarily generalizable to NYS teachers as a whole. Also, survey respondents were more likely to be female and less likely to be under age 50 than the source population of NYSUT members; however, we controlled for these variables in our analyses. Although several non-school-based exposures were controlled for in the analysis, information was not obtained on residential mold problems, which could be potentially related to some allergic or respiratory symptoms. Another potential weakness of this study is that it is based upon self-reported information rather than objective measurements. Those reporting one or more health symptoms may have been more likely to be aware of, and therefore report, unhealthy aspects of their work environment relative to those reporting no symptoms, resulting in the over-estimation of school environmental health symptom associations. Reporting bias in questionnaire-based research was identified as an issue in a study that compared findings for indoor dampness and childhood asthma in cross-sectional and longitudinal studies (Larsson et al., 2011). However, the results of the current analysis are consistent with the findings of other studies as described previously, many of which used objective measures of exposures and/or health conditions, lending confidence in them. Still, additional studies that incorporate objective measurements and observations of multiple IAQ-related school environmental conditions would be useful to validate these findings.

Conclusion

In this study of 501 teachers in NYS primary and secondary schools, many classroom characteristics potentially related to poor IAQ were reported by significant proportions of teachers, and over 40% reported at least one building-related health symptom. Most adverse classroom characteristics were associated with having one or more symptoms, with the strongest associations found for dust, dust reservoirs, paint odors, mold, and moldy odors. These results are consistent with those of other studies and can be used together with research on the impact of school IAQ on school children to advocate for school environmental health programmes that address indoor air quality issues.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. (a) Multivariable analysis of classroom characteristics and building-related symptoms stratified by teacher sex. (b) Multivariable analysis of classroom characteristics and building-related respiratory or allergic symptoms stratified by teacher sex.

Table S2. Multivariable analysis of classroom characteristics and building-related symptoms among teachers age (a) 20–39 ($N = 140$), (b) Multivariable analysis of classroom characteristics and building-related symptoms among teachers age 40–49 ($N = 132$), (c) Multivariable analysis of classroom characteristics and building-related symptoms among teachers age 50 or older ($N = 223$).

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Building-Related Health Symptoms and Classroom Indoor Air Quality: A Survey of School Teachers in New York State

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Table 1a. Multivariable analysis of classroom characteristics and building-related symptoms

Any Symptom						
Classroom Characteristics	Males (N=97)			Females (N=404)		
	N*	%	RR ^a (95% CI)	N*	%	RR ^a (95% CI)
Visible Allergens/Irritants						
Mold	7	58.3	2.21 (1.19-4.11)	35	74.5	1.61 (1.28-2.02)
Moisture Damage	12	52.2	2.08 (1.11-3.90)	69	64.5	1.44 (1.18-1.76)
Dust	18	47.4	2.89 (1.47-5.69)	160	67.2	3.80 (2.57-5.62)
Dust reservoirs	13	48.2	2.36 (1.27-4.41)	117	67.6	2.05 (1.63-2.57)
Construction	9	30.0	0.88 (0.45-1.72)	53	59.6	1.25 (0.99-1.56)
Pets	3	42.9	1.67 (0.64-4.40)	11	68.8	1.40 (1.03-1.92)
Roaches or rodents	2	18.2	0.57 (0.17-1.95)	58	63.0	1.43 (1.16-1.77)
Environmental tobacco smoke	2	66.7	2.62 (1.20-5.74)	5	50.0	0.99 (0.55-1.79)
Odors or Fumes						
Mold	3	75.0	2.68 (1.20-5.98)	22	75.9	1.54 (1.19-1.97)
Diesel	5	38.5	1.10 (0.51-2.37)	40	67.8	1.40 (1.11-1.78)
Construction or renovation	5	31.3	0.92 (0.42-2.01)	37	67.3	1.33 (1.06-1.67)
Art supplies/ whiteboard markers	12	34.3	1.50 (0.81-2.76)	69	60.5	1.31 (1.07-1.62)
Perfumes/air fresheners	4	22.2	0.67 (0.29-1.57)	42	68.9	1.56 (1.25-1.95)
Cleaning chemicals	4	26.7	1.11 (0.50-2.48)	46	66.7	1.52 (1.24-1.87)
Paint	4	50.0	1.74 (0.73-4.16)	25	83.3	1.72 (1.41-2.09)
Pesticides	0	00.0	-----	6	75.0	1.47 (0.90-2.40)
Other IAQ-Related Conditions						
Open storage	16	26.2	0.67 (0.33-1.35)	135	50.0	1.07 (0.84-1.38)
Inadequate storage	8	38.1	1.36 (0.69-2.68)	72	60.5	1.37 (1.12-1.69)
Food eaten often	16	33.3	1.37 (0.68-2.76)	134	51.9	1.18 (0.93-1.51)
Carpets or area rugs	7	29.2	1.41 (0.65-3.05)	101	51.3	1.07 (0.85-1.34)
Poor floor condition	4	44.4	1.22 (0.51-2.89)	42	63.6	1.41 (1.12-1.77)
Inadequate fresh air	3	27.3	0.82 (0.34-1.96)	51	64.6	1.49 (1.20-1.85)
Objects blocking air vents	5	71.4	2.54 (1.13-5.70)	14	58.3	1.19 (0.85-1.68)

^aRR: relative risk adjusted for age ≥ 50 vs < 50, years worked at current location, overtime work, school size, high vs average/low district economic need, elementary vs middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence

*Exposed cases

Table 1b. Multivariable analysis of classroom characteristics and building-related respiratory or allergic symptoms stratified by teacher sex

Any Allergic or Respiratory Symptom						
	Males (N=97)			Females (N=404)		
Classroom Characteristics	N [*]	%	RR ^b (95% CI)	N [*]	%	RR ^b (95% CI)
Visible Allergens/Irritants						
Mold	3	37.5	1.97 (0.83-4.68)	31	72.1	1.84 (1.43-2.37)
Moisture Damage	7	38.9	2.11 (0.89-4.98)	57	60.0	1.57 (1.23-1.99)
Dust	12	37.5	4.24 (1.41-12.74)	129	62.3	4.62 (2.89-7.39)
Dust reservoirs	9	39.1	2.93 (1.20-7.13)	94	62.7	2.22 (1.70-2.90)
Construction	5	19.2	0.79 (0.36-1.72)	48	57.1	1.44 (1.12-1.85)
Pets	3	42.9	2.48 (0.80-7.69)	10	66.7	1.62 (1.15-2.28)
Roaches or rodents	2	18.2	1.55 (0.37-6.45)	47	58.0	1.57 (1.23-2.00)
Environmental tobacco smoke	1	50.0	2.09 (0.73-5.98)	5	50.0	1.11 (0.61-2.03)
Odors or Fumes						
Mold	1	50.0	1.39 (0.56-3.46)	21	75.0	1.80 (1.36-2.39)
Diesel	4	33.3	1.30 (0.52-3.26)	30	61.2	1.38 (1.03-1.83)
Construction or renovation	2	15.4	0.62 (0.20-1.89)	34	65.4	1.51 (1.17-1.95)
Art supplies/ whiteboard markers	7	23.3	1.74 (0.80-3.79)	53	54.1	1.33 (1.04-1.70)
Perfumes/air fresheners	4	22.2	1.22 (0.53-2.82)	33	63.5	1.59 (1.21-2.10)
Cleaning chemicals	3	21.4	1.77 (0.66-4.75)	37	61.7	1.59 (1.24-2.03)
Paint	3	42.9	1.87 (0.62-5.66)	22	81.5	1.93 (1.54-2.42)
Pesticides	0	00.0	-----	6	75.0	1.65 (1.01-2.71)
Other IAQ-Related Conditions						
Open storage	9	16.7	0.35 (0.14-0.85)	107	44.2	1.08 (0.81-1.44)
Inadequate storage	4	23.5	0.85 (0.31-2.37)	56	54.4	1.42 (1.11-1.82)
Food eaten often	8	20.0	0.70 (0.31-1.64)	104	45.6	1.16 (0.88-1.53)
Carpets or area rugs	3	15.0	1.27 (0.43-3.78)	79	45.1	1.11 (0.85-1.45)
Poor floor condition	3	37.5	1.52 (0.57-4.02)	35	59.3	1.49 (1.14-1.94)
Inadequate fresh air	2	20.0	0.79 (0.23-2.68)	38	57.6	1.52 (1.17-1.97)
Objects blocking air vents	5	71.4	3.11 (1.10-8.81)	10	50.0	1.18 (0.76-1.83)

^aDefined as having one or more of the following symptoms: allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds/flu, cough without cold, asthma attacks

^bRR: relative risk adjusted for age ≥ 50 vs < 50, years worked at current location, overtime work, school size, high vs average/low district economic need, elementary vs middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence

*Exposed cases

Table 2a. Multivariable analysis of classroom characteristics and building-related symptoms among teachers age 20-39 (N=140).

Classroom Characteristics	Any Symptom			Any Allergic/Respiratory Symptom ^a		
	N*	%	RR ^b (95% CI)	N*	%	RR ^b (95% CI)
Visible Allergens/Irritants						
Mold	14	82.4	1.73 (1.22-2.46)	10	76.9	1.76 (1.14-2.71)
Moisture Damage	28	75.7	1.82 (1.35-2.46)	22	71.0	1.85 (1.31-2.63)
Dust	53	68.0	2.38 (1.43-3.97)	45	64.3	3.01 (1.56-5.81)
Dust reservoirs	36	70.6	1.81 (1.29-2.55)	31	67.4	2.05 (1.38-3.03)
Construction	17	54.8	1.08 (0.75-1.55)	17	54.8	1.26 (0.86-1.85)
Pets	5	71.4	1.58 (0.96-2.60)	5	71.4	1.91 (1.15-3.17)
Roaches or rodents	17	58.6	1.05 (0.72-1.54)	15	55.6	1.16 (0.76-1.77)
Environmental tobacco smoke	2	66.7	1.20 (0.56-2.56)	2	66.7	1.45 (0.69-3.05)
Odors or Fumes						
Mold	7	70.0	1.30 (0.81-2.09)	7	70.0	1.40 (0.82-2.39)
Diesel	14	66.7	1.34 (0.89-2.01)	12	63.2	1.36 (0.88-2.11)
Construction or renovation	12	60.0	1.03 (0.69-1.53)	12	60.0	1.17 (0.77-1.76)
Art supplies/ whiteboard markers	27	55.1	1.07 (0.77-1.49)	21	48.8	1.07 (0.73-1.55)
Perfumes/air fresheners	10	50.0	0.91 (0.57-1.46)	7	41.2	0.89 (0.48-1.66)
Cleaning chemicals	17	68.0	1.27 (0.90-1.79)	16	66.7	1.52 (1.03-2.24)
Paint	8	80.0	1.64 (1.15-2.33)	7	77.8	1.90 (1.25-2.86)
Pesticides	1	100.0	1.78 (0.58-5.44)	1	100.0	2.01 (0.48-8.45)
Other IAQ-Related Conditions						
Open storage	43	49.4	0.76 (0.51-1.11)	37	45.7	0.83 (0.53-1.30)
Inadequate storage	16	51.6	0.85 (0.58-1.25)	11	42.3	0.78 (0.50-1.22)
Food eaten often	42	54.6	0.97 (0.68-1.40)	34	49.3	0.97 (0.64-1.47)
Carpets or area rugs	34	64.2	1.31 (0.89-1.94)	28	59.6	1.38 (0.89-2.12)
Poor floor condition	17	68.0	1.38 (0.98-1.96)	14	63.6	1.43 (0.94-2.17)
Inadequate fresh air	20	76.9	1.45 (1.05-2.00)	17	73.9	1.57 (1.08-2.29)
Objects blocking air vents	8	66.7	1.36 (0.90-2.06)	6	60.0	1.44 (0.84-2.48)

^aDefined as having one or more of the following symptoms: allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds/flu, cough without cold, asthma attacks

^bRR: relative risk adjusted for sex, years worked at current location, overtime work, school size, high vs average/low district economic need, elementary vs middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence

*Exposed cases

Table 2b. Multivariable analysis of classroom characteristics and building-related symptoms among teachers age 40-49 (N=132)

Classroom Characteristics	Any Symptom			Any Allergic/Respiratory Symptom ^a		
	N**	%	RR ^b (95% CI)	N**	%	RR ^b (95% CI)
Visible Allergens/Irritants						
Mold	12	75.0	2.35 (1.54-3.58)	9	69.2	2.85 (1.68-4.86)
Moisture Damage	18	52.9	1.63 (1.05-2.55)	14	46.7	1.70 (0.99-2.94)
Dust	42	61.8	4.48 (2.39-8.42)	34	56.7	5.92 (2.67-13.15)
Dust reservoirs	34	60.7	3.06 (1.88-4.99)	28	56.0	3.90 (2.11-7.20)
Construction	17	48.6	1.50 (0.95-2.37)	14	43.8	1.74 (1.01-3.01)
Pets	3	75.0	2.12 (1.13-3.95)	3	75.0	2.97 (1.38-6.39)
Roaches or rodents	16	59.3	2.02 (1.31-3.11)	14	56.0	2.38 (1.42-4.00)
Environmental tobacco smoke	3	75.0	3.14 (1.28-7.74)	2	66.7	2.39 (0.68-8.44)
Odors or Fumes						
Mold	7	87.5	2.89 (1.74-4.81)	5	83.3	3.51 (1.61-7.66)
Diesel	7	63.6	1.78 (0.97-3.24)	6	60.0	2.03 (0.99-4.16)
Construction or renovation	14	58.3	1.81 (1.15-2.84)	10	50.0	1.84 (1.07-3.15)
Art supplies/ whiteboard markers	22	55.0	1.79 (1.15-2.81)	17	48.6	1.94 (1.15-3.27)
Perfumes/air fresheners	12	57.1	2.03 (1.16-3.55)	12	57.1	2.39 (1.30-4.41)
Cleaning chemicals	11	52.4	1.68 (1.07-2.64)	7	41.2	1.55 (0.89-2.71)
Paint	7	70.0	1.96 (1.10-3.50)	7	70.0	2.26 (1.18-4.33)
Pesticides	1	100.0	2.12 (1.32-3.40)	1	100.0	2.65 (1.50-4.69)
Other IAQ-Related Conditions						
Open storage	37	38.5	1.00 (0.58-1.73)	27	31.4	0.93 (0.51-1.69)
Inadequate storage	19	57.6	2.04 (1.31-3.17)	16	53.3	2.52 (1.50-4.25)
Food eaten often	37	42.5	1.61 (0.92-2.81)	27	35.1	1.50 (0.81-2.78)
Carpets or area rugs	26	39.4	0.89 (0.55-1.46)	18	31.0	0.75 (0.43-1.29)
Poor floor condition	10	58.8	1.62 (0.96-2.73)	10	58.8	2.26 (1.24-4.12)
Inadequate fresh air	13	52.0	1.49 (0.91-2.44)	9	42.9	1.36 (0.74-2.49)
Objects blocking air vents	5	83.3	3.09 (1.63-5.83)	5	83.3	4.24 (1.92-9.33)

^aDefined as having one or more of the following symptoms: allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds/flu, cough without cold, asthma attacks

^bRR: relative risk adjusted for sex, years worked at current location, overtime work, school size, high vs average/low district economic need, elementary vs middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence

*Exposed cases

Table 2c. Multivariable analysis of classroom characteristics and building-related symptoms among teachers age 50 or older (N=223)

Classroom Characteristics	Any Symptom			Any Allergic/Respiratory Symptom ^a		
	N*	%	RR ^b (95% CI)	N*	%	RR ^b (95% CI)
Visible Allergens/Irritants						
Mold	16	61.5	1.36 (0.96-1.93)	15	60.0	1.68 (1.15-2.44)
Moisture Damage	34	58.6	1.36 (1.01-1.83)	27	52.9	1.61 (1.12-2.31)
Dust	81	64.3	4.43 (2.43-8.09)	60	57.1	5.94 (2.69-13.16)
Dust reservoirs	58	65.9	2.11 (1.52-2.93)	42	58.3	2.36 (1.57-3.52)
Construction	27	52.9	1.13 (0.81-1.56)	21	46.7	1.26 (0.84-1.90)
Pets	6	50.0	1.04 (0.62-1.75)	5	45.5	1.34 (0.70-2.54)
Roaches or rodents	27	58.7	1.34 (0.99-1.81)	20	51.3	1.50 (1.05-2.14)
Environmental tobacco smoke	2	33.3	0.77 (0.30-1.98)	2	33.3	0.90 (0.35-2.30)
Odors or Fumes						
Mold	10	71.4	1.57 (1.07-2.30)	9	69.2	1.90 (1.24-2.89)
Diesel	23	59.0	1.28 (0.93-1.76)	15	48.4	1.21 (0.80-1.81)
Construction or renovation	16	59.3	1.18 (0.84-1.66)	14	56.0	1.45 (0.98-2.15)
Art supplies/ whiteboard markers	32	55.2	1.31 (0.96-1.78)	22	45.8	1.34 (0.90-1.98)
Perfumes/air fresheners	23	63.9	1.53 (1.14-2.06)	17	56.7	1.73 (1.20-2.49)
Cleaning chemicals	21	58.3	1.46 (1.08-1.96)	16	51.6	1.61 (1.12-2.32)
Paint	14	77.8	1.75 (1.29-2.38)	11	73.3	2.20 (1.45-3.32)
Pesticides	4	66.7	1.28 (0.72-2.29)	4	66.7	1.40 (0.79-2.47)
Other IAQ-Related Conditions						
Open storage	68	47.6	1.18 (0.82-1.71)	49	39.5	1.21 (0.76-1.94)
Inadequate storage	44	59.5	1.53 (1.14-2.05)	32	51.6	1.56 (1.07-2.26)
Food eaten often	68	49.6	1.31 (0.92-1.86)	48	41.0	1.25 (0.83-1.90)
Carpets or area rugs	46	46.0	1.03 (0.75-1.42)	34	38.6	1.13 (0.76-1.68)
Poor floor condition	19	57.6	1.34 (0.93-1.92)	14	50.0	1.36 (0.89-2.09)
Inadequate fresh air	20	54.1	1.34 (0.95-1.90)	13	43.3	1.29 (0.82-2.03)
Objects blocking air vents	6	46.2	0.92 (0.50-1.71)	4	36.4	0.92 (0.41-2.10)

^aDefined as having one or more of the following symptoms: allergies/congestion, wheezing, sinus problems, sneezing, throat irritation, frequent colds/flu, cough without cold, asthma attacks

^bRR: relative risk adjusted for sex, years worked at current location, overtime work, school size, high vs average/low district economic need, elementary vs middle/high school, smoking or ETS exposure, residential proximity to highways, furred or feathered pets in residence

*Exposed cases