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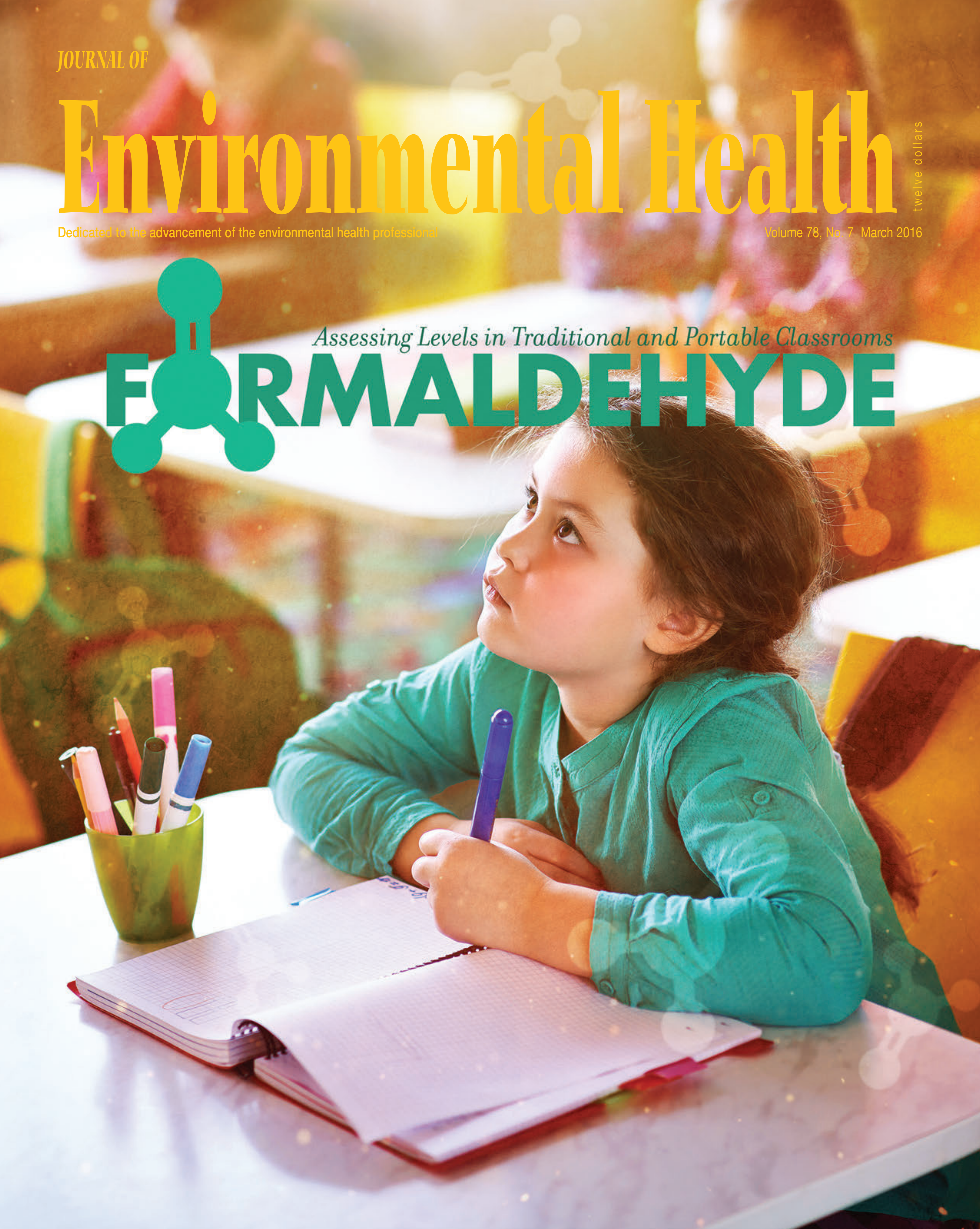
FORMALDEHYDE

Assessing Levels in Traditional and Portable Classrooms



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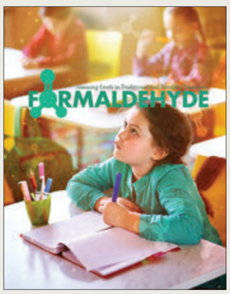

In this month's cover feature, "Formaldehyde Levels in Traditional and Portable Classrooms: A Pilot Investigation," the authors evaluated formaldehyde levels in day and overnight indoor air samples from three different schools in Atlanta, Georgia. Carbon dioxide, temperature, and relative humidity were also measured as each can influence indoor air quality. Formaldehyde levels were similar among the two classroom types and were consistent with previous studies. Elevated levels of carbon dioxide were measured, indicating inadequate ventilation. To protect the health of classroom occupants, the authors recommend improved ventilation, especially to reduce carbon dioxide levels.

See page 8.

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Erratum

In "A Step Towards Improving Food Safety in India: Determining Baseline Knowledge and Behaviors Among Restaurant Food Handlers in Chennai," published in the *Journal of Environmental Health*, 78(6), 18–25, the third sentence in the third column of page 22 should read, "At the time of our study, food handlers employed in restaurants in Chennai were required to obtain a certificate, but only **62%** reported having one."

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PRESIDENT'S MESSAGE

Bob Custard,
REHS, CP-FS

Making Environmental Health Indispensable

The "2015 Forces of Change Survey" published by the National Association of County and City Health Officials (NACCHO) estimated that over the previous seven years (2008–2014) approximately 51,700 jobs were eliminated at local health departments. This represented more than 20% of the local public health workforce. Thousands of the positions that were eliminated were in environmental health.

I, like many of you, saw firsthand the impact of the loss of so many positions from the environmental health workforce. In my work unit we lost two of 13 full-time professional positions. Our vector control program was nearly eliminated and our food safety program was downsized. It was a continual fight to save as many of our positions and resources as we eventually did.

As we engaged in the perennial budget battles, I began to observe how other city departments made their case for continued program funding. Some departments would offer up their most visible and popular services for cuts believing that no cuts would be made if they did not offer any politically viable plan for budget reduction. This disingenuous "Washington Monument" strategy often just angered top decision makers and resulted in a fixed percentage of that department's budget being cut. (It is called the "Washington Monument" strategy in reference to the National Park Service's [NPS's] decision, when faced with budget cuts in 1969, to close the Washington Monument for two days a week. Congress restored the NPS funding as a result of the public outcry, but the NPS director was forced to resign.)

> *I believe that we need to establish clear voluntary national performance standards for local environmental health services.*

Other departments, such as our community services board (CSB), mobilized their clients to lobby our city council directly. At budget hearings CSB clients (or the friends and families of their clients) would relate touching stories about how CSB services helped them successfully cope with disabilities, mental illness, or drug abuse. The personal stories of the positive impact of CSB services often helped CSB minimize the cuts to their budget. Our city council did not want to seem uncompassionate.

Some organizations funded by the city such as the small business development center and the planning and zoning department argued that the services that they provided were critical to business development in the city and, by extension, growing the city's tax base. The case was made that programs that helped businesses succeed ultimately resulted in more tax revenue than the investment made in these programs.

Some departments justified parts of their budget based on the need for the city to reduce its risk or liability in a particular area. For example, improvements were made to some public buildings to abate fire or safety hazards, to remove asbestos, or improve ventilation.

Most successful in the annual budget battles was the local fire department. Everyone understood the role of the fire department. Everyone knew what EMTs and firefighters did. No one questioned that they were essential to the health and safety of the community. No one questioned their need to maintain the capability to respond to various types of emergencies, some of which occurred rarely. In short, fire and emergency management services were considered indispensable.

Further, clear national performance standards from the National Fire Protection Association specified that on-scene emergency response should be within four minutes at least 90% of the time. The fire department had excellent data on its actual response times and could show which parts of the city had slower response times that construction of a new fire station or addition of more staff would address. Failure to meet national standards had potential implications on the cost of fire insurance for property owners.

Those annual budget battles helped me understand why environmental health was often a low priority program in city government. Environmental health was not seen as being indispensable. For me, the five key lessons learned were as follows:

- Environmental health as a profession has done a terrible job of helping the public understand the value of what we do. In a previous column ("We Haven't Told Our Story"; www.neha.org/sites/default/files/publications/jeh/JEH10.15-Pres-We-Havent-Told-Our-Story.pdf), I made some recommendations on improving the visibility of environmental health. Decision makers have to clearly understand what environmental health does before it will be adequately funded.
- Environmental health needs to mobilize its clients to advocate for environmental health services. Residents and local businesses (i.e., voters) have a huge effect on resource allocation by local governments. When environmental health clients speak out in support of environmental health programs, decision makers listen. For example:
  - » When local restaurant owners support the collaborative food safety programs of the health department, those programs get funded.
  - » When contractors explain to decision makers the importance of prompt environmental health plan review and construction inspections to business development, those programs get adequately staffed.
- Environmental health needs to describe its programs more graphically in terms of reducing health risks, preventing economic losses, and limiting liability. Sometimes it is helpful to frame this dialogue with leading questions such as
  - » What would the city's potential liability be if a foodborne illness outbreak occurred at one of our local schools?
  - » What would the impact be on local tourism if an outbreak of mosquito-borne illness occurred in the community?
- Environmental health should use fire department analogies to explain the importance of its programs in preventing disease and injury and in maintaining its capacity to respond to emergencies. For example:
  - » Restaurant inspections are like smoke detectors—they often provide an early warning of a condition that could cause injury or loss of life in time for us to respond and take corrective action before a tragedy occurs. Reducing the number of inspections of restaurants is like taking the batteries out of half your smoke detectors.
  - » Our fire department seldom needs its 100' ladder truck. It didn't wait, however, to purchase one until a fire happened in a tall building. Similarly, it would be foolish to eliminate a vector control program and then wait until an outbreak of chikungunya or dengue fever occurs to start rebuilding the capability to respond. A good vector control program that knows the local mosquito species and their local habitats takes several years to develop.

Environmental health needs objective national performance standards. As a manager, as I fought the annual budget wars, I used the Food and Drug Administration's Voluntary National Food Regulatory Program Standards as an objective measure of how our food safety program was doing. On a quarterly basis, I reported how many of the standards we met to the city manager and city council. Every quarter I reported that we did not meet Standard 8 because our staffing level was inadequate. Eventually an environmental health position in food safety for which we had lost funding was restored.

As Dr. Dyjack announced at the Annual Education Conference & Exhibition in Orlando, NEHA is fully committed to "ripping the cloak of invisibility" off the environmental health profession. Beyond helping the public and decision makers understand what environmental health professionals do and why it is important, however, I believe that we need to establish clear voluntary national performance standards for local environmental health services. Doing so would help us clearly establish the need for adequate staffing and resources.

Some years ago, the Centers for Disease Control and Prevention facilitated the development of the "Environmental Public Health Performance Standards." (The most recent version can be found at www.cdc.gov/nceh/ehs/envphps/docs/envphpsv2.pdf.) These standards are well written and are based on the "Ten Essential Public Health Services." In my view, however, these standards don't go far enough in helping local environmental health units adopt SMART (Specific, Measurable, Achievable, Relevant, Time-Bound) programmatic goals that are based on accepted national standards. As an example, an appropriate standard for investigation of public complaints about possible foodborne illness might be, "An environmental health investigation of a complaint about a possible foodborne illness should be initiated within 24 hours after the time the complaint is received at least 95% of the time."

As management guru Joseph Juran said, "Without a standard, there is no logical basis for making a decision or taking action." With clear voluntary national performance standards for local environmental health services, local governments could easily see where the performance of their environmental health units fell short and what staffing levels and resources would be required in order to meet the national standards.

I would hope that these standards would meet the American National Standards Institute (ANSI) criteria for voluntary consensus standards development based on stakeholder input, best practices, and applicable research studies. Perhaps Underwriters Laboratories (UL) and NSF International (both of which have extensive experience in standards development for everything from electrical equipment to water treatment devices) would partner with NEHA in such an effort.

In the coming year, I hope that we can begin a conversation on how consensus voluntary national programmatic performance standards for local environmental health services could be established. Your input into that dialogue would be welcomed. What should environmental health performance standards look like?

Bob Custard

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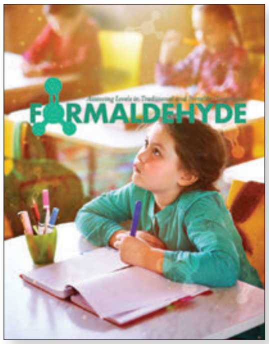

Formaldehyde Levels in Traditional and Portable Classrooms: A Pilot Investigation

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Abstract **The pilot study discussed in this article assessed formaldehyde levels in portable classrooms (PCs) and traditional classrooms (TCs) and explored factors influencing indoor air quality (e.g., carbon dioxide, temperature, and relative humidity). In a cross-sectional design, the authors evaluated formaldehyde levels in day and overnight indoor air samples from nine PCs renovated within three years previously and three TCs in a school district in metropolitan Atlanta, Georgia. Formaldehyde levels ranged from 0.0068 to 0.038 parts per million (ppm). In both types of classroom, overnight formaldehyde median levels (PCs = 0.018 ppm; TCs = 0.019 ppm) were higher than day formaldehyde median levels (PCs = 0.011 ppm; TCs = 0.016 ppm). Carbon dioxide levels measured 470–790 ppm at 7:00 a.m. and 470–1800 ppm at 4:00 p.m. Afternoon medians were higher in TCs (1,400 ppm) than in PCs (780 ppm). Consistent with previous studies, formaldehyde levels were similar among PCs and TCs. Reducing carbon dioxide levels by improving ventilation is recommended for classrooms.**

Introduction

During 1985–2008, public school enrollment increased from 39.4 million to 49.8 million in the U.S. (National Center for Educational Statistics [NCES], 2008), which led to overcrowding in some schools districts. A common response to overcrowding is to install temporary structures such as modular or portable buildings for use as classrooms. An estimated 33% (26,700 of 80,910) schools reported the use of portable classrooms (PCs) in 2005. Over 350,000 PCs are used throughout the U.S. (NCES, 2007).

Typical materials for building and furnishing PCs and new or modernized traditional school buildings may off-gas formaldehyde and other volatile organic compounds (VOCs) and result in exposures of public health concern (Hodgson, Shendell, Fisk, & Apte, 2004). Formaldehyde levels vary with type of construction materials, presence of pressed wood products, type of carpeting and flooring material, and efficiency of heating, ventilating, and air conditioning (HVAC) systems. The release of formaldehyde from pressed wood products and other sources is known to decrease over time (Meyer, 1979). Studies consistently show that highest indoor formaldehyde concentrations occur in new mobile homes and buildings, with values decreasing gradually over time (Hanrahan, Dally, Anderson, Kanarek, & Rankin, 1984; Norsted, Kozinetz, & Annegers, 1985; Sexton, Petreas, & Liu, 1989). Additionally, formaldehyde emissions from indoor sources, such as plywood and particle board, increase with temperature and relative humidity, being highest in the summer months (Meyer, 1979).

Children have greater susceptibility than adults to some environmental pollutants including formaldehyde because they breathe higher volumes of air relative to their body weights and have actively growing tissues and organs (Faustman, Silbernagel, Fenske, Burbacher, & Ponce, 2000). Acute exposure to formaldehyde can result in irritation of the throat, nose, eyes, and skin (Agency for Toxic Substances and Disease Registry [ATSDR], 2010). Several observational studies have demonstrated associations between formaldehyde and asthma outcomes, such as increased bronchial responsiveness in children with asthma, emergency treatment for asthma, increased risk of IgE-mediated sensitization, and increased diagnoses of asthma (ATSDR, 2010). Indoor exposure to formaldehyde has also been associated with chronic respiratory symptoms and decreased pulmonary function among children (Krzyzanowski, Quackenboss, & Lebowitz, 1990). Nasal irritation, eye irritation, and increased risk of asthma and allergies have been observed at airborne formaldehyde levels at 0.01–0.5 parts per million (ppm). Continuous exposure to formaldehyde also has led to increased IgE-mediated sensitization and symptoms at levels greater than 0.05 ppm, the World Health Organization's threshold, among primary schoolchildren (Wantke, Demmer, Tappler, Götz, & Jarisch, 1996). Formaldehyde is also a human carcinogen (National Toxicology Program, 2013).

Few published studies have examined formaldehyde levels in occupied PCs, mainly from California (California Air Resources Board [CARB], 2003; Hodgson et al., 2004; Shendell et al., 2004; Shendell, Winer, Weker, & Colome, 2004a). Public health concerns about formaldehyde exposure during travel trailer and mobile home use following the Gulf Coast Hurricane Katrina in 2005 prompted this investigation (Centers for Disease Control and Prevention [CDC], 2008). Our primary objective was to describe formaldehyde levels in PCs and traditional classrooms (TCs) occupied by school-aged children, a potentially sensitive population. Secondary objectives were 1) to develop and field test a noninvasive, nonintrusive, and nondisruptive sampling protocol to measure levels of formaldehyde during school hours and overnight; and 2) to explore factors that may influence indoor air quality, such as use of HVAC systems, levels of carbon dioxide, temperature, and relative humidity. To our knowledge, this is the first study assessing levels of formaldehyde in school classrooms in the southeastern U.S., where hot temperatures and high humidity characterize spring and summer months.

Methods

Participants

The metro Atlanta School District participating in this study has nine PC units that were renovated within three years of the investigation. Twelve classrooms were sampled as follows: School A = four PCs (quad units) and one TC; School B = one PC and one TC; and School C = four PCs (each as an individual portable unit) and one TC. Because quad units have four classrooms per unit, one classroom per unit was randomly selected at School A. The school district was selected by convenience and data were collected in the last week of the district's school year, May 18–21, 2009.

Procedures

Investigators pretested a standardized nine-page questionnaire with the school district's indoor air quality (IAQ) coordinator, who then distributed it to facility managers and teachers for recording indoor environment and classroom exterior characteristics. Teachers from PCs and TCs responded to questions about the HVAC system such as noise level and use during class hours, as well as air quality and environmental conditions in the classrooms.

Two simultaneous nine-hour school day and two overnight 15-hour samples of formaldehyde were collected in each classroom, using the 1994 National Institute for Occupational Safety and Health *Manual of Analytical Methods*, Method 2016 (NIOSH, 1994). Samplers were positioned in opposite corners of the PCs and TCs within 10 m distance. Teachers were requested to open or close doors and windows as they might during typical classroom instruction hours. Samples were collected using personal sampling pumps. Samples were drawn at a low-flow rate between 0.05 and 0.1 L per minute, and the pumps were placed at a height of 1.2 m. Air sampling pumps were calibrated before and after use with a calibrator primary standard. For day sampling, pumps were started immediately prior to the beginning of the school day (i.e., the arrival of the students at 7:00 a.m.) and stopped after the end of the school day (around 4:00 p.m.). For overnight sampling, pumps were operated after the school day ended (4:00 p.m.) and stopped in the morning prior to the school day's start (7:00 a.m.). One outdoor and one field blank sample were collected on each sampling day (four days) in the field from all three schools. Field blanks are used as part of quality control procedures and no contamination was observed during handling. All sample tubes were stored in a freezer or in a cooler on ice at all times when not being used for sampling. At the end of each sampling day, sample cartridges were resealed using cartridge plugs and placed in a resealable pouch. Samples were transported to a refrigerator and shipped to the designated analytical laboratory in coolers via overnight express.

Strict quality assurance/quality control (QA/QC) procedures were observed including the use of chain of custody forms (NIOSH, 1994). To ensure schools' privacy and safeguard data, each PC or TC was assigned a unique identifier number linked to data recorded on paper interview and abstraction forms. Laboratory samples were analyzed using specific standard QA/QC procedures (NIOSH, 1994) for an American Industrial Hygiene Association–accredited laboratory.

Concurrent (day and overnight) measurements of indoor temperature and relative humidity were conducted in each classroom using dataloggers. Carbon dioxide was measured in each classroom at the start (7:00 a.m.) and at the end (4:00 p.m.) of the school day. Temperature, relative humidity, and outdoor carbon dioxide were also measured in all three schools; carbon dioxide levels were used as indicators of classroom ventilation.

The primary outcome variable was the one entire school-day concentration of formaldehyde measured in PCs and TCs. The average between the two formaldehyde samples from each classroom was used to calculate the overnight and day means and medians for over the four days of testing. Data on potential factors that might affect the formaldehyde levels were collected, including indoor temperature, indoor relative humidity, and carbon dioxide concentration. Other classroom characteristics, such as window or air conditioning use, time spent in classroom, age of construction or renovation of the PC, exterior temperature, and direction of prevailing wind during the sampling days were also collected.

Data Analysis

Data were analyzed using SAS version 9.1. Differences in means were tested for statistical significance using the unpaired Student's *t*-test. Statistically significant differences in proportions were determined using the Chi-square test. Since samples are small and the distribution of concentrations is unknown, differences in means and proportions were also analyzed using nonparametric methods, with no change in findings or conclusions (data not shown). Results were considered statistically significant at $p < .05$.

TABLE **1**

Building Characteristics of Portable and Traditional Classrooms Among Study Schools A, B, and C

Characteristics	School A Portable (n = 4)	School A Traditional (n = 1)	School B Portable (n = 1)	School B Traditional (n = 1)	School C Portable (n = 4)	School C Traditional (n = 1)
Acquisition status	New, ≤3 years before study	Built ≥3 years before study	New, renovated 1 year before study (originally built 15 years before study)	Built ≥3 years before study	New, renovated 1 year before study (originally built 10 years before study)	Built ≥3 years before study
Replacement status	—	No renovation	—	No renovation	—	Lighting, floor, and HVAC[a] unit replaced in last 3 years
Roof composition	Synthetic rubber	Composite shingle or tar/gravel	Synthetic rubber	Composite shingle or tar/gravel	Synthetic rubber	Composite shingle or tar/gravel
Exterior walls composition	Concrete-based, mixed wood/panel board, metal	Masonry	Concrete-based, mixed wood/panel board, metal	Masonry	Concrete-based, mixed wood/panel board, metal	Masonry
Interior walls composition	Vinyl-coated or gypsum dry wall	Painted cinderblock	Vinyl-coated or gypsum dry wall	Painted cinderblock	Vinyl-coated or gypsum dry wall	Painted cinderblock
Floor composition	Entirely carpeted	Concrete	Entirely carpeted	Entirely carpeted	Entirely carpeted	Concrete

[a]HVAC = heating, ventilating, and air conditioning.

Results

Three schools participated in this pilot study, two elementary—including pre-kindergarten aged children—and one high school. None of the studied classrooms was adjacent to a laboratory, an industrial building, an art shop, or other special purpose room. Building characteristics for PCs and TCs for all three schools (A, B, and C) are shown in Table 1. Even though only PCs in school A were built three or less years prior to this pilot study, all PCs were considered new because PCs in schools B and C had been fully renovated (with completely new interiors) within three years from the beginning of our study, and were acquired one year before our study. All TCs were built more than three years prior to the study and had not been renovated. With the exception of the TC in school C, no classrooms had interior items replaced in the last three years before our study since they were built new or renovated. Building construction materials such as the roof and interior and exterior walls were similar among the same type of classroom, but differed between PCs and TCs. The composition of classroom furnishings was similar across all PC and TC units sampled. Tables and desks were mostly a combination of solid and pressed wood, plastic, and metal, while bookcases, cabinets, and chairs were made primarily of solid and pressed wood. Floors in all PCs and in one TC (school B) were entirely carpeted and two TCs had concrete flooring. Finally, all 12 classrooms featured windows on only one side of the classroom.

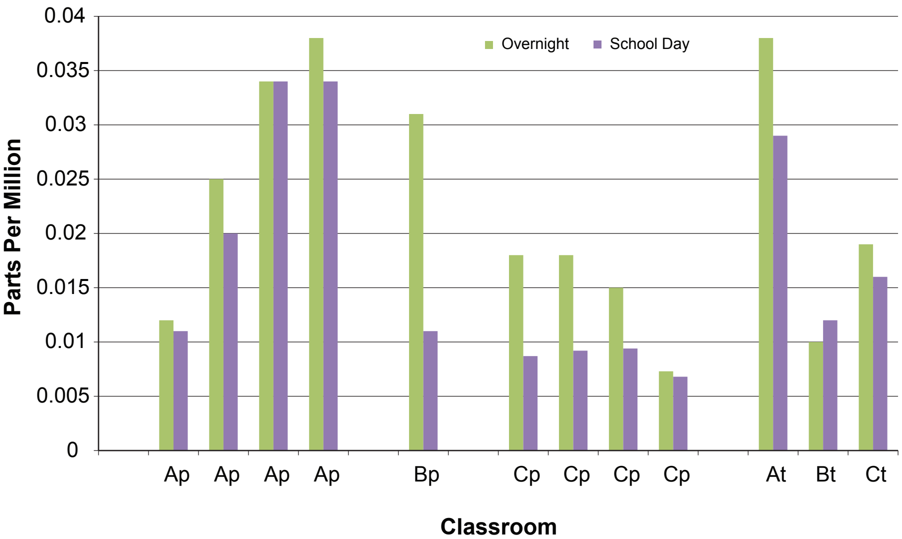
On average, 23 students occupied both PCs and TCs, with 83% typically changing rooms during the day, with the exception of two classrooms—one PC and one TC—where students stayed all day. The average time students spent inside the same classroom was 1.8 hours for PCs and 4.2 hours for TCs. Teachers typically spent six or more hours in the same classroom five days per week. Among the five classrooms with doors opening directly to the outdoors (all PCs), teachers of three classrooms reported occasionally leaving the door open during the school day. Of 12 teachers, five reported occasionally opening the classroom windows for natural ventilation. Each of the 12 classrooms had functioning air conditioning units and a thermostat; only one TC teacher reported not being able to adjust the thermostat because it was locked. Two teachers reported turning off the air conditioning frequently, and two reported turning it off occasionally.

At the time the samplers were placed inside the classrooms (7:00 a.m. for day and 4:00 p.m. for overnight measures), none of the classrooms had open windows or exhaust vents and the air conditioning was on only in two PCs and one TC at the beginning of the overnight sampling period, and in one PC at the beginning of the day sampling period. Four of 48 formaldehyde samples were void during the sampling period due to battery pump failure (three during the day and one overnight). Overall, across schools (A, B, and C), classroom types (portable, traditional), and sampled period (overnight, day), measured levels of formaldehyde ranged from 0.0068 ppm to 0.038 ppm with a median of 0.017 ppm. Figure 1 illustrates measured overnight and day formaldehyde levels in all 12 classrooms. No statistically significant differences were observed when comparing formaldehyde levels in TCs versus PCs for daytime ($t[10]$ = -0.05, p = .96) or overnight ($t[10]$ = -0.43, p = .68) periods. School A consistently presented the highest concentrations of formaldehyde across sampled period and classroom type. School C presented the lowest levels among the PCs. The overall variability in formaldehyde concentrations in schools A and B was greater than in school C, respectively (SD = 0.010, 0.010, and 0.0048 ppm).

Between-school variability, measured by comparing the average and median values

FIGURE 1

Average Indoor Air Formaldehyde Levels in Portable and Traditional Classrooms



Ap = School A—portable classroom; At = School A—traditional classroom; Bp = School B—portable classroom; Bt = School B—traditional classroom; Cp = School C—portable classroom; Ct = School C—traditional classroom.

and the ranges of measured values, was also substantially high. Median values, for both classroom types, in school A (0.031 ppm) were over twice as high as in schools B and C (0.011 and 0.012 ppm, respectively), and means were 0.027, 0.016, and 0.013 ppm for schools A, B, and C, respectively. The day average concentration of formaldehyde (ppm) was higher in TCs (0.019) than in PCs (0.016); however, the highest value was found in a PC (0.034) (Table 2). Overnight mean formaldehyde levels were similar for PCs and TCs. Both overnight mean and median levels were higher than day levels across the two types of classrooms but these differences were not statistically significant ($t[22] = 1.24$, $p = .23$). Day-night differences among formaldehyde levels may be reflective of differences in classrooms' nighttime HVAC settings.

Temperature and relative humidity exhibited small variations, compared to formaldehyde and carbon dioxide concentrations. Seven classrooms (three traditional and four portable) had at least one of the measured indoor carbon dioxide concentrations above 1,000 ppm. Outdoor carbon dioxide concentrations were 380, 420, and 420 ppm at schools A, B, and C, respectively. Table 2 summarizes descriptive statistics (mean, median, *SD*, range) of day and overnight environmental measures. Carbon dioxide day and night concentrations were significantly different ($t[22] = 3.36$, $p = .003$). The overall difference in carbon dioxide concentrations between PCs and TCs (including day and night measurements), however, were not statistically significant ($t[22] = -1.28$, $p = .21$) (Figure 2). Carbon dioxide day concentrations did not differ between PCs and TCs ($t[10] = -0.75$, $p = .47$), nor did overnight concentrations between PCs and TCs ($t[10] = -1.46$, $p = .18$) (Figure 2). Temperature and relative humidity median values were similar between PCs and TCs (Table 2). Indoor temperatures were higher overnight than during the day, and this finding was very similar among PCs and TCs. Measured indoor relative humidity was higher during the day than overnight, and again, relative humidity was fairly similar across the two types of classrooms.

Discussion

Formaldehyde levels in PCs measured during this investigation were similar to those measured in TCs and those found in portable trailers in California (CARB, 2003), and below levels observed to result in eye and nasal irritation and increased risk of asthma (ATSDR, 2010). The mean formaldehyde levels measured in a comprehensive study of air quality in PCs conducted by the California Air Resources Board (CARB) were 0.015 ppm for PCs ($n = 135$) and 0.012 ppm for TCs ($n = 64$); indoor carbon dioxide and humidity showed positive associations with formaldehyde levels (CARB, 2003). The measured levels of formaldehyde in air were below the American Conference of Governmental Industrial Hygienists' (ACGIH) threshold limit value (TLV) for formaldehyde of 0.3 ppm as a ceiling concentration not to exceed during the work day (ACGIH, 2001).

In our pilot study, teachers from PCs complained more about indoor noise, specifically noise produced by the HVAC system, than teachers from TCs and a few teachers reported having to turn the air conditioning off because of its excessive noise, a finding similar to that observed in the CARB study (CARB, 2003) (data not shown). Because HVAC systems tend to reduce indoor VOCs, including formaldehyde among other chemical and microbiological potential sources of respiratory illness, it is important that these systems are well designed and functioning adequately. HVAC systems are often used to mechanically ventilate classrooms, although these systems may provide less ventilation than intended as a result of design and installation problems, poor maintenance, and infrequent operation during occupancy (Shendell, Winer, Weker, & Colome, 2004b).

Because measuring the actual ventilation rate requires specialized skill and equipment, the indoor concentration of carbon dioxide has been used as a surrogate for the ventilation rate per occupant, including in schools (Lee & Chang, 1999; Shaughnessy, Haverinen-Shaughnessy, Nevalainen, & Moschandreas, 2006; Shendell et al., 2004). The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) developed consensus standards and a guideline for HVAC systems. The ANSI/ASHRAE 62.1-2007: "Ventilation for Acceptable Indoor Air Quality" recommends that indoor carbon dioxide concentrations be no greater than 700 ppm above outdoor carbon dioxide concentrations in order to satisfy comfort needs of the majority of occupants (ASHRAE, 2009). This standard corresponds to indoor levels less than 1,080

TABLE **2**

Day and Overnight Environmental Measures Distribution (Mean, *SD*, and Range) for Portable and Traditional Classrooms

Environmental Measure	Portable (*n* = 9)					Traditional (*n* = 3)				
	Mean	Median	*SD*	Minimum	Maximum	Mean	Median	*SD*	Minimum	Maximum
Day										
Formaldehyde (ppm[a])	0.016	0.011	0.011	0.0068	0.034	0.019	0.016	0.009	0.012	0.029
Carbon dioxide[b] (ppm)	890	780	440	480	1800	1300	1400	216	1000	1400
Temperature (ºC)	21.4		1.4	19.5	23.4	22.3		1	21.3	23.3
RH[c] (%)	48		10.6	37.7	69.7	47.3		10.3	38.8	58.8
Overnight										
Formaldehyde (ppm)	0.022	0.018	0.011	0.0073	0.038	0.022	0.019	0.014	0.01	0.038
Carbon dioxide[d] (ppm)	560	580	72	470	680	610	540	166	480	790
Temperature (ºC)	25.3		1.9	22.2	27.4	25.1		1.4	24.1	23.3
RH (%)	43.6		5.2	37.3	53.9	38.2		3.2	35.8	58.8

[a]ppm = parts per million.
[b]Measured at 4:00 p.m.
[c]RH = relative humidity.
[d]Measured at 7:00 a.m.

ppm since outdoor carbon dioxide concentrations usually range between 380 and 410 ppm. NIOSH (2008) states that "Elevated carbon dioxide concentrations suggest that other indoor contaminants may also be increased." The Occupational Safety and Health Administration's (OSHA) permissible exposure limit for indoor carbon dioxide is 5,000 ppm (Air Contaminants, 2006).

In this pilot investigation, elevated (>1,080 ppm) levels of carbon dioxide were observed particularly in TCs in concurrence with the findings of Shendell and co-authors (2004) of lower ventilation rates in TCs than in PCs. Although the levels of carbon dioxide concentrations observed in our pilot study do not represent a health threat, this finding is noteworthy because lower rates of ventilation, as indicated by higher carbon dioxide concentrations, are known to be associated with increased respiratory illness (Fisk, 2000). In addition, high carbon dioxide concentrations have been associated with relative increases in students' school absence (Mendell et al., 2013; Shendell et al., 2004b) and lower performance (Haverinen-Shaughnessy, Nevalainen, Moschandreas, & Shaughnessy, 2010; Mendell & Heath, 2005). It might be noted that OSHA standards for exposure concentrations do not apply to children, who may be at greater risk to adverse effects from exposure to carbon dioxide.

These results demonstrated the feasibility of conducting IAQ investigations in the school environment with minimal disruption on school days, which was the goal of the investigation. This pilot investigation has a number of limitations. First, the field team was allowed limited, fixed time on the schools' grounds and inside classrooms, a restriction reducing the ability to complete a comprehensive walk-through survey in classrooms. Because the data collection occurred in the last week of the school year, conditions may not have been representative of the whole year pattern, and such factors (e.g., attendance) could have affected the magnitude of measured indoor carbon dioxide concentrations. A 100% questionnaire response rate was attributed to a small sample size and the ability of the school system's IAQ coordinator to follow up with facility managers and teachers. This questionnaire may be useful for conducting similar school air quality investigations, particularly for study designs involving larger sample sizes.

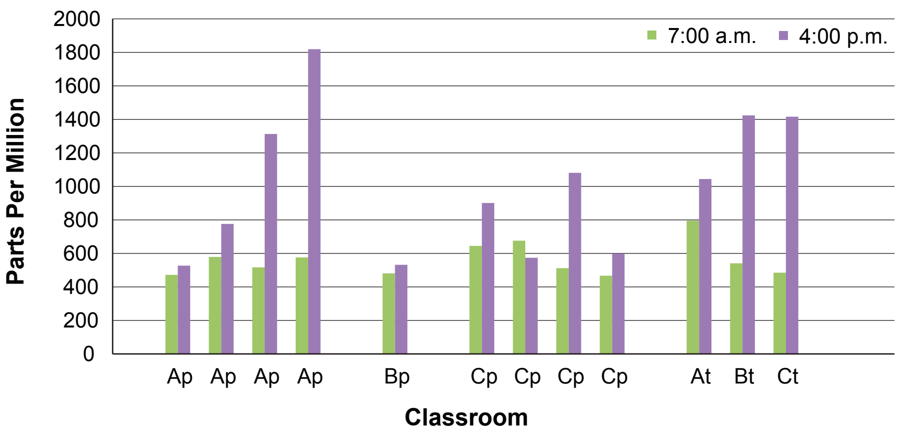
Because our pilot study was carried out in only one school district, interpretation of results was limited to these parameters as well as a relatively small number of classrooms sampled and different configurations of classrooms in each school. Further, sampling newly manufactured PCs that might be expected to off-gas more formaldehyde than older ones was not possible. Lastly, airborne particulate levels in PCs were not measured although classrooms often were located adjacent to particulate sources such as parking lots and roadways.

Conclusion

Consistent with previous findings, the levels of formaldehyde measured in PCs were similar to levels observed in TCs. Elevated levels of carbon dioxide were found in both PCs and TCs, indicating inadequate ventilation. On the basis of this work, we believe that a well-designed study of PCs and TCs would be an appropriate effort that should not only examine formaldehyde levels and ventilation in PCs, including carbon dioxide levels, but also address other potential factors affecting indoor environments in PCs and TCs. Upon acquisition or renovation of PCs, a school district is encouraged to access resources, such as the U.S. Environmental Protection Agency's (U.S. EPA's) Indoor Air Quality Tools for Schools Reference Guide and Design Tools for Schools (U.S. EPA, 2009, 2010).

FIGURE **2**

Average Indoor Carbon Dioxide Levels in Portable and Traditional Classrooms



Ap = School A—portable classroom; At = School A—traditional classroom; Bp = School B—portable classroom; Bt = School B—traditional classroom; Cp = School C—portable classroom; Ct = School C—traditional classroom.

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Disclaimer: The findings and conclusions in this article are those of the authors and do not necessarily represent the views of CDC. Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

Human Subjects Approval Statement: This pilot investigation was completed as a CDC Epi-AID to the state of Georgia and met all the CDC human subjects requirements.

In Memoriam: We, the co-authors of this paper, dedicate its publication to the memory of one of the authors, CAPT David Callahan, MD, who passed away unexpectedly in January 2015. David graduated with an undergraduate degree from the College of William and Mary in 1986. Following his graduation from the Medical College of Virginia in 1993, David completed a residency in family medicine at Fairfax Family Practice in Fairfax, Virginia. He served as an assistant clinical professor of family medicine at the Medical College of Virginia from 1996 to 1999. David was then accepted into the Centers for Disease Control and Prevention's (CDC's) Epidemic Intelligence Service program and was assigned to the San Diego County STD Control Program. After arriving at the headquarters of CDC in 1999, David continued to serve at CDC in a number of positions. In his last position as a career epidemiology field officer supervisor, he was doing what he loved most—guiding epidemiologists and working with state and local partners to advance public health. David embodied the very best of a public health professional. He was a family medicine physician who continued active clinical practice throughout his public health career. Whether he was practicing medicine at Emory University Hospital or in a rural southwestern American Indian reservation, he always provided competent and compassionate care to his patients. David was a dedicated husband, father, son, and brother and mentor to many at CDC; most of all, he was our friend and colleague, and we miss him greatly.

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continued on page 14

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The Investigation of Groundwater Contamination in Wicomico County's Morris Mill Community

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Wicomico County Health Department

Abstract **In 2012, the Wicomico County Health Department began investigating groundwater contamination in the Morris Mill community. The contamination was due to high levels of trichloroethylene (TCE). TCE is a colorless nonflammable liquid that has a sweet odor and a burning taste. Exposures can lead to acute effects as well as more chronic conditions such as cancer. A total of 300 wells were sampled during the course of the investigation. Fifty wells showed levels of TCE above the maximum contaminant level of 5 parts per billion. Timely communication with the residents and risk management played integral parts in assisting the community towards a long-term solution. In December 2013, the Wicomico County Urban Services Commission created an urban service district to provide public water from the city of Fruitland to the entire affected area. Completion of the water tower and distribution system for the 273 affected homes was expected in early 2016.**

Introduction

Wicomico County is located on the eastern shore of Maryland (Figure 1). With the exception of the residents located inside seven municipalities, the majority of the county's population of 100,000 relies on private wells and onsite sewage disposal systems. These wells are historically screened in the shallow, unconfined surficial aquifer (Salisbury Aquifer) at depths of 70'–80'. Water is recharged to this aquifer by local precipitation. Groundwater in the Salisbury Aquifer generally moves laterally fairly short distances to nearby perennial streams or marshes. The transmissivity rates average close to 53,500 square feet per day (Andreasen, Staley, & Achmad, 2013).

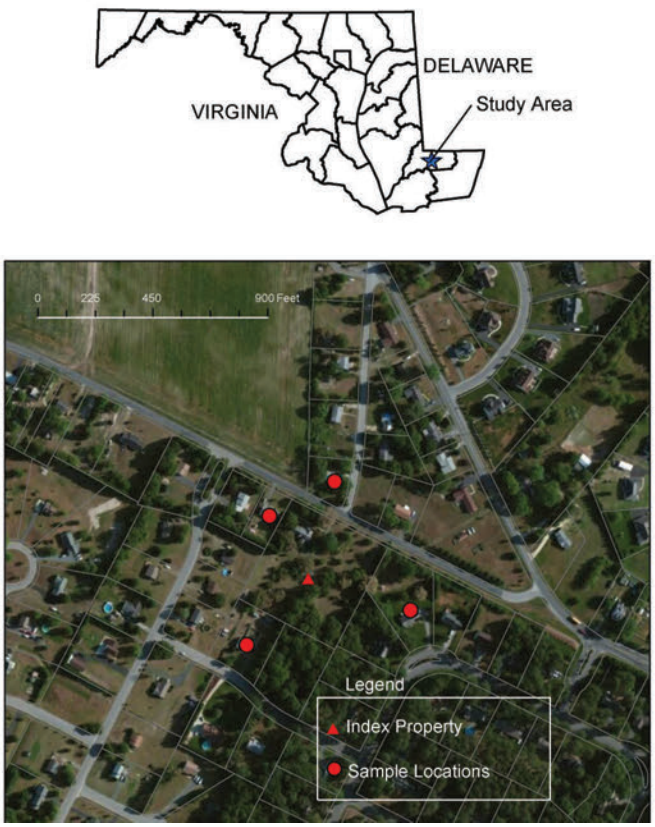
In August 2012, the Wicomico County Health Department was notified by a resident in the Salisbury, Maryland, area who noticed a chemical odor emanating from the water produced in the bathroom faucet. That resident had a private lab analyze his well water. Those results indicated the water contained 57.00 parts per billion (ppb) of trichloroethylene (TCE). Based on the resident's notification to the health department, four surrounding wells were sampled for volatile organic compounds (VOCs) on September 5, 2012 (Figure 1). The samples were sent via courier to the Laboratories Administration at the Maryland Department of Health and Mental Hygiene in Baltimore. The results indicated all four wells contained TCE ranging from 43.73 ppb to 141.65 ppb. The department then aggressively sampled 38 wells that were located within 1,000' of the original index property. Those results ranged from nondetect to 261.39 ppb. Based on the locations of the contaminated wells, the department identified the northeastern limit of the TCE plume (Figure 2). Once those results were received, however, it became evident that the magnitude of the contamination was going to exceed the department's resources. Assistance from the Maryland Department of the Environment (MDE) was requested in September 2012.

MDE began their investigation by expanding the sampling area. One hundred eighty-nine individual private wells were sampled between September and November of 2012 (Table 1). Those results indicated additional sampling would be required over a much larger area.

Based on the potential public health impacts, MDE requested assistance from the U.S. Environmental Protection Agency (U.S. EPA). After consulting with U.S. EPA and the Agency for Toxic Substances and Disease Registry, MDE established three separate levels for different populations within the affected area. The first action level was set at 2.18 ppb for TCE and represented the long-term remedial goal for those residing in the area. MDE calculated this action level using U.S. EPA's tap water risk-based screening level for all routes of exposure other than vapor intrusion using the residential default values and a 1 in 100,000 lifetime cancer risk exposure level. MDE provided bottled water to homes in excess of the 2.18 ppb TCE action level

FIGURE **1**

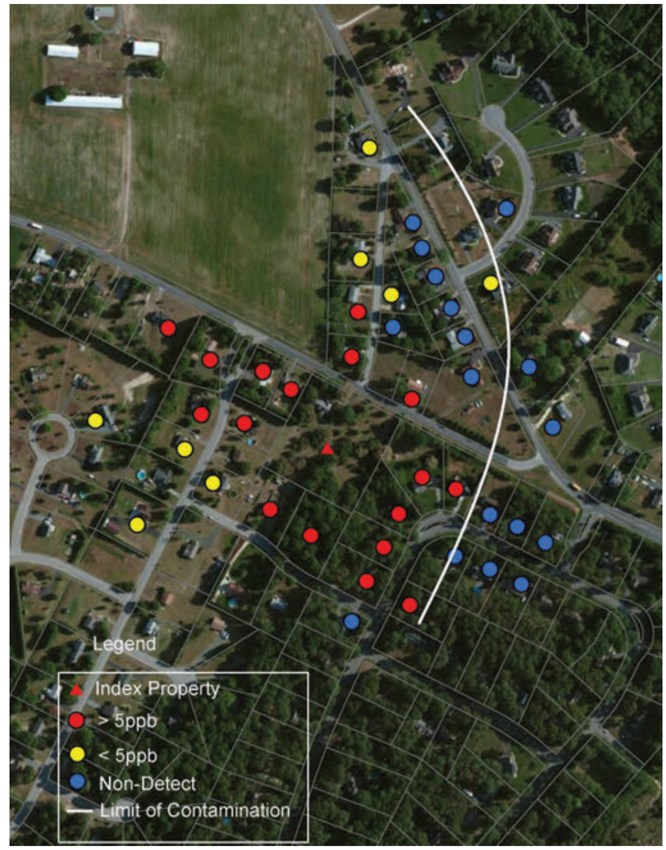
Study Area and Locations of Water Samples Collected on September 5, 2012



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

FIGURE **2**

Locations of Samples Collected September 17–October 2, 2012



ppb = parts per billion.
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

TABLE **1**

Results From September–November 2012 Sampling

Detection Level	# of Wells
Above MCL[a]	35
Above action level[b]	10
Below action level	10
Nondetect	134

[a]MCL = maximum contaminant level (5 parts per billion [ppb]).
[b]2.18 ppb.

to eliminate the ingestion exposure pathway. The second action level was set at the Safe Drinking Water Act maximum contaminant level (MCL) of 5 ppb for TCE. Those homes in excess of 5 ppb and the presence of a sensitive population received a whole-house carbon filtration system to eliminate the ingestion, absorption, and inhalation pathways. Sensitive populations were defined as women of childbearing age and children (newborn–six years old). The third action level was set at 30 ppb for all populations. At this action level, all populations with TCE greater than 30 ppb in the drinking water were provided with a whole-house carbon filtration system to eliminate the ingestion, absorption, and inhalation pathways.

Materials and Methods

Sampling for VOCs was conducted using 40-mL glass vials with teflon septum caps. Samples were preserved with hydrochloric acid and then kept on ice until they could be placed in refrigeration at the lab. For each drinking water sample collected, a field blank and a trip blank were also produced. These blanks consisted of ion-free water, known to be free of all volatiles, and were submitted to the lab for analysis with the drinking water sample to ensure no sample contamination occurred. The trip blank vial was filled before the sampling regimen began and was carried throughout the process and tested to ensure other samples were not contaminated during transportation.

FIGURE **3**

Monitoring Well Locations

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

FIGURE **4**

Maximum Trichloroethylene (TCE) Concentrations Detected

MCL = maximum contaminant level.
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

TABLE **2**

Total Trichloroethylene Detections

Detection Level	# of Wells	Range of Contamination (ppb[a])
Above MCL[b]	50	5.38–550.00
Above action level[c]	19	2.58–4.98
Below action level	25	0.08–2.17

[a]ppb = parts per billion.
[b]MCL = maximum contaminant level (5 ppb).
[c]2.18 ppb.

Field blank vials were filled at each sampling location to eliminate other environmental conditions that may have contributed to the presence of VOCs. Quarterly sampling of the affected area began in 2013.

In January of 2013, a well driller contracted by MDE installed 10 monitoring wells. The purpose of these wells was to determine the actual direction of groundwater movement as well as to determine if TCE concentrations varied at different depths. Unfortunately, no TCE was detected in the monitoring wells. The direction of groundwater movement, however, was determined to be generally north-northwest (Figure 3).

Results

The results of the overall private well sampling indicated that 50 wells contained TCE above the MCL; 19 wells were above the 2.18 ppb action level; and 25 wells contained TCE below that action level (Table 2). These levels required the installation of 40 whole-house carbon filtration systems. In addition, 22 homes were continually supplied with bottled water. The locations of the maximum concentrations observed throughout the investigation are shown in Figure 4.

In December 2012, U.S. EPA tested the indoor air quality of a representative subset of nine residences with impacted wells to determine if the TCE concentrations in indoor air were likely to pose a health risk to area residents. Both livable spaces and limited access areas (i.e., crawl spaces) were tested for TCE concentrations in indoor air. No TCE concentrations were detected at or above levels anticipated to pose a risk to human health.

Discussion and Conclusion

During the course of the investigation, dozens of interviews were conducted. According to the area residents, septage, the liquid and solid material pumped from a septic tank, was discarded on nearby farm fields. This practice was not uncommon in the 1950s to 1970s. Maryland began regulating the collection and disposal of septage in the early 1980s.

In order to keep the community informed of the investigation, the coordinating agencies held several public meetings. An engineering study was conducted to determine the most cost-effective long-term solution. That solution was identified as providing public water from the city of Fruitland through an urban service district. This district will provide the water at 1.5 times the current consumptive rate. Residents would not, however, be annexed into the municipality and be subject to additional taxes. The anticipated cost for the project was $8 million.

In 2013, funding was secured through a number of grants and loans. MDE provided $3 million in grants through the capital budget of fiscal year 2015. The U.S. Department of Agriculture agreed to provide $3 million in grants and a $2 million loan. All of the necessary engineering, design, and land acquisition occurred in 2014. The project was expected to be completed in early 2016, providing 273 homes with safe drinking water.

Accurate and timely dissemination of information was key to the success of this project. Three levels of government—local, state, and federal—worked seamlessly to provide a long-term solution to the area.

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INTERNATIONAL PERSPECTIVES

Poor Indoor Air Quality, Mold Exposure, and Upper Respiratory Tract Infections—Are We Placing Our Children at Risk?

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Abstract **Understanding how respiratory health risks are associated with poor housing is essential to designing effective strategies to improve children's quality of life. The objective of the study described in this article was to determine the relationship between respiratory health and housing conditions. A survey was completed by 3,424 parents of children in third and fourth grade in Winnipeg, Manitoba, Canada. An engineering audit and air samples were also taken in the homes of a subset of 715 homes. Results showed that a child's respiratory health is significantly associated with self-reported visible mold in the home and that a significant association existed between occupant-reported visible mold and tested airborne mold. Findings highlight the need for clearer standards of acceptable CFU/m^3 limits for mold genera that are applicable to homes. In the absence of such guidelines, problems associated with indoor mold will continue to impact the health of residents, despite growing evidence of the adverse effects from mold exposure.**

Introduction

Housing, as a neglected site for public health action, has been identified in a number of publications (Andriessen, Brunekreef, & Roemer, 1998; Bonnefoy et al., 2004; Bornehag et al., 2004; Breysse et al., 2004; Dunn, 2002; Haverinen-Shaughnessy et al., 2006; Spengler et al., 2004). Housing, however, encompasses many factors, including biological (mold, cockroaches, dust mites, etc.), chemical (tobacco smoke, paints, etc.), and structural (water moisture, heat ventilation, air conditioning, etc.), making the quantitative evaluation of the impact of these factors on health difficult. The relationship between housing and respiratory health remains unclear (Bonnefoy et al., 2004). A large body of literature, however, points to an association between damp or moldy indoor environments and respiratory problems (e.g., Curtis, Lieberman, Stark, Rea, & Vetter, 2004; Douwes & Pearce, 2003; Gunnbjörnsdottir et al., 2003; Meklin et al., 2002; National Institute for Occupational Safety and Health [NIOSH], 2003; Pekkanen et al., 2007; Rosenbaum et al., 2010; Tischer, Chen, & Heinrich, 2011.) In 2004, the Institute of Medicine (IOM) conducted a comprehensive review of the scientific literature to examine the "dampness" factor as a precursor to mold and as a suspected contributor to respiratory health problems. The study's committee of experts confirmed that "sufficient evidence" exists to conclude that mold and damp conditions are associated with asthma symptoms in sensitized persons (Institute of Medicine [IOM], 2004). This committee of experts suggests, however, that more research is required to establish the absence/presence of a causal relationship between mold spores and an occupant's health. This point is also made by Burr and co-authors (2007) who note that it is not clear whether associations between respiratory symptoms and indoor mold are causal. Although the results of their study were not entirely conclusive, the authors report that removal of mold in the houses under investigation improved the occupants' symptoms of asthma and rhinitis.

Results presented in this article are consistent with those of Antova and co-authors (2008), that indoor mold exposure is associated with the adverse respiratory health of children. Nevertheless, the question of whether mold causes asthma or simply exacerbates asthma or other allergy symptoms is the subject of considerable debate. Although it is unclear whether indoor dampness causes or only aggravates preexisting respiratory conditions, such as asthma, an extensive European Community Respiratory Health Survey (ECRHS) involving 38 study centers found not only a significant asso-

TABLE 1

Response Rates for Parts 1 and 2: Initial Contact Survey by Group

Part	Condition	No Asthma # (%)	Asthma[a] # (%)	Total # (%)
1	No/few colds	1956 (57)	171 (5)	2127 (62)
	Persistent colds[b]	841 (25)	456 (13)	1297 (38)
	Total	2797 (82)	627 (18)	3424 (100)
2	No/few colds	201 (28)	72 (10)	273 (38)
	Persistent colds	225 (31)	217 (30)	442 (62)
	Total	426 (60)	289 (40)	715 (100)

[a]Asthma: having received a formal diagnosis of asthma from a physician or had at least one asthma attack, gone one or more times to hospital emergency due to asthma, been hospitalized at least once due to an asthma attack, or been prescribed steroids, over the last 12 months.

[b]Persistent colds/respiratory infections: having ≥4 respiratory infections/colds in the past year (more conservative than Williamson, Martin, McGill, Monie, & Fennery's [1997] definition of ≥3/year).

ciation between self-reported mold exposure and asthma symptoms in adults, but also a higher prevalence of asthma in centers with high self-reported mold exposures (Zock, Jarvis, Luczynska, Sunyer, & Burney, 2002).

Understanding how respiratory health risks are associated with housing is essential to designing effective strategies to improve children's quality of life.

Objectives

Our study was part of a larger project whose objectives were to (1) examine the relationship between housing and respiratory health/asthma among children in third and fourth grade in Winnipeg; (2) compare the presence of self-reported indoor mold and air sample results; (3) develop a housing database documenting information such as history of water damage in the child's home, evidence of structural duress, air leakage, type of mechanical system in the home, relative humidity, wall moisture content, mold count, and genus type based on two indoor air samples from the basement and child's bedroom; (4) examine the relationship between mold count and home building materials (e.g., concrete block, wooden frame, or gypsum board); (5) cross-link the newly created housing database with three Manitoba health databases, *Manitoba Physician Claim, Hospital Discharge Abstracts,* and *Prescription Record*, to examine links to children's respiratory health; and (6) design a Composite Healthy Housing Index to evaluate the risk of mold/moisture in the home and upper respiratory problems of its occupants.

The focus of this article is on objectives 1 and 2.

Methods

The human research investigation committee at the University of Manitoba (education/nursing research ethics board) reviewed and approved this research (ethics protocol no. E2005: 058).

Step 1

In September 2005, following permission from all six school-division chief superintendents in Winnipeg, an initial parent contact survey was distributed to the entire Winnipeg third- and fourth-grade school student population (13,729 children). The one-page survey was designed to obtain parental information on (a) their child's respiratory health, including incidents of respiratory infections/asthma over the past academic year (2004–2005) and visits to the doctor or hospital; (b) the child's home environment, including the age of home, presence of mold, presence of carpets, number of smokers in the home, presence of cats or dogs, and whether other relatives have asthma; and (c) number of school days missed in 2004–2005 by the child due to respiratory tract infections or asthma.

The survey response rate was 25% (3,424/13,729). The mean age of the students was eight years, five months (minimum: six years, six months; maximum: 10 years, four months; *SD*: 7.3 months). There were 1,714 (51%) males and 1,675 (49%) females (35 missing information); 1,777 (52%) were in grade 3 and 1,623 (48%) in grade 4 (24 missing information).

Step 2

Based on the returned parent surveys, children were categorized into four groups: (1) healthy (no asthma and few/no colds), (2) persistent colds only (no asthma and persistent colds), (3) asthma only (asthma and few/no colds), and (4) both asthma and persistent colds (see Table 1).

Based on a 25% response rate, it is conceivable that the survey results potentially may be biased with primarily parents of children with known or even suspected respiratory health conditions responding. Our actual results, however, indicated that 57% of all respondents reported no respiratory health problems. Further, the reported proportion of asthma cases, 5%, was much lower than the reported percentage of asthmatic children of similar age within the Canadian population of 9%.

Step 3

Of the 3,424 parents who responded, 2,064 (61%) agreed to participate in Part 2 of the research study. A stratified random sample of 1,100 participants gave permission to have their homes inspected. A total of 732 (66.5%) agreed to participate in Part 2 of the study. Of these, only 715 homes were completely inspected. For the remaining homes, the owners had moved before the inspection process was completed. The number of homes inspected is given in Table 1.

Based on the IOM (2004) study, and assuming a prevalence of mold and/or dampness of 25% in the homes, we would have an 80% power of detecting a relative risk of 1.51 for asthma exacerbation or upper respiratory illnesses if we had an $n = 207$ per group. If the prevalence was actually 15%, we would have the same power (80%) to detect a higher relative risk of 1.75 for asthma exacerbation or upper respiratory illnesses if $n = 202$ per group. We therefore set 210 as a target sample size for each group.

Step 4

Inspections were conducted by trained engineering graduate assistants under the supervision of two professional engineers (Polyzois and Wells, two of the authors of this paper). Each home was visited by a two-member team. The inspection process is detailed below.

Home Visit 1

First, air samples were collected in the child's bedroom (area 1) and in the basement (area 2) of each home using an air sampler device. A simultaneous control or outdoor sample was taken in each neighborhood. Sampling time for each location was set at four minutes, programmed into the air sampler's programmable control for consistency. The air samples were transferred within 48 hours to an accredited laboratory where they were incubated and mold colonies counted.

A report released by the National Institute for Occupational Safety and Health (NIOSH, 2003) describes the results from a health hazard evaluation of a government facility located in Somerset, Pennsylvania, in which the mean value of total indoor culturable airborne fungi was 123 CFU/m^3. Of the 62 participants in the NIOSH study, 15% reported asthma and 36% reported chest symptoms (wheezing or shortness of breath). Thus, for purposes of our study, a value of 100 CFU/m^3 was set as the minimum level of mold count for analysis. In addition to evaluating the volume of mold in each sample in CFU/m^3, the top three genus types of mold were identified if the total combined count was greater than 100 CFU/m^3. Air sampling was carried out in spring 2006 (April, May, and June) while building moisture content was anticipated to be higher due to condensation and before windows were routinely opened during the day. A total of 1,911 air samples were taken from 715 homes. Concurrently, a one-page housing survey was conducted where the home's history of water and moisture damage, history of home renovations, and reports of any visible mold were obtained from the participants. Measurements were also recorded of relative air humidity, temperature, and wall moisture content for each home.

Home Visit 2

In a subsequent home visit, an extensive eight-page engineering audit of each residence was conducted. The audit recorded the structural condition of the home (e.g., windows, walls, roof, basement), the type of mechanical system used in the home (e.g., furnace, air conditioning, humidifier), the absence/presence of effective groundwater management (e.g., sump-pit/weeping tile), and the presence of visible moisture damage, mold, and associated building envelope problems.

This article presents the results of the initial contact survey as well as of the biological air sampling conducted in the 715 residences.

TABLE **2**

Association of Selected Aspects of the Home Environment and Children's Persistent Colds or Asthma

Home Environment	Few or No Colds/No Asthma (%)	Persistent Colds Only (%)	Asthma Only (%)	Asthma and Persistent Colds (%)	χ^2 (*df*) *p*-Value
Mold in basement					29.11 (3) <.0001
Yes (n = 612)	47.4	29.9	5.9	16.8	
No (n = 2812)	59.3	23.4	4.8	12.5	
Mold in bathroom					35.44 (3) <.0001
Yes (n = 806)	48.3	30.1	6.6	15	
No (n = 2618)	59.9	22.8	4.5	12.8	
Mold in kitchen					33.62 (3) <.0001
Yes (n = 90)	30.0	47.8	4.4	17.8	
No (n = 3334)	57.9	23.9	5.0	13.2	
Asthmatic parents					181.28 (3) <.0001
Yes (n = 629)	38.2	26.1	8.4	27.3	
No (n = 2795)	61.4	24.2	4.2	10.2	
Asthmatic siblings					117.57 (3) <.0001
Yes (n = 539)	41.2	24.7	8.3	25.8	
No (n = 2885)	60.1	24.5	4.4	11.0	
Asthmatic relatives					155.37 (3) <.0001
Yes (n = 1368)	45.5	27.9	6.4	20.2	
No (n = 2056)	64.9	22.3	4.1	8.7	
Number of carpets					8.0 (3) .0460
≤3 (n = 1535)	56.0	23.6	5.6	14.8	
≥4 (n = 1868)	58.1	25.3	4.5	12.1	
Smokers living in the home					19.03 (3) .0003
Yes (n = 888)	50.9	27.8	5.6	15.7	
No (n = 2529)	59.3	23.4	4.8	12.5	
Rodents in home					13.34 (3) .0040
Yes (n = 259)	47.9	30.1	3.9	18.1	
No (n = 3165)	57.9	24.1	5.1	12.9	
Own home					13.31 (3) .004
Yes (n = 2824)	58.2	23.7	5.3	12.8	
No (n = 600)	52.2	28.5	3.7	15.7	

Results

Results are presented in the form of responses to four key questions.

Question #1: What Is the Relationship Between Selected Aspects of the Children's Home Environment and Their Respiratory Health?

Tests of independence (Pearson's Chi-squared test) for contingency tables were used to assess these relationships (Table 2). The data show that the child's respiratory

TABLE **3**

Independent Predictors of Childhood Persistent Colds, Asthma, and Asthma in Combination With Persistent Colds

Predictor	Persistent Colds Only *OR*[a] (95% *CI*[a])	Asthma Only *OR* (95% *CI*)	Asthma in Combination With Persistent Colds *OR* (95% *CI*)
Mold in basement	1.35 (1.09–1.68)[b]	1.26 (0.84–1.88)	1.39 (1.06–1.82)[b]
Mold in bathroom	1.33 (1.09–1.62)[b]	1.59 (1.11–2.27)[b]	1.19 (0.92–1.54)
Mold in kitchen	2.85 (1.70–4.77)[b]	1.09 (0.37–3.27)	1.79 (0.91–3.53)
Asthmatic parents	1.44 (1.15–1.81)[b]	2.37 (1.64–3.44)[b]	2.94 (2.29–3.77)[b]
Asthmatic siblings	1.15 (0.90–1.46)	1.93 (1.31–2.86)[b]	2.05 (1.58–2.67)[b]
Asthmatic relatives	1.59 (1.34–1.89)[b]	1.63 (1.17–2.27)[b]	2.29 (1.83–2.87)[b]
Smokers living in the home	1.33 (1.10–1.60)[b]	1.33 (0.94–1.89)	1.41 (1.11–1.79)[b]

[a]*OR* = odds ratio; *CI* = confidence interval.
[b]$p < .05$.

health was significantly associated with self-reported visible mold in the home. Generally, more healthy children (few or no colds/no asthma) lived in homes where mold was not reported. In addition, significant associations were found between the respiratory health of child occupants and carpeting in the home, smokers living in the home, the presence of rodents in the home, and home rental versus ownership. Genetic associations (parents, siblings, or other relatives with asthma) and the children's respiratory heath were also noted. No statistically significant associations were found between respiratory health and the age of the home, or number of years living in the home, or whether cats or dogs lived in the home.

A step-wise multinomial logistic regression was subsequently run to determine independent predictors of persistent colds only, asthma only, and asthma and persistent colds. The healthy group, defined as those children with few or no colds/no asthma, was taken as the reference group. Wald-type Chi-squared statistics were used to assess the statistical significance of the independent variables. Only significant independent variables were retained in the model. Table 3 summarizes the estimated odds ratios (*OR*) and 95% confidence intervals (95% *CI*) from this analysis. For each aspect of the child's home environment, the *OR* compares the odds of a child having a respiratory health condition (persistent colds only, asthma only, or asthma and persistent colds versus few or no colds/no asthma) in an exposed group (e.g., mold present in the basement) to the odds of a child having the same respiratory health condition in a group that is not exposed to mold.

The following is a list of the key findings from this analysis.

Persistent Colds Only

The odds of having persistent colds were higher in children with reported mold in their home compared to those with no mold reported (*OR*s ranged from 1.33 to 2.85).

Children with asthmatic parents or other asthmatic relatives had higher odds of having persistent colds (*OR*: 1.44 and *OR*: 1.59, respectively) than children with relatives without asthma.

Children with smokers living in the home were more likely to have persistent colds (*OR*: 1.33) than those without.

Asthma Only

Children with asthmatic parents, asthmatic relatives, or asthmatic siblings were more likely to have asthma. The odds ratios ranged from 1.63 to 2.37.

Some evidence existed to suggest that children with reported mold in the bathroom were more likely to have asthma than those with no reported mold (*OR*: 1.59).

Asthma and Persistent Colds

Children with reported mold in their basement were more likely to have persistent colds in combination with asthma (*OR*: 1.39).

Children with asthmatic parents, siblings, or other relatives had more than double the odds of having asthma and persistent colds. In this case, *OR*s ranged from 2.05 to 2.94.

Children with smokers living in the home were more likely to have persistent colds in combination with asthma (*OR*: 1.41).

Question #2: What Are the Most Common Types of Airborne Mold Found in Winnipeg Homes?

A high number of children's bedrooms (63.6%) and basements (65.1%) in Winnipeg homes had total airborne mold levels (all species across all months) of at least 100 CFU/m^3.

When airborne mold test results were analyzed for April alone, the most common test month in our study, similar patterns were observed: 52.4% to 53.7% of homes had airborne mold levels (all species) of at least 100 CFU/m^3.

For all homes with mold counts ≥100 CFU/m^3 (all species combined), the genus type for the top three molds was identified and measured separately. *Cladosporium* was the most common mold found in Winnipeg homes (98.2% of children's bedrooms; 97.8% of basements), followed by *Alternaria* (82.4% of children's bedrooms; 77.0% of basements) and *Penicillium* (35.4% of children's bedrooms; 48.8% of basements). These levels were much higher than those reported elsewhere. Gent and co-authors (2012) reported that in the 1,233 homes they tested, *Cladosporium* was found in 65% of the homes, *Alternaria* in 33% of the homes, and *Penicillium* in 33% of the homes. The level of *Penicillium* (150 CFU/m^3 at the 90th percentile) reported by Gent and co-authors (2012) is much higher than the level recorded in our study.

Given the prevalence of *Cladosporium* in children's bedrooms and basements, the number of homes with minimum counts of *Cladosporium* levels was also examined. The great majority of homes (70.7% of children's bedrooms and 64.1% of basements) had *Cladosporium* levels ≥100 CFU/m^3; 13.9% of children's bedrooms and 19.2% of basements had *Cladosporium* levels ≥400 CFU/m^3.

Question #3: What Is the Relationship Between Self-Reported Visible Mold in the Home and the Presence of Airborne Mold (Measured in CFU/m^3)?

Using tests of independence (Pearson's Chi-squared test) for contingency tables, a statistically significant association was found for the month of April between occupant-reported visible mold in the house and airborne mold (all species combined) ≥100/m^3, ≥200/m^3, and ≥400/m^3 in the children's bedrooms (Table 4).

A statistically significant association was found between self-reported visible mold and tested airborne mold in the basement for mold levels ≥100/m^3 and ≥200/m^3 for all testing months combined. For April, this association also held for mold levels ≥300 CFU/m^3 (Table 4). These results suggest that the presence of self-reported mold was confirmed by the air sample CFU counts for the months of April for both the children's bedroom and basements.

TABLE **4**

Self-Reported Indoor Mold (Yes/No) by Total Airborne Mold in CFU/m^3

Location	Period (Presence/Absence)	Air Sample Results in CFU/m^3			
		≥100 # (%)	≥200 # (%)	≥300 # (%)	≥400 # (%)
Children's bedroom	All months combined				
	Yes (*n* = 347)	231 (66.6)	153 (44.2)	100 (28.8)	73 (21.0)
	No (*n* = 368)	224 (60.8)	145 (39.4)	88 (23.9)	62 (16.9)
	For April only				
	Yes (*n* = 143)	85 (59.4)[a]	46 (32.2)[a]	16 (11.2)	10 (7.0)[a]
	No (*n* = 145)	66 (45.5)[a]	27 (18.6)[a]	9 (6.2)	1 (0.7)[a]
Basement	All months combined				
	Yes (*n* = 331)	228 (68.9)[a]	157 (47.4)[a]	103 (31.1)	76 (23.0)
	No (*n* = 356)	219 (61.5)[a]	139 (39.0)[a]	99 (27.8)	84 (23.6)
	For April only				
	Yes (*n* = 139)	85 (61.2)[a]	46 (33.1)[a]	28 (20.1)[a]	18 (12.9)
	No (*n* = 142)	66 (46.5)[a]	29 (20.4)[a]	15 (10.6)[a]	9 (6.3)

[a] $p < .05$.

Question #4: What Is the Relationship Between Tested *Cladosporium* in the Home (Based on CFU/m^3 Counts) and Persistent Colds and/or Asthma Among Child Occupants?

A Kruskal-Wallace non-parametric test of the distribution of *Cladosporium* spores by area of the home (children's bedroom or basement) was carried out (see Table 5). Analyses of the data show a significant association between *Cladosporium* levels from air samples taken in April and children's asthma in combination with persistent colds. For example, median mold counts found in the bedrooms of children who have asthma in combination with persistent colds was significantly higher, 125 CFU/m^3, in comparison with: mold counts of 97 CFU/m^3 in the bedrooms of children with asthma only, mold counts of 91 CFU/m^3 in the bedrooms of children with persistent colds only, and mold counts of 97 CFU/m^3 in the bedrooms of healthy children.

Two housing conditions produced statistically significant associations with respect to *Cladosporium* levels in the children's bedrooms: the condition of the roof waterproofing system and the age of windows. More homes had roofs in good/excellent condition with *Cladosporium* levels equal to or greater than 200 CFU/m^3 than homes with roofs in poor/fair condition. Also, more homes had windows 10 years old or less with *Cladosporium* levels equal to or greater than 200 CFU/m^3 than homes with windows older than 10 years old.

These results, although initially counterintuitive, can be explained through an examination of the air tightness of the building envelope. In our study, we found that houses with newer windows produced a higher relative humidity compared to houses with older windows. While no statistically significant relationship existed between the condition of the roof and relative humidity, a statistically significant association existed between the condition of the exterior walls and relative humidity. Children's bedrooms in homes with exterior walls rated as good/excellent had almost 4% higher relative humidity than bedrooms in homes whose exterior walls rated as poor/fair. The effect of air tightness on the respiratory health of children has been the subject of investigation by a number of researchers (Choi et al., 2014; Hahm et al., 2014; Mavrogianni et al., 2013).

Discussion

Several studies have linked *Cladosporium* to an increased risk of allergic reactions (Garrett, Rayment, Hooper, Abramson, & Hooper, 1998; Huang & Kimbrough, 1997; Jovanovic et al., 2004; Li & Hsu, 1997). Our study showed that the median *Cladosporium* level during the month of April ranged from 91 to 125 CFU/m^3 in the children's bedrooms and from 75 to 131 CFU/m^3 in the basement of the homes. Our results showed a significant association between *Cladosporium* levels taken in April and reported asthma in combination with persistent colds. The difference between the results from our study and that reported by other researchers (e.g., Gent et al., 2002) is that the association between mold and respiratory health held at *Cladosporium* levels lower than those reported in the literature and even lower than those defined as "acceptable" by various organizations (Schleibinger & Young, 2007).

In our study, of those homes where the total mold count was ≥100 CFU/m^3, 35.4% of children's bedrooms and 48.8% of basements were found to have *Penicillium* among the top three genus types of mold. We did not, however, find any statistically significant association between *Penicillium* and respiratory health. Nevertheless, a direct link between *Penicillium* and respiratory health has been documented in relevant lit-

TABLE 5

Median *Cladosporium* levels (CFU/m^3) by Area in the Home (Child's Bedroom or Basement) by Respiratory Condition of Child, April Only

Median *Cladosporium* Levels (in CFU/m^3) by Area in the Home	Respiratory Condition of Child				
	Few or No Colds/ No Asthma	Persistent Colds Only	Asthma Only	Asthma and Persistent Colds	χ^2 (*df*) *p*-Value
Bedroom					9.82 (3) .020
Median mold counts (25th percentile, 75th percentile)	97 (63, 125)	91 (59, 137)	97 (44, 190)	125 (91, 181)	
Basement					9.65 (3) .022
Median mold counts (25th percentile, 75th percentile)	88 (63, 119)	75 (44, 125)	112 (69, 197)	131 (66, 187)	

erature (Bundy et al., 2009; Gent et al., 2012; Rosenbaum et al., 2010) with any detectable levels (>0 CFU/m^3) of *Penicillium* being significantly associated with respiratory effects among sensitized individuals.

Conclusion

In our study, we examined the relationship between the respiratory health/asthma among children in third and fourth grade in Winnipeg and the presence of self-reported indoor mold. We also compared self-reported mold to mold counts obtained through air sampling. Statistical analyses of the 3,424 survey results revealed that children with reported mold in their home were more likely to have persistent colds; asthmatic versus nonasthmatic children living in homes with visible mold also tended to be more prone to persistent colds; children with asthmatic parents or siblings were more likely to have asthma. Additionally, *Cladosporium* levels obtained through air sampling were associated with higher levels of asthma in combination with colds among children. Housing audits conducted on 715 homes revealed that more homes had *Cladosporium* levels ≥200 CFU/m^3 if the windows were less than 10 years old or the roof was in good/excellent condition. Relative humidity in the children's bedrooms was higher if the windows were less than 10 years old or if the condition of the exterior walls was rated as good/excellent. These results highlight the importance of proper ventilation in homes as a way of reducing the relative humidity in the homes and improving the indoor air quality, particularly during the winter months.

Limitations

The data obtained in our study represent a snapshot in time. Data logging of the environmental conditions in the home, where multiple measurements are taken over time, can lead to a better understanding of these associations.

Due to financial constraints, mold genus type was only identified if the total mold count was over 100 CFU/m^3. Genus type identification of all samples may have provided opportunities to examine additional associations between other types of mold, such as *Alternaria* or *Penecillium,* and respiratory health.

While most air sampling was carried out in April, a number of homes were sampled in May and June when the external influence of mold contamination increases with warmer temperatures.

It may also be perceived that for a return rate of 25% in our survey, the results are potentially biased in favor of those parents with known or even suspected respiratory health conditions in their children. Results indicated, however, that 57% of the respondents had no reported respiratory health problems. Further, the reported proportion of asthma cases, 5%, was much lower than the reported percentage of asthmatic children of similar age within the larger Canadian population of 9%.

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Did You Know?

The NEHA 2016 AEC and HUD Healthy Homes Conference celebrates accomplishments at its awards ceremony; submit a colleague at www.neha.org/about-neha/awards.

GUEST COMMENTARY

NEHA/UL Sabbatical Exchange Program Report: To Glove or Not to Glove?

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Introduction

Both the U.S. and the UK have seen decreases in the number of lab-confirmed foodborne illness outbreaks since the 1990s (Foodborne Diseases Active Surveillance Network, 2012; Health Protection Agency, 2012). This is especially impressive considering the fact that the surveillance and reporting of foodborne illnesses has improved since then with electronic surveillance systems like FoodNet in the U.S. and Electronic Foodborne and Non-foodborne Gastrointestinal Outbreak Surveillance System (eFOSS) in the UK. Despite some differences, the U.S. and the UK have a very similar approach to retail food safety in order to protect the public from foodborne illness. This is reflected in their food safety regulations: the U.S. Food and Drug Administration (FDA) *Food Code* and the UK Food Standards Agency (FSA) Code of Practice. These standards change with advancements in science and technology as well as changes in society such as the recent increased focus on nutrition and food allergies. Despite some of our differences, a universal consensus exists that hand washing is the most important practice to prevent the spread of foodborne illnesses. So, during my sabbatical to the UK, I sought to compare and contrast how each country regulates and enforces hand hygiene and glove use.

Hands of food workers are easily contaminated with bacteria and viruses that can then be spread through direct contact with food consumed by the general public. But is hand washing enough to prevent contamination of food and beverages by food service workers? The U.S. promotes wearing gloves as a barrier between potentially contaminated hands of food service workers and ready-to-eat foods. The UK, however, has a different point of view. FSA and the Chartered Institute of Environmental Health (CIEH) discourage glove use as they may become a source of contamination through improper use. Through review of previous studies on this matter and the opportunity to visit the UK to observe their inspection process, I hoped to come to a consensus on which method is more effective. At the very least I wanted to understand the implementation of this concept in the UK. Perhaps both countries have something to learn from each other. Are clean hands and properly used gloves achievable goals, or might clean bare hands be better than potentially dirty gloves?

In the U.S., glove use with ready-to-eat food is an integral component of preventing contamination of food because gloves create a barrier between contaminated hands and food to be consumed. Additionally, regulators are trained to enforce the FDA *Food Code*, which reads as follows (Food and Drug Administration, 2013):

> "3-301.11 Preventing Contamination from Hands.
> (A) FOOD EMPLOYEES shall wash their hands as specified under § 2-301.12.
> (B) Except when washing fruits and vegetables as specified under § 3-302.15 or as specified in (D) and (E) of this section, FOOD EMPLOYEES may not contact exposed, READY-TO-EAT FOOD with their bare hands and shall use suitable UTENSILS such as deli tissue, spatulas, tongs, single-use gloves, or dispensing EQUIPMENT.
> (C) FOOD EMPLOYEES shall minimize bare hand and arm contact with exposed FOOD that is not in a READY-TO-EAT form."

This section of the FDA *Food Code* was added in response to outbreaks of foodborne illness caused by food that had been contaminated with pathogens transmitted by food workers (Guzewich & Ross, 1999) and is based on studies showing that gloves function as an effective means of preventing the spread of illness via ready-to-eat food. While the authors noted the issues that can lead to contamination of gloves (material, permeability, duration of wearing, and hand washing prior to donning), they also noted that proper hand washing and glove use provides more protection than either method alone (Paulson, 1997).

FSA also promotes limiting bare hand contact with ready-to-eat foods, but warns business about the risks associated with improper glove use. The European Union Regulation 852/2004 on the hygiene of foodstuffs, Annex II, Chapter VIII, states, "Every person working in a food handling area shall maintain a high degree of personal cleanliness and shall wear suitable, clean, and where appropriate, protective clothing." This is very general, but the Safer Food Better Business plans created by FSA, which establishments are required to have and use, states in its hand washing portion:

> "Think twice! If you use disposable gloves in your business, they should never be used as an alternative to effective hand washing. When using disposable gloves, make sure you:

- Wash your hands thoroughly before putting them on and after taking them off.
- Always change them regularly, especially when handling raw and ready-to-eat food.
- Throw them away after use or if damaged.

Hygienic hand rubs and gels can be useful when used as an additional precaution, but should **never** be used as a replacement for effective hand washing."

Thus, FSA emphasizes that glove failure may lead to contamination of food. A single glove hole can release tens of thousands of bacteria from the moist environment inside the glove (Guzewich & Ross, 1999). Considering the fact that the infective dose of some of the most infectious foodborne illnesses is very small (FDA, 2012), this is a major factor to consider. When hands are not washed properly before gloves are worn, bacteria multiply inside the glove, especially when they are not changed frequently (Fendler, Dolan, & Williams, 1998). Because proper hand washing and glove use require a great deal of time, training, education, availability of resources, and active managerial control, many professionals feel that the process required for gloves to act as an effective barrier to prevent contamination of food from hands is not achievable (Green, 2012).

A literature review in 1998 by Fendler and co-authors concluded that a lack of scientific evidence existed to support the use of gloves as a means to prevent contamination of food with pathogens. The authors stated that gloves may provide a false sense of security and encouraged more studies to be done in a food handing setting. Studies that have been done in a food handling setting, however, have shown the use of gloves to be counterproductive (Green, Selman, & Radke, 2006; Lynch, Phillips, Elledge, Hanumanthaiah, & Boatright, 2005). When food workers are stressed for time and not properly educated on proper glove use and hand washing, the barrier that gloves are supposed to provide can be compromised (Green & Selman, 2005).

Sabbatical

In 2014 I was awarded the NEHA/UL Sabbatical Exchange Award, which allowed me to travel to the UK to investigate and study this question. My goals for this study were as follows: to compare and contrast how the U.S. and the UK regulate and enforce hand hygiene and glove use; to understand how the UK's ideas about glove use are reflected in their inspection and enforcement strategies; to learn more about the logistics of their inspections process; to learn the opinion of industry in the UK on glove use; and to understand more about the environmental health profession in the UK and their required training.

I was in the UK for three weeks from August 30 to September 23, 2014, during which time I visited the following locations listed by category to speak with professionals and my counterparts:

Industry
- Benugo
- McDonald's training headquarters
- Aramark

Regulatory Authorities
- CIEH (and the Academic Conference)
- FSA

Local Jurisdictions
- Tower Hamlets in London
- Islington in London
- Port Authority in London
- Pendle (England)
- Bury (England)
- Cardiff (Wales)

Universities
- Middlesex University
- Leeds Metropolitan University
- Liverpool John Moores University

Environmental health professionals (EHPs) are trained very differently in the UK. They attend a university accredited by CIEH where they will obtain an undergraduate environmental health degree in three years. The program is currently tailored towards training EHPs for local government work by incorporating enforcement of Code of Practice and other environmental health regulations (Chartered Institute of Environmental Health, 2013). Additionally, EHPs are required to complete a portfolio about a work experience that they would typically get from a work placement at a local jurisdiction as an intern. These placements are difficult to find, however, with jobs being lost due to local budget cuts. I attended an education conference with representatives from accredited universities and CIEH where much discussion occurred about moving from a vocational program geared towards local government employment towards a more academic program focused on public health, which is generally what we have in the U.S. I was able to offer my insight coming from a background in biology and moving into a career in environmental health.

On a broader food safety scope, I was able to get a clearer picture of how food regulations are written and implemented from my visit with FSA and local jurisdictions. All the countries in the European Union have their own set of food safety regulations based on the very general European Union Regulation. In the UK, the FSA created their Code of Practice, which is more prescriptive. These are the regulations that are enforced throughout the UK. Additionally, each jurisdiction has its own procedures and policies for enforcement and inspections. This can lead to some variation between jurisdictions in their enforcement and inspection procedures. That is why the FSA provides standardized documents and reference guides to help ensure that regulations are enforced similarly across the country. This is important because violations to the Code of Practice are a criminal offense in the UK.

Local jurisdictions are typically located in a city hall or other government building and are often housed with or near Health and Safety (similar to the Occupational Safety and Health Administration or local building code in the U.S.) since their duties are related. Local jurisdictions also inspect manufacturers as part of their retail food safety program, unlike the U.S., where manufacturers are often inspected at the state or federal level. Many local borough directors expressed that budget constraints are very challenging and have led to a decrease in staff, as many in the U.S. have experienced. They are still feeling much of the pressure of having to do more with less in addition to complying with the business-friendly government initiative to cut red tape for businesses. Food establishments are not licensed in the UK. Rather, they are required to register about a month after opening, at which point an inspection would be conducted. All of the EHPs I talked to were intrigued by the plan review and permitting process required in the U.S. as a way of alleviating issues related to the structure and facility layout. Many local boroughs have had to decrease inspection frequency while trying to focus their efforts on the establishments that need the most help coming into or staying in compliance. This is partly achieved through the newly implemented Food Hygiene Rating (FHR) scheme.

Annex 5 of the Code of Practice details the FHR system and how it should be implemented. During an inspection, the establishment receives a rating of 0–5 (0 being the worst, 5 being the best). This score incorporates the level of (current) compliance with food hygiene and safety procedures, the level of (current) compliance with structural requirements, and confidence in management/control procedures. Standardized scoring rubrics also help the EHP to determine a risk assessment for the establishment with ratings A–C (A being low risk and C being high risk). This risk assessment takes into account risk, compliance, and confidence in management, and will determine the inspection frequency for the establishment. An establishment with a high score and low risk rating may only be inspected every 18 months. The FHR is meant to act as in incentive for establishments to be in compliance. These ratings are not yet required to be posted in every jurisdiction, however, as the program is slowly being phased in. Cardiff was the only jurisdiction I visited that requires them to be posted, and they reported positive results. In addition to the FHR system, Cardiff is also piloting a training program for establishments that perform poorly. It focuses on employee health and hand hygiene, and their hope is to share it nationally if it proves effective.

Establishments are also required to have a hazard analysis and critical control point (HACCP)–based plan, which includes hand hygiene. This can be prepared by the establishment/company, or the FSA has prepared a resource for establishments called Safer Food Better Business (Food Standards Agency, n.d.). It is a generic HACCP plan that can be filled in with all of an establishment's specific information and procedures. It still requires them to have their own individualized plan, but it guides them through the process and provides reference materials that are more visual and picture based for those who do not speak English. In addition to an HACCP plan, establishments are also required to have employees who are trained in food safety. CIEH offers training in four different levels commensurate with the tasks of the worker, the most basic one focusing on hand hygiene and employee health. In order to get a high FHR, all of these things must be in place in addition to general cleanliness, structural maintenance, and confidence in management. In theory, an establishment with an FHR of 5 and risk assessment rating of A would need less frequent inspections since they are controlling food safety without intervention from an EHP.

HACCP plans, different levels of training for food workers, risk assessment to determine inspection frequency, and FHRs all play a role in the enforcement of hand washing and glove use. Hand washing is promoted in the Safer Food Better Business plans, in CIEH training, and in resources provided by FSA including picture-based posters and videos in various languages. Glove use, however, is not encouraged. In fact, many resources warn against their use, but provide guides on how to use them properly. When I asked why they were using disposable gloves, some of the food service workers reported that customers want to see the food handlers wearing gloves. The same is true in the U.S., but many of the major food service companies in the UK do not require glove use with ready-to-eat foods. During my visit to the McDonald's training headquarters in London, I learned that they do not require glove or utensil use for ready-to-eat foods for immediate service, but do require them for ready-to-eat foods that have a shelf life and for raw meats. The theory behind this is that items with a longer shelf life have more opportunity for bacterial growth, and are prepared ahead of time so less time pressure exists that can lead to glove misuse. I also spoke with representatives from CIEH and Aramark, who planned and executed the food service for the London Olympics. They did not want disposable gloves to be used at this event because they had concerns about glove misuse due to their cost and a lack of knowledge about how to use them properly. They also felt that it discouraged frequent hand washing, and that gloves may transfer more bacteria than regularly washed hands if used incorrectly.

Conclusion

Should the U.S. reconsider the promotion of gloves for ready-to-eat food? It may not be advisable to ignore the studies showing that a combination of properly washed hands and properly used gloves is better than either method alone. But is that an achievable goal? It might be more effective for some establishments to focus on just hand washing considering the fact that some studies show that food workers often misuse gloves. The UK certainly has a functional food safety program without restricting bare hand contact with ready-to-eat foods, but it is not directly comparable with the program in the U.S. Further studies should be done on bacteria transfer on gloved vs. bare hands in a real-world industry setting. Adenosine triphosphate test technology can be used for such studies to measure growth of microorganisms. We need to know more about glove use in well- and poor-performing establishments, and consider other factors that affect proper glove use such as active managerial control and support or interventions from regulators. Glove use does not only affect food establishments. These types of studies would also be applicable to medical settings where a closer look at glove misuse may be needed.

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DIRECT FROM AEHAP

Collaborating to Solve Complex Environmental Health Issues in Our Communities

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University of Illinois at Springfield

Editor's Note: **In an effort to promote the growth of the environmental health profession and the academic programs that fuel that growth, NEHA has teamed up with the Association of Environmental Health Academic Programs (AEHAP) to publish two columns a year in the *Journal*. AEHAP's mission is to support environmental health education to ensure the optimal health of people and the environment. The organization works hand in hand with the National Environmental Health Science and Protection Accreditation Council (EHAC) to accredit, market, and promote EHAC-accredited environmental health degree programs. AEHAP focuses on increasing the environmental health workforce, supporting students and graduates of EHAC-accredited degree programs, increasing diversity in environmental health degree programs, and educating the next generation.**

This column will provide AEHAP with the opportunity to share current trends within undergraduate and graduate environmental health programs, as well as their efforts to further the environmental health field and available resources and information. Furthermore, professors from different EHAC-accredited degree programs will share with the *Journal's* readership the successes of their programs and the work being done within academia to foster the growth of future environmental health leaders.

Kristin Osiecki is an assistant professor of public health (environmental health) at the University of Illinois at Springfield. Her research examines cumulative impact models to investigate the spatial relationship between environmental burden, disadvantage, and negative health outcomes in urban areas including Houston and Chicago.

The future of the environmental health profession from an academic perspective involves embracing interdisciplinary and collaborative approaches to solve environmental health issues in our communities. We know that environmental conditions play an important role in generating and perpetuating health disparities that influence the health and well-being of a community (Lee, 2002; Sexton, 2006; Yem & Syme, 1999). And to better understand these conditions, the use of ecological models in environmental and health disparities research allows us to investigate the linkages and relationships among multiple environmental, social, and behavioral factors (Gebbie, Rosenstock, & Hernandez, 2003). In recent years, the development of environmental cumulative risk assessment models incorporate a variety of indicators including social determinants, health disparities, and environmental stressors to study the multitude of factors contributing to negative health outcomes (Linder & Sexton, 2008). The examination of these models will require environmental health professionals to work with disciplines within public health such as health policy, epidemiology, and bioinformatics while reaching out to experts in social and behavioral sciences, engineering, and medicine, to name a few.

Interdisciplinary teams provide the depth of knowledge to look comprehensively at communities, especially at-risk communities, to understand the mechanisms, interactions, and mediating factors contributing to negative health outcomes. For example, a current research project in Houston, Texas, the Houston Aerosol Characterization and Health Experiment, is studying the impact of air pollution on negative health outcomes in Houston neighborhoods (Kinder Institute for Urban Research, n.d.). A research team that includes experts in sociology, environmental engineering, environmental health, and bioinformatics from University of Houston, University of Texas Health, and Rice University are investigating levels of particulate matter in relation to various health outcomes such as asthma, respiratory disease, and heart attacks. Current maps show concentrations levels of particulate matter, socioeconomic and demographic indicators, and health outcomes to identify at-risk neighborhoods with the long-term goal of developing health initiatives (Kinder Institute for Urban Research, n.d.).

In addition to interdisciplinary research, academia, government, and community organizations are working together to engage citizens in community-based collaborative research to identify environmental health problems and proposing workable solutions. The Protocol for Assessing Community Excellence in Environmental Health (PACE-EH), developed by the National Association of County and City Health Officials (NACCHO), is a community-based environmental health assessment that encourages communities to prioritize and address local environmental health issues (NACCHO, 2015). A comprehensive toolbox provides resources for public health professionals to work with a variety of stakeholders that is being successfully implemented for the first time in California by the South Gate Community Environmental Health Assessment Team in South Gate, California. A diverse 20-member committee prioritizes neighborhood environmental health concerns to create an action plan to implement changes in their community (City of South Gate California, 2015).

Furthermore, the U.S. Environmental Protection Agency (U.S. EPA) is developing a wide variety of interactive web-based environmental justice tools to inform individuals and communities about possible environmental concerns. For example, Community-Focused Exposure and Risk Screening Tool (C-FERST) is a pilot project that examines cumulative risk with integrated mapping techniques for community assessment and decision making (Zartarian et al., 2011). In Tacoma, Washington, the Tacoma-Pierce County Health Department and Evergreen State College are collaborating on a C-FERST evaluation to identify environmental stressors in relation to social determinants within the Tacoma area (Stewart, 2015).

A key component to successful interdisciplinary research and collaborations is environmental health academic programs providing an integrative and comprehensive curriculum to prepare environmental health professionals for ever-changing and increasingly complex problems affecting our communities. The environmental public health workforce will continue to face a myriad of issues such as food security, climate change, disaster preparedness, drinking water threats, and environmental hazards requiring specialized training as we continue to deal with these challenging public health concerns (Rosenstock et al., 2008). The National Environmental Health Science and Protection Accreditation Council (EHAC)–accredited graduate programs fulfill this demand by providing environmental health professionals the scientific and technical knowledge while obtaining valuable management and administrative skills to work in collaborative settings. The Association of Environmental Health Academic Programs (AEHAP) plays an essential role in supporting EHAC-accredited graduate programs and addressing the severe shortage of national environmental health professionals. In addition to increasing awareness of education programs, AEHAP provides students with numerous resources from internship opportunities to exploring career options. We work together to ensure that students have the tools to succeed as environmental health professionals in government, academia, and the private sector.

Population health assimilates both environmental and health disparities taking into consideration social determinants that include health care, the social environment, built environment, and physical environment. Environmental health professionals offer expertise on environmental health exposures and risks that can sometimes be difficult to integrate into the ecological models. More importantly, they can contribute the technical knowledge and offer guidance to help communities navigate through the complexity of environmental health issues.

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DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES BRANCH


Martin Kalis

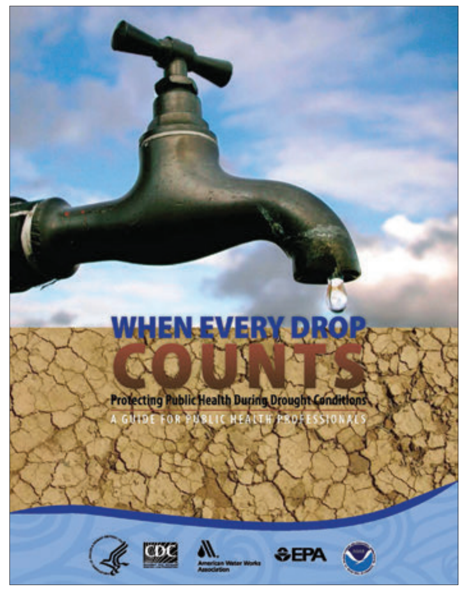

Elaine Curtiss, MEd

CDC's Drought Guidance: Your Public Health Resource for Understanding and Preparing for Drought in Your Community

Editor's Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In these columns, EHSB and guest authors share insights and information about environmental health programs, trends, issues, and resources. The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

Martin Kalis works at EHSB on emergency preparedness and environmental health issues. Elaine Curtiss works on EHSB's communications team.



Are drought issues affecting your community, or could they affect your community in the future? CDC's drought guidance, *When Every Drop Counts,* can help you understand how drought may impact public health in your community and how to prepare for it.

Although many aspects and implications of drought have been well researched, the Centers for Disease Control and Prevention (CDC) recognize that there is much to be learned about drought as it affects the health of the U.S. public. To help public health professionals prepare for or respond to drought, CDC recognized the need for a comprehensive, public health–focused guidance document on drought.

As a first step toward developing the document, CDC's National Center for Environmental Health (NCEH) formed a working group of both internal and external subject-matter experts representing all levels of public health, environmental protection, and water-related sciences. This group determined the types of drought-related information to include in the drought guidance.

To consolidate existing information about the public health effects of drought and identify future research needs and next steps, CDC and its partners sponsored the "Public Health Effects of Drought" workshop in September 2008. This workshop hosted participants from

- federal, state, and local public health;
- environmental engineering and science;
- coastal ecology;
- regulatory engineering;
- water-related research;
- risk communication;
- water systems management; and
- emergency management.

Workshop participants identified and prioritized drought-related public health issues, identified research gaps and needs in the area of public health as it relates to drought, and developed recommendations to ensure that the nation's public health system is better prepared for drought. Participants also engaged in discussions and shared personal experiences with drought within their regions, including lessons learned, best practices, and challenges.

The publication resulting from these efforts, *When Every Drop Counts: Protecting Public Health During Drought Conditions—a Guide for Public Health Professionals*, reflects the experience and knowledge of the working group members, experts who attended the 2008 "Public Health Effects of Drought"

Response Activities for Early- and Late-Stage Drought Conditions

Response Activities for Early Stages of Drought	Response Activities for Late-Stage, Severe Drought Conditions
• Assessing internal capacity • Participating in a jurisdiction-wide hazard and vulnerability assessment • Conducting a public health vulnerability assessment • Identifying and coordinating with key partners and stakeholders • Communicating drought strategies and recommendations • Educating and training key partners • Developing mitigation strategies • Documenting and evaluating drought preparedness activities	• Evaluating drought-related public health impacts • Coordinating drought-response activities with key stakeholders and partners • Developing and communicating health-response objectives and action plans • Assigning and using resources to achieve objectives • Participating in incident management systems and structures • Addressing requests for information and assistance • Documenting and evaluating drought response activities

Drought-Related Public Health Effects

- Compromised quality and quantity of potable water
- Compromised food and nutrition
- Diminished living conditions pertaining to energy, air quality, sanitation, and hygiene
- Increased risk of water-related recreational injuries and illnesses
- Increased risk of mental and behavioral health issues such as depression, anxiety, and other conditions and disorders, especially among persons who rely on rainfall and water for their economic survival
- Increased risk to vulnerable populations such as persons suffering from various chronic health conditions and immune disorders
- Increased disease incidence for infectious, chronic, and vectorborne/zoonotic diseases

workshop, and the existing literature and data that have been collected on the impact of drought on health.

In addition to providing an overview of basic drought- and water-related information and principles (such as the definition of drought; U.S. drought and water-use trends; the relationship between drought and climate change; water distribution; water treatment and classification; and water-related policy), this document addresses numerous drought-related public health effects, which are organized into several broad categories within the document.

To assist public health professionals and others concerned with human health during drought conditions, this guidance document also contains information about drought preparation and response. To ensure usability, the document organizes these activities into two broad categories: those that should be conducted before and in the early stages of drought and those relevant to late-stage, severe drought conditions (see Sidebar 1).

This document also provides readers with tables and tools designed to provide further guidance on preparedness activities, such as examples of at-risk populations and the health implications relevant for specific groups (see Sidebar 2), potential partners in drought preparedness activities, and communication objectives and actions relevant to specific target audiences.

The document concludes with a discussion of much-needed drought-related research and initiatives. Identified by the experts participating in the "Public Health Effects of Drought" workshop, the extensive recommendations for future needs are organized into research-related endeavors and those pertaining to initiatives and resources. Also included in the document is a list of diverse drought-related resources likely to be helpful to those committed to protecting the health of the U.S. public.

When Every Drop Counts: Protecting Public Health During Drought Conditions—a Guide for Public Health Professionals is a collaborative effort by CDC, the American Water Works Association, the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and other stakeholder agencies and organizations. Public health officials, practitioners, and other stakeholders can use this guide first to understand and then to prepare for drought within their own communities.

For your free copy of *When Every Drop Counts*, go to www.cdc.gov/nceh/ehs/publications/drought.htm.

Corresponding Author: Martin Kalis, Public Health Advisor, NCEH/DEEHS, 4770 Buford Highway, Atlanta, GA 30341.
E-mail: Izk6@cdc.gov.

Did You Know?

The NEHA 2016 AEC and HUD Healthy Homes Conference is being held in San Antonio! The conference will take place at the San Antonio Marriott Rivercenter on June 13 –14, and for the final two days, June 15–16, it will be at the Hyatt Regency San Antonio. Visit www.neha.org/aec for all AEC-related information.

DIRECT FROM CDC ENVIRONMENTAL PUBLIC HEALTH TRACKING NETWORK

Veronica Burkel, MPH

Environmental Health Tracking Rides the Open Data Wave

Editor's Note: **As part of our continuing effort to highlight innovative approaches and tools to improve the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the Centers for Disease Control and Prevention's (CDC's) Environmental Public Health Tracking Network (Tracking Network). The Tracking Network is a system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources. The Tracking Network brings together data concerning health and environmental problems with the goal of providing information to help improve where we live, work, and play.**

Environmental causes of chronic diseases are hard to identify. Measuring amounts of hazardous substances in our environment in a standard way, tracing the spread of these over time and area, seeing how they show up in human tissues, and understanding how they may cause illness is critical. The Tracking Network is a tool that can help connect these efforts. Through these columns, readers will learn about the program and the resources, tools, and information available from CDC's Tracking Network.

The conclusions of this article are those of the author(s) and do not necessarily represent the views of CDC.

Veronica Burkel has been an ASPPH/CDC informatics fellow with the Environmental Health Tracking Branch since February 2015. Prior to joining Tracking, she was an information analyst for the Michigan PBB Registry at Emory University.

Raise your hand if you've ever used an online map. Raise your hand if you like your phone giving you directions in the car. Did you know that the Global Positioning System (GPS), developed by the U.S. Department of Defense, only became operational for public use in 1995 and had restricted precision even then (National Coordination Office, 2014)? The U.S. military piloted and used the satellite navigation system for decades prior. Only in 1983 did President Reagan require it be provided for civilian use and, in 2000, it became available with the same precision as used by the military (Sullivan, 2012). Since then, the innovations with GPS have been and will likely continue to be limitless. Just the other day, I went for a run and my phone tracked not only my route, but also my varying running speeds along the way. How cool is that?! What other systems, tools, and data can be made available as to produce such useful innovation? Luckily, more innovation and idea syntheses are on their way with the federal government's new demand for open data.

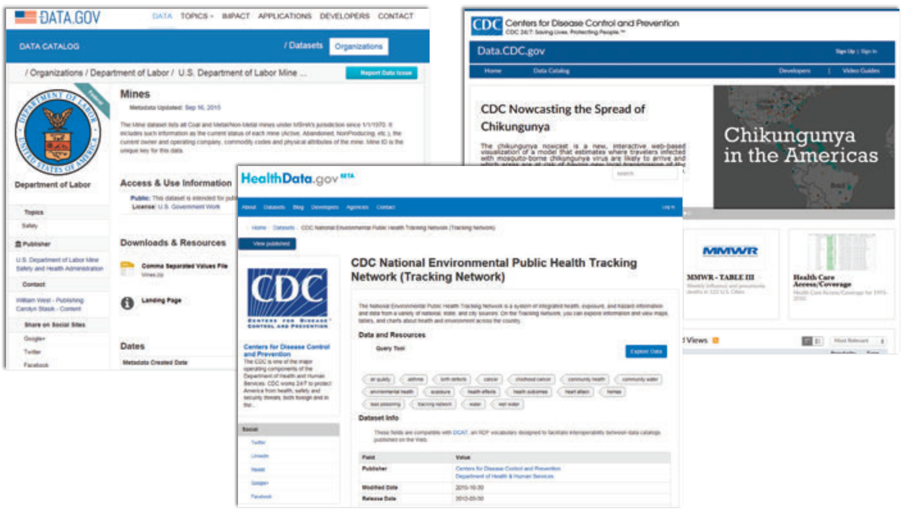
The executive order for open data was released in May 2013, 30 years after the request for public GPS. It's a federal government-wide order to make data easily available to the public in machine-readable formats. The purpose is to make appropriate data and information resources easy to find, access, and use. If history is a guide, the results of this mandate will promote entrepreneurship, innovation, and scientific discovery, which, besides creating jobs, will improve the lives of Americans in creative and unimaginable ways (Obama, 2013).

Before discussing the potential of open data, let's look at the language in the executive order. First, what is "appropriate" data? Appropriate data for public display include data that would not jeopardize individual privacy, confidentiality, or national security. Good examples include data for all planned snowmobile trails in North Dakota, or all coal mines in the U.S. since 1970. Another term to clarify is "machine readable." Do not mistake "machine readable" with "me reading on my computer"; machine readable means data are shared in a format with a standard computer language (e.g., CSV, XML, JSON files) read by a web browser, computer system, or computer program, not people-friendly formats like HTML, PDF, or DOC files.

The open data initiative is underway as I type. The federal government created data.gov, a Web site housing governmental data with standardized metadata fields (e.g., title, description, tags, last update, etc.) (Office of

FIGURE 1

Web Sites Created as Part of the Open Data Initiative



Left to right: data.gov, healthdata.gov, and data.cdc.gov.

Citizen Services and Innovative Technologies, n.d.). Data.gov includes data from the Department of Agriculture, Department of Transportation, U.S. Environmental Protection Agency, National Aeronautics and Space Administration, Small Business Administration, Department of Justice, and other Chief Financial Officers Act (CFO-Act) agencies. Health and Human Services, also a CFO-Act agency, established healthdata.gov, a site specific to health information and datasets generated by the U.S. government. Further down the chain is data.CDC.gov, a site to centralize data from the Centers for Disease Control and Prevention (CDC) that allows in-site visualizations and machine-readable downloads. All of these Web sites (Figure 1) increase the discoverability and accessibility of government data and information. Many programs at CDC are riding this open data wave. One such program is the National Environmental Public Health Tracking Program (Tracking Program).

The purpose of the Tracking Program is, as indicated in the Pew Environmental Health Commission report in 2000 (Environmental Health Tracking Project Team, 2000), to create a nationwide system to track environmentally related exposures and diseases such that the link between environment and health may be more readily monitored. The cornerstone of this program, the National Environmental Public Health Tracking Network (Tracking Network), is a multi-tiered, Web-based surveillance system. Tracking Network data include environmental exposures, hazards, and health effects data from national, state, and city sources. Tracking provides standardized data on content areas such as asthma, air quality, community water systems, heart disease, birth outcomes, climate change, lead poisoning, cancer, lifestyle risk factors, and more. Maintaining quality, standardized, understandable, up-to-date, and precise data is Tracking's priority. The intent is for others to use this network of information to identify trends, target interventions, and explore the links between environment and health status.

How does Tracking ride the open data wave? For starters, Tracking already exists as a store with shelves full of available data (National Center for Health Statistics, 2015). A visit to the Web site will reveal environmental and health data at your fingertips. Until now, Tracking has provided data in primarily people-friendly displays with cookie-cutter visualization tools across the data measures. You can look up data based on location; understand topic areas such as carbon monoxide poisoning or water quality; explore Tracking data in map, table, or chart views; and share your data results via Facebook, Twitter, or URL. Tracking data are machine readable, too. You can download a CSV (Microsoft Excel) file. And, touching on the Tracking Program's latest project, users can access the Tracking Application Program Interface (API).

An API is a tool for accessing data in machine-readable format. It provides machine-friendly data for a person to program a machine to read and create people-friendly data tools. The typical audience for an API is programmers, as they use APIs to build software applications more easily. The applications built directly request information, machine-to-machine, from an API's code-based library to create people-friendly tools. If you've seen a YouTube video embedded in a non-YouTube Web site, this is an example of API in action: the YouTube API that allows a video to be viewed and for that view to count towards Web site analytics is integrated into the host site's page. For the user, the experience is seamless, but in the background, the Web site is dynamically interacting with other machines and systems to deliver this functionality.

The Tracking API is simply a different interface for accessing Tracking data, especially for entrepreneurs, innovators, researchers, and others (Figure 2). In contrast to the Tracking Network's people-friendly maps, charts, and tables, the API provides results in coded, machine-friendly tables. Software that retrieves these tables can more efficiently create specialized visuals and results that the Web site does not currently provide. The Tracking Network's Web site serves as a vehicle for idea and hypothesis generation, offering data for your exploration. The power of Tracking is in its ability to handle large amounts of data across a broad range of health and environmental topics, and, as such, generates the one-size-fits-all results mentioned above. Embracing open data through the Tracking API empowers users to find new ways to display health and environmental data, to make it more discoverable, and, as is the mission of Tracking, to utilize the data to improve the health and knowledge of individuals and communities.

How will you use the Tracking API? Will you create a mobile app that cross-visualizes asthma hospitalizations with air quality? A program that models how many children in each county should be tested for blood lead, based on the age of housing, and compares it to the actual number of children tested?

Can you find a pattern in Tracking data that nobody has yet realized? The potential for innovation with open data, similar to that of GPS and its uses, is limitless. The impact this and other open data efforts will have on public health are unimaginable.

For more information on our API, please visit http://ephtracking.cdc.gov/apihelp.

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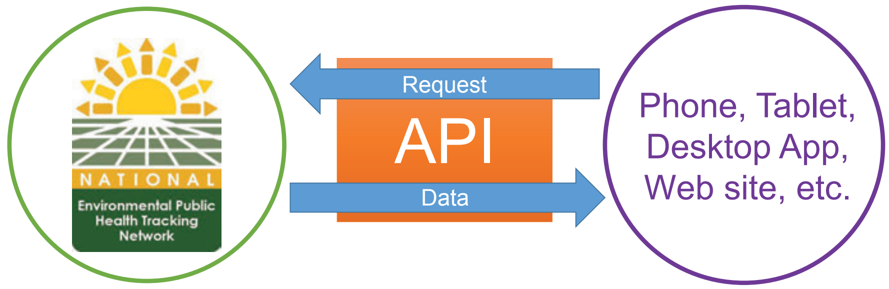
FIGURE **2**

Requesting Machine-Readable Data From the Environmental Public Health Tracking Network's Application Program Interface (API)



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Bismarck, ND	Green Bay, WI	New Orleans, LA	Sioux City, IA	Tulsa, OK
Boise, ID	Jacksonville, FL	Owatonna, MN	Sioux Falls, SD	Wichita, KS
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EH CALENDAR

UPCOMING NEHA CONFERENCE

June 13–16, 2016: NEHA 2016 Annual Educational Conference & Exhibition and HUD Healthy Homes Conference, San Antonio, TX. For more information, visit www.neha.org/aec.

NEHA AFFILIATE AND REGIONAL LISTINGS

Alabama
April 12–14, 2016: 2016 Interstate Environmental Health Seminar, hosted by the Alabama Environmental Health Association and held in conjunction with its Annual Education Conference, Guntersville, AL. For more information, visit www.aeha-online.com/upcoming-events.html.

California
March 21–25, 2016: 65th Annual Educational Symposium, hosted by the California Environmental Health Association, Oakland, CA. For more information, visit www.ceha.org.

Georgia
June 28–July 1, 2016: Annual Education Conference, hosted by the Georgia Environmental Health Association, Savannah, GA. For more information, visit www.geha-online.org/conferences.

Idaho
March 16–17, 2016: Annual Education Conference, hosted by the Idaho Environmental Health Association, Boise, ID. For more information, visit www.ieha.wildapricot.org.

Indiana
April 14, 2016: Spring Conference, hosted by the Indiana Environmental Health Association, Indianapolis, IN. For more information, visit www.iehaind.org/Conference.

Michigan
March 16–18, 2016: Annual Education Conference, hosted by the Michigan Environmental Health Association, Bay City, MI. For more information, visit www.meha.net/AEC.

New Jersey
March 6–8, 2016: Educational Conference & Exhibition, hosted by the New Jersey Environmental Health Association, Atlantic City, NJ. For more information, visit www.njeha.org.

Ohio
April 18–20, 2016: Annual Education Conference, hosted by the Ohio Environmental Health Association, Columbus, OH. For more information, visit www.ohioeha.org/annual-education-conference.aspx.

Utah
April 27–29, 2016: Spring Conference, hosted by the Utah Environmental Health Association, Springdale, UT. For more information, visit www.ueha.org/events.html.

TOPICAL LISTING

Public Health
April 12–13, 2016: Iowa Governor's Conference on Public Health, Navigating a Changing Landscape: Partnerships for Population Health, Des Moines, IA. For more information, visit www.ieha.net.

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Did You Know?

NEHA is in the process of developing a new credential, the food safety auditor, which will launch mid-2016. This credential will signify professionals who have the skills, knowledge, and critical thinking behaviors for good auditing practices and preventive controls.

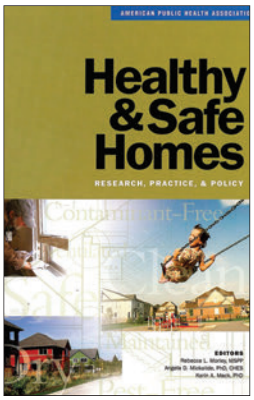
RESOURCE CORNER

Resource Corner highlights different resources that NEHA has available to meet your education and training needs. These timely resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional information about these, and many other, pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

Healthy & Safe Homes: Research, Practice, & Policy

Edited by Rebecca L. Morley, MSPP; Angela D. Mickalide, PhD, CHES; and Karin A. Mack, PhD (2011)

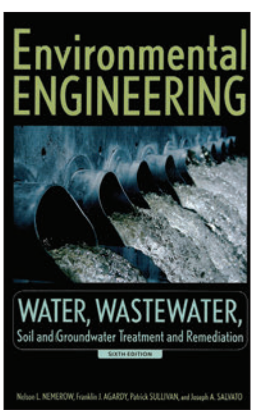


This book marks an exciting advance in the effort to ensure that people across all socioeconomic levels have access to healthy and affordable housing. It provides practical tools and information to make the connection between health and housing conditions relatable to everyone. The book brings together perspectives from noted scientists, public health experts, housing advocates, and policy leaders to fully explain the problem of substandard housing that plagues our nation and offers holistic, strategic, and long-term solutions to fix it. Study reference for NEHA's Healthy Homes Specialist credential exam.

225 pages / Paperback / Catalog #1111
Member: $52 / Nonmember: $55

Environmental Engineering: Water, Wastewater, Soil and Groundwater Treatment and Remediation (Sixth Edition)

Edited by Nelson L. Nemerow, PhD; Franklin J. Agardy, PhD; Patrick Sullivan, PhD; and Joseph A. Salvato (2009)

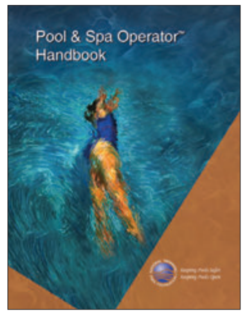


First published in 1958, Salvato's *Environmental Engineering* has long been the definitive reference for generations of sanitation and environmental engineers. The most recent edition was completely rewritten by leading experts in the field and offers succinct case studies, new process and plant design examples, and added coverage of such subjects as urban and rural systems. This volume covers water and wastewater treatment, water supply, soil and groundwater remediation and protection, and industrial waste management. Study reference for NEHA's REHS/RS exam.

384 pages / Hardback / Catalog #709
Member: $130 / Nonmember: $140

Pool & Spa Operator™ Handbook

National Swimming Pool Foundation (2014)



This fundamental training and reference manual is for professionals who help protect those who use aquatic venues, including operators, health officials, service technicians, retailers, property managers, and manufacturers. Industry leaders recognize it as the single most important resource for the recreational water industry. This *Handbook* educates readers on how to reduce risks in and around the water; provides valuable information to prevent drowning, recreational water illness, suction entrapment, evisceration, diving accidents, electrocutions, chemical hazards, and slips and falls; and summarizes regulatory guidelines, disinfection, water balance, water problems, troubleshooting, chemical testing, record keeping, chemical feed, and control technology. Study reference for NEHA's REHS/RS exam.

298 pages / Spiral-bound paperback / Catalog #1014
Member: $55 / Nonmember: $59

Pool Math™ Workbook

National Swimming Pool Foundation (2007)

This workbook is designed for operators, service technicians, health officials, retail technicians, and renovators who need to perform common math. The workbook helps people calculate pool surface area, water volume, chemical dosage amounts, saturation index, filter surface area, flow rate, filter flow rate capacity, turnover rate, heater sizing, spa water draining frequency, make-up water amount, maximum user load, and total dynamic head. The workbook is broken into three parts. Part one reviews important calculations and conversions. The second and third parts work together. Part two contains over 40 pages of math problems, presenting typical calculations. More important "must-know" calculations are highlighted in color to separate them from "nice-to-know" calculations. Part three provides step-by-step answers to solve each problem presented in the second part.

102 pages / Paperback / Catalog #1071
Member: $18 / Nonmember: $20

JEH QUIZ

FEATURED ARTICLE **QUIZ #5**

Formaldehyde Levels in Traditional and Portable Classrooms: A Pilot Investigation

Available to those holding an individual NEHA membership only, the *JEH* Quiz, offered six times per calendar year through the *Journal of Environmental Health,* is an easily accessible means to accumulate continuing-education (CE) credits toward maintaining your NEHA credentials.

1. Read the featured article carefully.
2. Select the correct answer to each *JEH* Quiz question.
3. a) Complete the online quiz at www.neha.org/publications/journal-environmental-health (click on the March 2016 issue in the left menu),

   b) Fax the quiz to (303) 691-9490, or

   c) Mail the completed quiz to
   JEH Quiz, NEHA
   720 S. Colorado Blvd., Suite 1000-N
   Denver, CO 80246.

   Be sure to include your name and membership number!
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5. Check your continuing education account online at www.neha.org.
6. You're on your way to earning CE hours!

Quiz Registration

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JEH Quiz #3 Answers

December 2015

1. b	4. e	7. c	10. a
2. d	5. c	8. b	11. b
3. c	6. d	9. c	12. b

➔ Quiz deadline: June 1, 2016

1. During 1985–2008, public school enrollment __ in the U.S.
   a. decreased
   b. stayed the same
   c. increased

2. According to a 2005 study, an estimated __ of schools reported the use of portable classrooms.
   a. 23%
   b. 33%
   c. 43%
   d. 53%

3. This pilot study assessed formaldehyde levels in portable and traditional classrooms and explored __ as a factor influencing indoor air quality.
   a. relative humidity
   b. carbon dioxide
   c. temperature
   d. all of the above

4. Studies consistently show that __ indoor formaldehyde concentrations occur in __ mobile homes and buildings.
   a. highest; new
   b. highest; old
   c. lowest; new

5. Formaldehyde emissions from indoor sources __ with temperature and relative humidity.
   a. decrease
   b. do not change
   c. increase

6. In this study, __ measurements were used as indicators of classroom ventilation.
   a. temperature
   b. relative humidity
   c. formaldehyde
   d. carbon dioxide

7. The average time students spent inside the same classroom was __ for portable classrooms and __ for temporary classrooms.
   a. 1.8 hours; 2.2 hours
   b. 1.8 hours; 4.2 hours
   c. 2.1 hours; 4.2 hours
   d. 6.8 hours; 2.2 hours

8. Overall, across schools, classroom types, and sampled periods, measured levels of formaldehyde had a median of __.
   a. 0.0068 parts per million (ppm)
   b. 0.010 ppm
   c. 0.017 ppm
   d. 0.038 ppm

9. Statistically significant differences were observed when comparing formaldehyde levels in temporary classrooms versus portable classrooms for daytime.
   a. True.
   b. False.

10. School __ consistently presented the highest concentrations of formaldehyde across sampled period and classroom type.
    a. A
    b. B
    c. C
    d. D

11. The day average concentration of formaldehyde was __ in temporary classrooms compared to portable classrooms.
    a. lower
    b. similar
    c. higher

12. The American Conference of Governmental Industrial Hygienists' threshold limit value for formaldehyde is __.
    a. 0.03 ppm
    b. 0.05 ppm
    c. 0.3 ppm
    d. 0.5 ppm


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Please submit any information updates to jeh@neha.org.

NEHA NEWS

NEHA Staff Profile

As part of tradition, NEHA features staff members in the *Journal* around the time of their one-year anniversary. These profiles give you an opportunity to get to know the NEHA staff better and to learn more about the great programs and activities going on in your association. Contact information for all NEHA staff can be found on page 49.

Arwa Hurley

Prior to NEHA and while completing my degree in communications at the University of Colorado, I worked at a national association in chapter relations. An opportunity arose where I was asked to transition from my current position into the role of Web site producer for the association. I enjoyed managing the main Web site and designing annual conference Web sites; my favorite part of the job was helping nurses create Web sites for their local chapters. I loved the behind the scenes technical work and engaging with the members. Over the years, I have worked with many associations and nonprofits, blending my love for technology and people.

Fast forward to 2014 and my joining the NEHA staff first as a consultant and then as a full-time staff member. Seeing the NEHA Web site for the first time made me want to apply for the job of Web site and digital media specialist. Prior to August 2015, the NEHA Web site had been stuck in an outdated technology from the early 2000s. I knew I wanted dust the cobwebs off the NEHA site and make it useable. I was up for the challenge and ready to harness my passion for this line of work.

Throughout 2015, the NEHA staff rallied around the Web site and helped drive it into the present. NEHA was proud to introduce to its members a new Web site in September 2015 that looks and functions better. As with any technology project, the work is ongoing and we continue to tweak and add to the current Web site to make it even more useful, engaging, and relevant to our members. With the framework in place the fun part begins—showcasing the work of environmental health professionals.

Outside of work, my husband and I have both found that Colorado is the perfect place to raise our son and daughter. Despite having two dogs, a cat, and two turtles, the kids are vying to add "just one more to make it even." I am very excited to be a part of the NEHA staff and to see it into the bright and highly technological future!

2016 Joe Beck Educational Contribution Award

This award was established to recognize NEHA members, teams, or organizations for an outstanding educational contribution within the field of environmental health.

Named in honor of the late Professor Joe Beck, this award provides a pathway for the sharing of creative methods and tools to educate one another and the public about environmental health principles and practices. Don't miss this opportunity to submit a nomination to highlight the great works of your colleagues!

Nominations are due in the NEHA office by March 15, 2016.

For more information, please visit www.neha.org/joe-beck-educational-contribution-award.

NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION

NEHA SECOND VICE PRESIDENTIAL CANDIDATE PROFILE

NEHA elects its leaders through a ballot that goes to all active and life members prior to the annual conference. Among other things, the ballot features the election for the position of NEHA second vice president. The person elected to this position begins a five-year commitment to NEHA that involves advancing each year to a different national office, eventually to become NEHA's president.

Election policies specify that profiles for the second vice president be limited to 800 words in total length. If a candidate's profile exceeds that limit, the policy requires that the profile is terminated at the last sentence before the 800-word limit is exceeded. In addition, the submitted profiles have not been grammatically edited, but presented as submitted and within the 800-word limitation. This year, NEHA presents one candidate for the second vice president office.

Priscilla Oliver, PhD

Priscilla Oliver, PhD, is a Senior Life Scientist/Regional Program Manager in the Office of the Regional Administrator, U.S. Environmental Protection Agency (U.S. EPA) in Atlanta, Georgia. She is a graduate of the University of Alabama in Tuscaloosa with a BS degree in Biology and a twice graduate of Georgia State University with MPA and PhD degrees in Educational/Health Administration. Dr. Oliver attended her first National Environmental Health Association (NEHA) Annual Educational Conference (AEC) in 1993. She joined then and has remained an active strong member.

Her NEHA activities have expanded over the years. Since 2001 she has volunteered time supporting the following NEHA Technical Sections: Emerging Diseases/Vector Control/Zoonotic Diseases, Institutional Environmental Health, and Environmental Health in Schools. She later chaired and co- chaired the Hazardous Materials and Toxic Substances Section and served as Technical Advisor. Dr. Oliver was a member of the *Journal of Environmental Health* Technical Editorial Advisory Board for more than 12 years and has been a Peer Reviewer for more than 15 years. She consistently attends and supports each NEHA AEC.

Dr. Oliver received the 2014 Walter F. Snyder Award from NSF International and NEHA for achievement in advancing environmental health. She received the 2013 NEHA Past Presidents Award, the 2010 Presidential Citation Award, and numerous letters of appreciation for longstanding contributions for dedicated service to NEHA and the profession.

As a 1988 Greater Leadership Opportunities graduate, Dr. Oliver was a legislative fellow with the Environment and Health Subcommittee, U.S. House of Representatives under Congressman Roy Roland, MD (GA). She served as a fellow in the Office of the Secretary, U.S. Department of Health and Human Services under Dr. Louis Sullivan in 1989. She also rotated in the Office of Administration and Management, U.S. EPA Headquarters under Mr. Charlie Grizzle. Dr. Oliver worked with the U. S. Army Corps of Engineers, Baltimore District and the U. S. Fish and Wildlife Service Brunswick Field Office as a Biologist.

In academia, Dr. Oliver taught Academic Medicine and Environmental Health at the Morehouse School of Medicine and wrote several grants for research and to promote school development. She also taught Public Administration at Kennesaw State University and Troy University Atlanta Campus. She is currently a Practitioner on the National Environmental Health Science and Protection Accreditation Council. Dr. Oliver helped create the National Council on Diversity in Environmental (N-CODE) Health with Professor Joe Beck, other Eastern Kentucky University officials, and representatives from various federal, state, local, and industrial organizations. In 1995, she founded the Physician and Undergraduate Student Educational (PAUSE) Partnerships Foundation, Inc. to mentor students and increase the number of minority and diverse physicians.

Since 2009, Dr. Oliver, has organized and been a member of the Board of Directors of the American Federation of Government Employees (AFGE) Local 534 in U.S. EPA. She is currently the President and received an award for increasing membership. Dr. Oliver represents some 550 scientists, engineers, attorneys, and accountants, and is the Women and Fair Practices National U.S. EPA Council Coordinator. She works with employees, AFGE district and national leaders, and with agencies to provide better leadership for contracts and labor relations policies and laws for environmental health professionals. Under the Partnership for Sustainable Healthcare, Dr. Oliver leads the Atlanta Federal Center in the Prescription Drug Take Back Program by collecting unused, unwanted, and expired drugs from employees in 20 agencies for proper disposal. Some 266 pounds of drugs have been collected in this partnership with the U. S. Drug Enforcement Agency and Food and Drug Administration since 2011. Teaching classes, coordinating union, health, and recruitment events, conducting congressional visits, inspecting industrial and wastewater facilities, attending show-cause meetings, making a variety of presentations, administering grants, and holding negotiations sessions with employees and managers have filled the federal work life for Dr. Oliver.

She received the 2005 U.S. EPA Diversity Award, the 2015 Georgia Public Administrator of the Year Award, the 2015 Delta Sorority Torch Award, the Clark Atlanta University Trailblazer Award, and the Anthony Rachal Award of Excellence from Xavier University of Louisiana. Dr. Oliver is a Licensed Georgia Real Estate Broker and a Certified Project Officer. She also is a Life Member of the Georgia State Alumni Association and Delta Sigma Theta Sorority, Inc.

Dr. Oliver has been consistent in her environmental health commitments and work ethics for some 42 years. She brings to the NEHA Board a variety of meaningful and relevant experiences, qualifications, and skills. Dr. Oliver has a simple platform for the NEHA future. She wants a visible NEHA that is more **Blue**, **Green**, and **Gold**: Limitless, Sustainable, and Resourceful. The focus is on advancing people, resources, and funding. The stronger partnership connections of urban and rural, industry and government, nonprofits and academia are needed and will be the future emphasis for success for the environmental health profession.

ACCREDITED ENVIRONMENTAL HEALTH SCIENCE AND PROTECTION PROGRAMS

The following colleges and universities offer accredited environmental health programs for undergraduate and graduate degrees (where indicated). For more information, please contact the schools directly, visit the National Environmental Health Science and Protection Accreditation Council (EHAC) Web site at www.ehacoffice.org, or contact EHAC at ehacinfo@aehap.org.

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††Accredited graduate program only.

2016 ACCEPTING NOMINATIONS NOW

Walter S. Mangold Award

The Walter S. Mangold Award recognizes an individual for extraordinary achievement in environmental health. Since 1956, this award acknowledges the brightest and the best in the profession. NEHA is currently accepting nominations for this award by an affiliate in good standing or by any five NEHA members, regardless of their affiliation.

The Mangold is NEHA's most prestigious award and while it recognizes an individual, it also honors an entire profession for its skill, knowledge, and commitment to public health.

Nominations are due in the NEHA office by **March 15, 2016.**

NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION

Visit www.neha.org/walter-s-mangold-award for application criteria.

NEHA's Excellence in Sustainability Award Program

NEHA's Excellence in Sustainability Award recognizes organizations, businesses, associations, and individuals who are solving environmental challenges by using innovative and environmentally sustainable practices.

Visit www.neha.org/excellence-sustainability-award to learn more about the Excellence in Sustainability Award Program and submission process.

Submission deadline is April 15, 2016.

For more information, please contact Laura Brister at lbrister@neha.org.

2016 Walter F. Snyder Award

Call for Nominations

Nomination deadline is April 30, 2016.

Given in honor of NSF International's co-founder and first executive director, the *Walter F. Snyder Award* recognizes outstanding leadership in public health and environmental health protection. The annual award is presented jointly by NSF International and the National Environmental Health Association.

❖ ❖ ❖

Nominations for the 2016 *Walter F. Snyder Award* are being accepted for environmental health professionals achieving peer recognition for:

- outstanding accomplishments in environmental and public health protection,
- notable contributions to protection of environment and quality of life,
- demonstrated capacity to work with all interests in solving environmental health challenges,
- participation in development and use of voluntary consensus standards for public health and safety, and
- leadership in securing action on behalf of environmental and public health goals.

❖ ❖ ❖

Past recipients of the *Walter F. Snyder Award* include:

2015 – Ron Grimes	2007 - Wilfried Kreisel	1998 - Chris J. Wiant	1989 - Boyd T. Marsh	1980 - Ray B. Watts
2014 – Priscilla Oliver	2006 - Arthur L. Banks	1997 - J. Roy Hickman	1988 - Mark D. Hollis	1979 - John G. Todd
2013 - Vincent J. Radke	2005 - John B. Conway	1996 - Robert M. Brown	1987 - George A. Kupfer	1978 - Larry J. Gordon
2012 - Harry E. Grenawitzke	2004 - Peter D. Thornton	1995 - Leonard F. Rice	1986 - Albert H. Brunwasser	1977 - Charles C. Johnson, Jr.
2011 - Gary P. Noonan	2002 - Gayle J. Smith	1994 - Nelson E. Fabian	1985 - William G. Walter	1975 - Charles L. Senn
2010 - James Balsamo, Jr.	2001 - Robert W. Powitz	1993 - Amer El-Ahraf	1984 - William Nix Anderson	1974 - James J. Jump
2009 - Terrance B. Gratton	2000 - Friedrich K. Kaeferstein	1992 - Robert Galvan	1983 - John R. Bagby, Jr.	1973 - William A. Broadway
2008 - CAPT. Craig A. Shepherd	1999 - Khalil H. Mancy	1991 - Trenton G. Davis	1982 - Emil T. Chanlett	1972 - Ralph C. Pickard
		1990 - Harvey F. Collins	1981 - Charles H. Gillham	1971 - Callis A. Atkins

The 2016 Walter F. Snyder Award will be presented during NEHA's 80th Annual Educational Conference (AEC) & Exhibition to be held in San Antonio, TX June 13-16, 2016.

For more information or to download nomination forms, please visit www.nsf.org or www.neha.org or contact Stan Hazan at NSF at 734-769-5105 or hazan@nsf.org.

DAVIS CALVIN WAGNER SANITARIAN AWARD

The American Academy of Sanitarians (AAS) announces the annual Davis Calvin Wagner Sanitarian Award. The award will be presented by AAS during the National Environmental Health Association's 2016 Annual Educational Conference & Exhibition. The award consists of a plaque and a $500 honorarium.

Nominations for this award are open to all AAS diplomates who:

1. Exhibit resourcefulness and dedication in promoting the improvement of the public's health through the application of environmental and public health practices.
2. Demonstrate professionalism, administrative and technical skill, and competence in applying such skills to raise the level of environmental health.
3. Continue to improve through involvement in continuing education type programs to keep abreast of new developments in environmental and public health.
4. Are of such excellence to merit AAS recognition.

NOMINATIONS MUST BE RECEIVED BY APRIL 15, 2016.
Nomination packages should be sent electronically to shep1578@gmail.com. If desired, three hard copies of the nomination document may be submitted to

American Academy of Sanitarians
c/o Craig A. Shepherd
1271 Statesville Road
Watertown, TN 37184

For more information about the award nomination, eligibility, and evaluation process and previous recipients of the award, please visit sanitarians.org/Awards.

Hotel Reservations

Make your hotel reservations early to get the room of your choice.

visitsanantonio.com

The conference will take place at two locations. Both hotels are in walking distance of one another along the Riverwalk and both will have educational sessions on different days.

- San Antonio Marriott Rivercenter,
  June 12–June 13: Education, Exhibition
- Hyatt Regency San Antonio,
  June 14–15: Education

Discounted room rates for the NEHA 2016 AEC and HUD Healthy Homes Conference are available at neha.org/aec/hotel.

Texas Social

New this year is a networking event on the final night of the conference to give you the sounds, sights, and flavors of San Antonio. Join us at the Texas Social—included in all full conference registrations—at La Villita Historic Arts Village where you'll enjoy a Texas barbecue dinner and the sounds of live country western entertainment with your fellow conference attendees.

Attendees kick up their heels at the 2006 San Antonio AEC.

Check out neha.org/aec/special-events for updates on more great events including the Community Event and the UL Event!

Students Welcome!

Students can receive a discounted rate and gain entry to all the events and education that are available to all full conference attendees. Included in the conference registration, the special student rate offers:

Student research presentation winners last year in Orlando.

- the opportunity for students to hone in on their careers and network to create meaningful connections with other professionals, and
- a one-year NEHA membership, which includes the electronic version of the *Journal of Environmental Health*, NEHA's popular E-News, and discounts on courses, books, and exams.

Students can learn more at neha.org/aec/register and neha.org/professional-development/students.

San Antonio

NEHA 2016 AEC and HUD Healthy Homes Conference

June 13–16, 2016

Educational Opportunities

Don't miss exciting educational opportunities to hear from your peers in the field of environmental health while earning continuing education credits!

Educational tracks will include dynamic sessions covering topic areas such as healthy homes and communities, food safety and protection, air quality, vector control, onsite wastewater, climate change, sustainability, emerging environmental health issues, and many more.

Get involved with interactive sessions like "The Biggest Loser: Learning from Our Failures," a campfire session moderated by NEHA Executive Director Dr. David Dyjack and Charles Treser that will give attendees the opportunity to share their personal stories.

Be there for our exciting opening session on June 13 at 4 pm that will include a cutting-edge panel presentation on the topic of the built environment, and then come mingle and network at the Exhibition Grand Opening & Party.

Students! We have special sessions and networking opportunities for you to meet experts in the field through special events, mentoring from environmental health leaders, student poster presentations, and student led sessions as well as sessions that apply to you and your future, such as NEHA President Bob Custard's presentation, "Selecting the Best: 25 Questions EH Managers Want Answered About Job Candidates."

Preliminary Schedule*

Friday, June 10
Review Courses: REHS/RS, CCFS

Saturday, June 11
Review Courses: REHS/RS, CCFS, CP-FS

Sunday, June 12
Review Courses: REHS/RS, CCFS, CP-FS
Exam: REHS/RS

Monday, June 13
Exams: CCFS, CP-FS, HHS
Events:
- Community Event
- First-Time Attendee Meeting
- Keynote & Opening Session
- Exhibition Grand Opening & Party

Tuesday, June 14
Events:
- Education Sessions
- Exhibition

Wednesday, June 15
Events:
- Education Sessions
- Breakfast & Town Hall Assembly
- Poster Session
- Texas Social

Thursday, June 16
Events:
- Education Sessions
- Closing Session

Opening Session Keynote!

Julian Castro, the current secretary of the U.S. Department of Housing and Urban Development and former mayor of San Antonio, has been invited to deliver the keynote address at the opening AEC session. See more at neha.org/aec.

*Schedule is subject to change.

DirecTalk
continued from page 62

infants, and children clinics, federally-qualified health centers, or public hospitals. While no one is suggesting environmental health should merge with clinical medicine, we should continuously endeavor to consciously move our efforts to the right side of the figure, in a manner in which we are considered a meaningful partner with those in the clinical professions. This will take vision, planning, and plenty of patience.

I believe each of us aspire to the shared goal of improved population health, and in a perfect world would like to contribute to something larger than ourselves. The primary care public health integration conversation is an ideal place to start. Recall that under the social determinants of health model, 80% of a person's health status is unrelated to clinical care. That means environmental health professionals have an important role in the health of the nation. Listen, environmental health is a best buy for the nation. We save lives, save money, and protect the nation's future. When environmental health professionals work with physicians, nurses, and mental health professionals, the nation wins.

When I think about the challenges in the news, e.g., lead in water in Flint, Michigan, *Legionella* in New York commercial buildings, norovirus in retail food, and extensively drug-resistant tuberculosis, I see abundant opportunities for us to reintroduce ourselves and the value we bring to clinical decision making. There is no end to what we can accomplish if we blur the distinction between the work we do and the work of other health professionals. We are pre-poised to be a *force majeure* in the health professions through the creation and delivery of solutions in ensuring every American reaches their full potential. In that journey we'll need to carefully articulate how people will be healthier because of our efforts and couple data with stories that illustrate our impact.

FIGURE **1**

Primary Care Public Health Integration Continuum

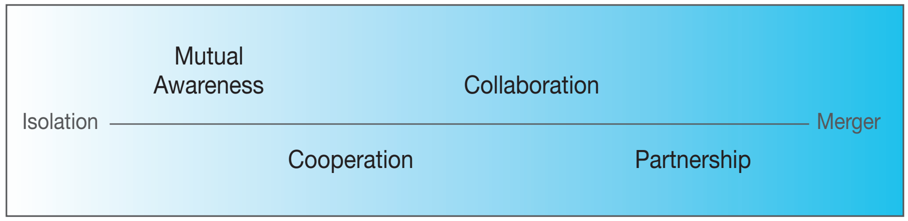

Figure reprinted with permission from *Primary Care and Public Health: Exploring Integration to Improve Population Health* (2012) by the National Academy of Sciences, courtesy of the National Academies Press, Washington, DC.

For my part I will be speaking publicly throughout the nation in 2016 on the increasingly important contributions you make to the health of the nation. I have accepted invitations to speak to physician's groups to raise awareness about us. I intend to illustrate our future roles in community health needs assessments, community health improvement plans, patient-centered medical homes, community health centers, and many other elements of the emerging health landscape.

I'd like to end with a quote from my friend Lloyd Michener, MD, of Duke University. Lloyd is professor and chairman at Duke Community and Family Medicine and director of the Duke Center for Community Research. "As primary care and public health learn to work together, both are rediscovering the importance of the environment. Whether it's mold in housing projects, contaminants in soil, or air and water pollution, medical groups, working with public health, are finding that some health problems can be solved with less attention to medication, and more attention to the environment." Dr. Michener gets it. As a national public health influencer, he is an important ally in our efforts to be increasingly seen as important contributors to the health of American families.

In summary, environmental health 2.0 is about progress, not process. It's about the space between the professions; that's where meaningful progress will be made in our journey to be the healthiest nation on earth.

If you'd like to learn more about primary care–public health integration, I encourage you to visit www.practicalplaybook.org.

Dave

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DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Environmental Health 2.0

It's about improving environmental health, not about the environmental health profession

It's about health, not health care

It's about population health, not population medicine

It's about interoperability and integration, not programmatic excellence

It's about blurring the lines between the health professions, not drawing clean distinctions

Environmental health 2.0, it's about progress, not process

In late 2015 the U.S. Department of Health and Human Services released a report containing mind-numbing figures. For fiscal year 2014, 17.5% of gross domestic product was spent on health care; that's $3 trillion, or roughly $9,500 for every man, woman, and child.. Each U.S. citizen has a vested interest in getting these expenditures under control. According to the Centers for Disease Control and Prevention, only 2.5% of that astonishing figure is invested in public health and prevention. At the same time, the health status of the U.S. population has languished. *E. coli* and noroviruses are daily news. The U.S. suffers from 20 million foodborne illnesses a year; globally, the number approaches 550 million with an estimated 230,000 deaths, mostly among children younger than five.

> *Environmental health is a best buy for the nation. We save lives, save money, and protect the nation's future.*

Here in the U.S. about 13% of the total burden of disease is attributable to the environment. That translates to 400,000 deaths and almost six million disability-adjusted life years lost each and every year. Leading the way is cardiovascular disease, in which air quality plays a major role. Neuropsychiatric disorders (think heavy metals such as lead) represent $4.3 billion in lost productivity among the exposed. The bronze medal goes to cancer; about 6% of all cancers are reportedly related to occupational and environmental exposures.

Ignoring the environment comes at a great cost to society. Environmental health professionals have an important, and in my estimation, growing role to play in the future of health at large. The critical nexus in our professional journey is the public health–health care interface. We are now entering an era where the traditional models of excellence are no longer sufficient, and we need to rethink our manner of conducting business, which will drive us to become more conversant and familiar with our colleagues in the clinical professions, who control 97.5% of health resources.

A case in point is the 2012 Institute of Medicine (IOM) report, *Primary Care and Public Health: Exploring Integration to Improve Population Health*. This seminal document outlines five principles to help primary care and environmental health professionals, like us, to work together to reduce the costs and burden of disease I outlined earlier. The five principles include the following:

- A shared goal of population health
- Aligned leadership
- Community engagement
- Sharing and collaborative use of data and analysis
- Sustainability

What does this mean to us? We need to increasingly see ourselves as part of a larger health continuum and commit to working more effectively with our clinical counterparts. Refer to Figure 1 on page 61 as taken from the IOM report. Where along the continuum of integration with the clinical field do you see your role, independent of whether you are in the public or private sector? Are your activities isolated from the curative health care apparatus? Thinking broadly, that apparatus could be under the guise of human resources, employee benefit support systems, or the company physician or nurse. Alternately, in traditional governmental organizations, our counterparts might be the women,

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INTERNATIONAL PERSPECTIVES

Disaster Management Policy Options to Address the Sanitation Challenges in South Africa

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Abstract **The current population of South Africa has been migrating into informal urban settlements that lack adequate sanitation service delivery, caused at least in part by the lack of the necessary skills in the local government sector and the lack of buy in from the community into the provided sanitation facilities. The authors report results of policy research into the relevant disaster management options that could be applied to improve the sanitation service delivery in South Africa. The best policy option was identified as the draft *Disaster Management Regulations: Disaster Management*. Local government can use these tools through the formation of the volunteer units from the nongovernmental organization sector, the business community, and from among the end users of sanitation facilities. Formation of the volunteer unit should follow the principles of cooperative governance and participatory approach to disaster management. Implementation should be facilitated through the adoption of locally specific municipal bylaws.**

Introduction

Recent data indicate that up to 55.1% of the South African population resides in provinces where the country's major metropolitan centers are located (Statistics South Africa [StatSA], 2013). During the 2002–2013 period, the rate of economic in-migration from rural to urban areas of South Africa increased significantly (Gauteng Department of Agriculture and Rural Development, 2011; StatSA, 2013). One of the indirect consequences of this economic in-migration and concurrent rapid urbanization is the influx of people into informal settlements and backyard shacks, i.e., the low-income areas in big cities (Beall, Crankshaw, & Parnell, 2002; National Disaster Management Centre [NDMC], 2013a). These low-income communities are generally more vulnerable to disasters than their high-income counterparts (Tandlich, Chirenda, & Srinivas, 2013). In addition, these low-income settlements suffer from lack of water and sanitation service delivery (Luyt, Muller, Wilhelmi, & Tandlich, 2011). The combination of these factors leads to increased population densities in slums, which in turn increase the size of the urban population exposed to inferior hygiene conditions (Lamond & Kinyanjui, 2012). These living conditions constitute a disaster hazard for the urban population and exposure to them (i.e., disaster exposure) increases the probability of infectious disease outbreaks in urban areas (Lamond & Kinyanjui, 2012), i.e., health-related disasters.

Hygiene and the related epidemics/disasters are interlinked with sanitation. Sanitation in South Africa has a disaster management dimension in connection with natural hazards triggering technology disasters (Ozunu et al., 2011) and the secondary effects of floods (Luyt et al., 2011). Problems with sanitation service delivery and the resulting impacts have been given attention by the national government in South Africa since 2001 (Hoossein, Whittington-Jones, & Tandlich, 2014). Several strategies were tested to improve the situation (Hoossein et al., 2014; Portfolio Committee on Human Settlements, 2012), but problems remain in the area of sustainability of sanitation provision (South African Human Rights Commission [SAHRC], 2010). The main causes for this are the shortage of sanitation skills at the local government level (Whittington-Jones, Tandlich, Zuma, Hoossein, & Villet, 2011) and the lack of buy in from the community and the end users into the sanitation facilities provided by the government to the population (Hoossein et al., 2014). Thus, in this article, we investigate the possibility of applying disaster management policy tools to address the sanitation backlog and capacity shortages in urban areas of South Africa.

Research Methodology

Policy research was conducted using South African government documents and online databases, i.e., the Parliamentary Monitoring Group Web site and SCOPUS. Further information was obtained from Web sites of the city of Cape Town Disaster Management, the Johannesburg Metropolitan Municipality, the Disaster Management Institute of Southern Africa, and the National Disaster Management Centre of South Africa. Limited field observations were also conducted to demonstrate certain practical implications of the sanitation provision in South Africa.

Results and Discussion

If a municipality's capacity is insufficient to meet the sanitation service delivery requirements, then our research indicates that one of the best policy tools to address them is the draft *Disaster Management Regulations: Disaster Management* (designated as the policy in the remainder of this article [DMRDM], 2005). Elimination of sanitation service delivery gaps is in particular facilitated by chapters 2 and 3, as well as appendices A and B of the policy (DMRDM, 2005). These sections of the policy allow the local government's disaster management component, namely the Municipal Disaster Management Centre (MDMC) to appoint volunteers to assist "with community and environmental health" and "waste water and solid waste services (DMRDM, 2005)." Further sanitation-related tasks can be assigned to the volunteer unit based on a "needs analysis"—an audit of the skills and technical capacity of the given local municipality (DMRDM, 2005). Volunteers are recruited from the local governments' own jurisdiction, providing the most-up-to-date knowledge needed to respond to local disasters. Such volunteers can assist MDMC in installation and maintenance of the sanitation infrastructure and prevention of environmental contamination with pathogens and fecal matter (Bakare, Foxon, Brouckaert, & Buckley, 2012).

The policy is flexible and provides good tools for appointment of relevant stakeholders to fill in the capacity gaps and engagement of nongovernment stakeholders such as nongovernmental organizations (NGOs). Practical implementation of the policy has, however, been slowed down by a time-consuming legislative process and concerns raised by the disaster management stakeholders during a thorough consultative process (Kilian, 2009; National Council of Provinces of South Africa, 2010). The first stakeholder concern was that volunteers were not to be used by local government to perform tasks that the existing municipal staff members were paid to do (Kilian, 2009). The second concern of the disaster management stakeholders was to ensure that proper insurance coverage was awarded to every volunteer (Kilian, 2009). The final concern was that the volunteers be allowed to apply for any existing disaster management vacancies in local government that they are qualified for (Kilian, 2009).

The consultative and legislative processes about the policy resulted in gazetting of the draft *Disaster Management Volunteer Regulations* in 2010 (designated as guidelines for the rest of this article; Department of Cooperative Governance and Traditional Affairs [DCGTA], 2010). Sections that are most relevant to sanitation are sections 1–6, sections 9–13; and finally annexures A(2) and A(3) (DCGTA, 2010). According to the guidelines, head of MDMC or their designate are the leaders of the volunteer unit (DCGTA, 2010). A particular volunteer, so-called "component leader," can be appointed by MDMC to oversee sanitation activities of the volunteer unit (DCGTA, 2010). Sanitation volunteers work in close coordination with the volunteer unit component working on "water supply, waste water, and solid waste services" (DCGTA, 2010). Quality of any equipment used by the volunteers must meet preset specifications and they must be provided with protective clothing by the particular MDMC (DCGTA, 2010). Any actively serving volunteers must have an official insignia, IDs, and undergo a health check before commencement of service (DCGTA, 2010). Based on the above information, combination of the policy and the guidelines offers a viable tool to local government for addressing the service delivery backlogs in sanitation in South Africa.

The policy and the guidelines could be used effectively to address the existing sanitation backlogs in South Africa, if the volunteer units are run following the principles of participatory approach to disaster management. NGOs accumulate substantial knowledge on addressing sanitation problems and their sanitation expertise is often broader than that of any other stakeholder. Thus the component leader for sanitation should be an NGO member. Members of the business community should be recruited to the volunteer unit to provide logistical and material support. Users of sanitation facilities, i.e. community members, are the best source of information about the sanitation preferences in the particular settlement. Therefore their involvement in the volunteer unit could simplify the sanitation project implementation. It can also facilitate transfer of the sanitation skills to the community members. This might be used to develop entrepreneurial activity in the sanitation sector in the low-income segments of the metropolitan population. Economic and health vulnerability of the South African population could be decreased in this way and through development of new hygiene knowledge in the community. Training of volunteers should follow the principles of "informal learning" and "nonformal learning (NDMC, 2013b, 2013c)."

In general, the use of volunteers has varied significantly in the urban areas of South Africa. The eThekwini metropolitan municipality in the province of KwaZulu-Natal held a workshop for volunteers in disaster management (eThekwini Disaster Management, 2011). No volunteer unit has been established, however. Only limited progress has been made in the use of disaster management volunteers in the city of Johannesburg (City of Johannesburg, 2014). The city of Cape Town has formed a volunteer unit that is divided into segments that correspond to the city's various boroughs (City of Cape Town Disaster Management, 2014). Sanitation is, however, not on the list of functions that the volunteers perform (City of Cape Town Disaster Management, 2014). This is likely to change in the near future given the recent problems reported in the public domain (Social Justice Coalition, 2014).

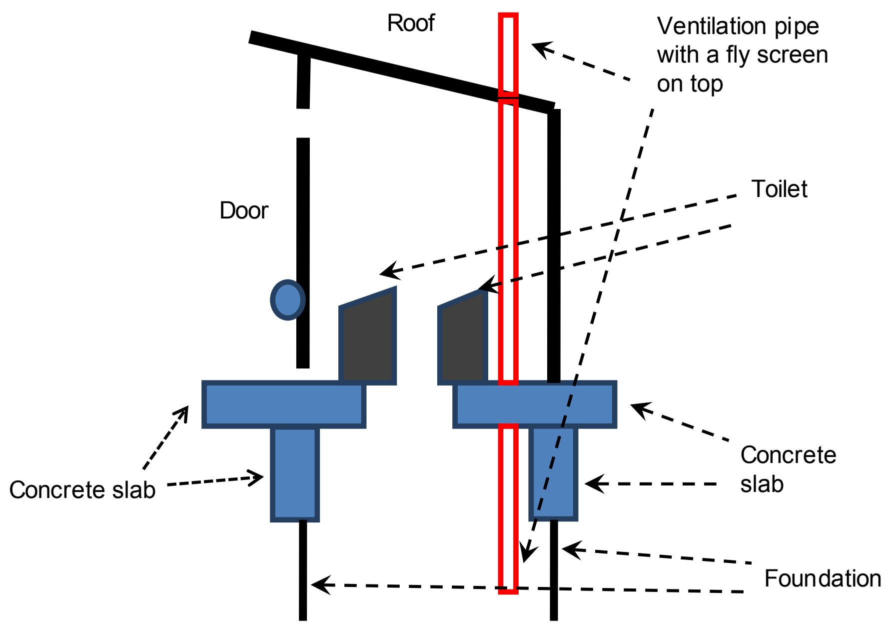
A site for an urgent application of the policy and the guidelines is the sanitation service delivery in geographically isolated urban municipalities in South Africa, where skills and financial shortages are often very pressing. An example is the Makana local municipality and its geographical center, the city of Grahamstown (hereafter referred to as Makana; Local Government Handbook, 2015). Volunteers could be recruited from among the academic and research staff at Rhodes University, which is located in Makana. This is derived from the systematic research into the sanitation in Makana, which is performed by the said stakeholders and funded by the Gates Foundation through the Water Research Commission of South Africa (grant number K5/2306). The said project is focused on the valorization of the fecal sludge from ventilated improved pit latrines (VIPLs). Schematic representation of a VIPL is shown in Figure 1. The VIPLs constitute the minimum standard of improved sanitation in South Africa (Socio-Economic Rights Institute, 2011; StatSA, 2014). The VIPLs are also the preferred option in sanitation service delivery in urban areas of South Africa due to simplicity of installation and meeting of regulatory requirements (Hoossein et al., 2014) (Figure 1).

In a VIPL, a toilet sits on a cement pedestal that is attached to two concrete slabs and enclosed with a cabin-like structure to provide privacy for the toilet facility users (see door and roof in Figure 1; Mara, 1982). Below the concrete slabs is the foundation, which should provide a stable support to the weight of the toilet facility (Hoossein, 2009). The foundation can completely enclose the pit at the bottom leading to the formation of a VIPL vault (Bhagwan, Still, Buckley, & Foxon, 2008). Alternatively, the foundation can be sunk into the soil in the form of side walls made out of bricks to stabilize the fecal waste collection pit (Figure 1; Mara, 1982). Soil conditions and the water table on site determine which of these two foundations should be used. The ventilation pipe provides aeration of the pit, eliminating odors from the VIPL. The top of the ventilation pipe should be covered with a fly screen to prevent the entry of disease vectors into the VIPL pit (Mara, 1982). Overall, a VIPL should be a durable and effective barrier between the toilet users and the fecal wastes collected in the pit, namely feces and greywater.

Construction and maintenance of VIPLs and other sanitation infrastructure are often compromised at the local level of government in South Africa due to lack of necessary skills and compliance among the contractors (Hoossein et al., 2014; Whittington-Jones et al., 2011). Observations to this effect made in Makana in September 2014 are shown in Figures 2 and 3. Construction of the piping to collect sanitation wastes such as greywater is unfinished, even though the facilities are in use by settlement residents (see Figure 2a). Lack of proper foundation of the VIPL is demonstrated by the missing side walls (see Figure 2b). As a result, only wooden beams carry the entire weight of the VIPL, which increases the chances of this structure toppling over. This is a real possibility given the signs of soil erosion that can be seen on the sides of the foundation (see Figure 2b).

FIGURE **1**

Schematic Representation of a Ventilated Improved Pit Latrine



Based on Mara, 1982.

Missing or corroded fly screens were detected in some VIPLs around Makana, while a complete breakdown of the sanitation facilities was observed at other sites (see Figure 3 for details). The latter observation indicates a violation the South African National Housing Code, which states that any structures that the human population resides in must be impermeable to sewage and greywater (NHC, 2009). Therefore the population in Makana can be exposed to sanitation wastes, which in turn creates a public health and disaster hazard. Observations similar to those from Makana have been reported for the flush toilets in the Free State Province of South Africa (SAHRC, 2010) and in the city of Cape Town (Social Justice Coalition, 2014). This indicates that an urgent need for action and involvement of volunteer units from among the sanitation facility users to address the lack of skills could be a viable option.

Successful cooperation between academic stakeholders and NGOs has taken place in Makana on issues such as rainwater provision and quality and microbial water quality monitoring (Rhodes University Environment Programme, 2014; Tandlich, Luyt, & Ngqwala, 2014; Tandlich et al., 2014). In the wider South African context, the large-scale volunteer initiatives in the water sector have been run over several years in the Gauteng Province (FirstRand Volunteers, 2010). Long-term involvement and use of the volunteer units is scarce, however (City of Cape Town, 2014), and no such initiatives are currently run in the sanitation sec-

FIGURE **2**

Examples of Broken Sanitation Infrastructure in Makana

a) **b)**

a) Light blue circle = an unsewered toilet facility; b) light green circle = erosion soil under the improperly laid ventilated improved pit latrine foundation.

tor in South Africa. Existing and successful campaigns from the water sector could be extended to sanitation, given the expertise of local nongovernmental stakeholders (e.g., Tandlich, Zuma, Burgess, & Whittington-Jones, 2009; Whittington-Jones et al., 2011; Zuma, Tandlich, Burgess, & Whittington-Jones, 2009). The framework for this cooperation would be developed using the policy and the guidelines. Practical obstacles to implementation probably include the lack of awareness of these policy options among the local government and some controversy, such as that experienced by the authors in Makana in engagement with local government. Similar problems have been encountered in other countries (Al-Shaqsi et al., 2013; Chou & Chen, 2013).

Before any volunteer programs are to be implemented in South Africa, recent international literature was reviewed to provide benchmarking of any proposed strategies. International literature indicates that standard procedures of emergency management include protocols for citizen participation (Kim, 2014). Participation of volunteers in disaster management has been implemented into the housing policy in certain cities in Mexico (Wessex Institute of Technology, 2013). In preparation for disasters, it is advisable to put in place cooperation agreements between state authorities and volunteer organizations (Al-Shaqsi et al., 2013; Chou & Chen, 2013). This is required as the (early) response to disasters depends heavily on help from volunteers (Al-Shaqsi et al., 2013; Chou & Chen, 2013). In the context of sanitation, such agreements would imply the use of cooperative governance and the inclusion of the sanitation stakeholders in the planning stages of sanitation service delivery, i.e., the principle of participatory approach to disaster management.

To a large extent, this has been implemented in sanitation planning in South Africa in recent years (Hoossein et al., 2014). Therefore the literature data seem to indicate that the use of volunteers in response to the sanitation skills shortages in South Africa would only be a natural extension of the existing principles that have already been implemented in the country's sanitation service delivery. At the same time, the policy and the guidelines seem to follow the general principles for volunteer involvement from similar programs run internationally. A new policy development in South Africa, which could facilitate a better volunteer recruitment, is the proposed Disaster Management Bill of 2015 in which

FIGURE 3

Further Examples of Broken Sanitation Infrastructure in Makana

a)

b)

Specific problems including the ventilation pipe of a ventilated improved pit latrine without a fly screen (a—red circle) and housing structures in contact or permeable to sewage (b).

clauses 2 and 12 propose that traditional leaders become more involved in disaster management in South Africa (Parliament of the Republic of South Africa, 2015). These leaders carry the cultural heritage and customs of the various ethnic groups that make up the South African population. Their inclusion into the sanitation service delivery and connected disaster management considerations will surely contribute significantly to improvement in the current situation. Increased chances of widespread volunteer programs could also be improved by the likely increased buy in from the community members.

Conclusion

Findings from this article indicate that the policy and the guidelines can be combined to draft an efficient policy tool for the involvement of volunteers and filling the sanitation capacity gaps at the local government level in South Africa. The most suitable format seems to be the drafting of bylaws in a given local or district/metropolitan municipality. The integration of "informal" and "nonformal" learning into the functioning of the volunteer units should be strongly considered for implementation across South Africa.

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