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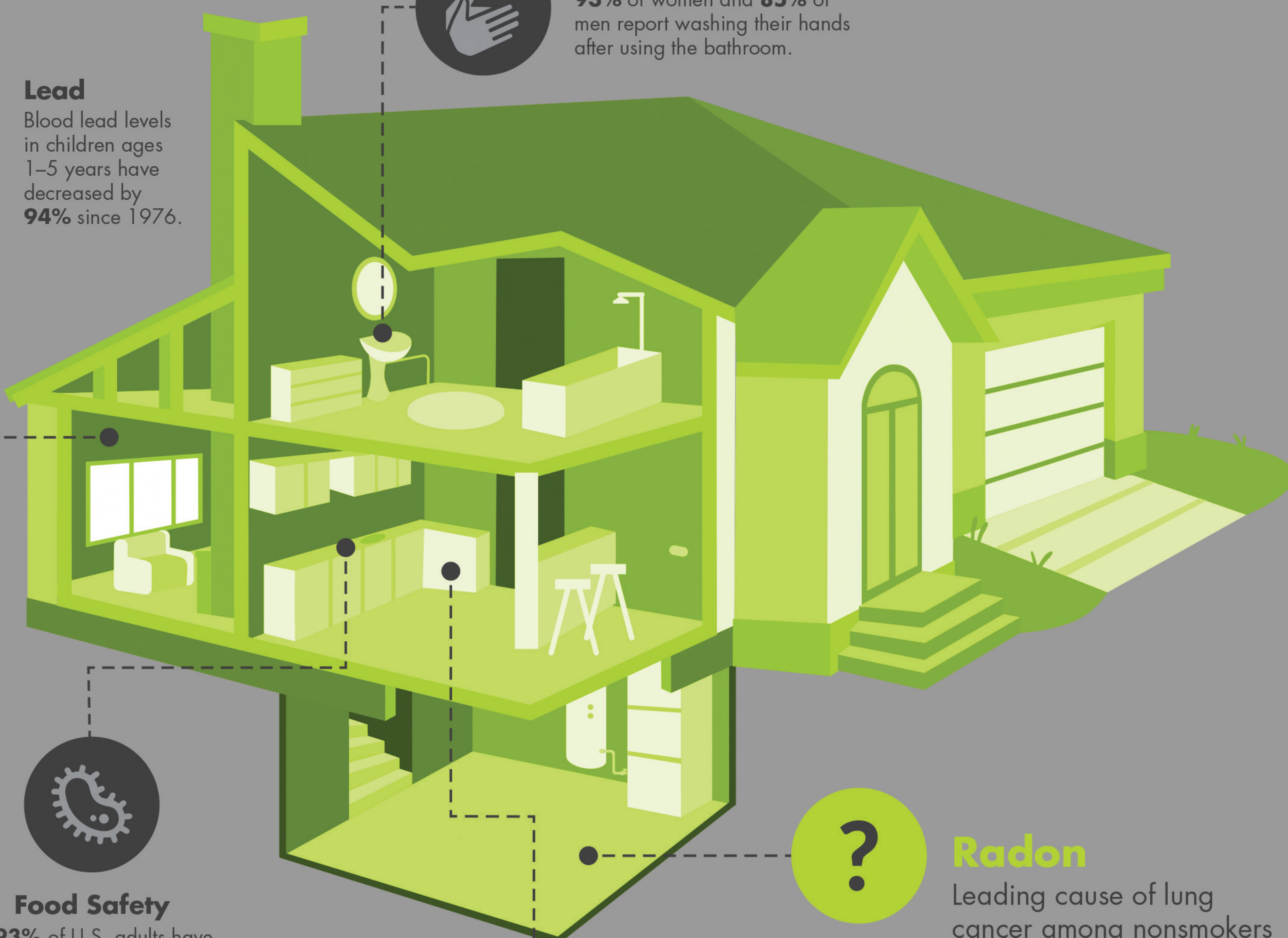
Volume 82, No. 3 October 2019

Home Hazards: Why Is Public Awareness of Radon Low?

Hand Washing
93% of women and **85%** of men report washing their hands after using the bathroom.

Pb

Lead
Blood lead levels in children ages 1–5 years have decreased by **94%** since 1976.



Food Safety
93% of U.S. adults have heard of *Salmonella* being a problem in food.

?

Radon
Leading cause of lung cancer among nonsmokers in the U.S.

In Utah
75% have never tested their homes for radon.
80% are unaware of radon's link to lung cancer.

Toxic Chemicals
Unintentional poisoning death rate for children ages 0–4 years has dropped by **65%** since 1981.

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ABOUT THE COVER

Hazards in the home present challenges to our health and safety. We are, however, aware of many of those hazards, such as the ones highlighted on this month's cover—lead, toxic chemicals, food contamination, and bacteria and viruses that cause sickness. Government regulations, policies, and standards, as well as personal habits and choices, help to reduce our exposure to these hazards. While we understand these hazards, why is public awareness of radon low? This month's cover article, "Public Awareness and Perceptions Surrounding Radon Testing," highlights a lack of public understanding of radon and calls for support to improve radon education, awareness, and testing.

See page 8.

Cover information sources: Centers for Disease Control and Prevention (National Health and Nutrition Examination Survey, Web-Based Injury Statistics Query and Reporting System), Statista, and All Portable Sinks.

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PRESIDENT'S MESSAGE

Priscilla Oliver, PhD

Environmental Health Leadership: Where Do We Go From Here?

All of us should help leaders to lead. There is a demand for good quality leadership all around us. Leadership affects us all as we are either leading and/or being led. It is the way of life. I submit that there are different kinds of leaders and we tolerate, overlook, or celebrate them. Perhaps you are leaning to be more involved with environmental health leadership to become a leader or a better leader.

There is a demand for good quality leadership all around us.

I feel compelled to discuss this topic as I begin my presidency. I have studied and taught leadership in graduate school and practiced leadership in social and educational settings, nonprofit organizations, and federal levels of government. It has been a delightfully rewarding long-term adventure. I am a student, professor, and practitioner of leadership.

First, we are taught that there isn't a single way to lead. There are numerous models (e.g., situational leadership), theories, and thoughts on leadership. The literature and quotes are massive and growing. Are leaders born or made? Some would argue they are born. You are born with traits and into some leadership positions. It is genetic and you build on that and leap or creep into it. Most would say that many of our leaders in environmental health are made.

I refer to the following quotes:

"Leaders are made, they are not born. They are made by hard effort, which is the price which all of us must pay to achieve any goal that is worthwhile," Vince Lombardi, football player, coach, and executive in the National Football League.

"Leadership is lifting a person's vision to high sights, the raising of a person's performance to a higher standard, the building of a personality beyond its normal limitations," Peter Drucker, management consultant, educator, and author.

Hard work is the price that you generally pay to become a leader in a specific area. For environmental health it means you get the education, degrees, training, credentials, and the varied exposure and work experiences to help you stand out in the pack. You mirror the background of other leaders and add more to what others have.

Every profession is engaged in recruiting, educating, training, counseling, developing, motivating, and planning for a better future. We learn best from each other and we also can learn from other professions. Medicine as a profession does a great job in screening, recruiting, training, and developing physicians to take on leadership roles in healthcare. The requirements and paths are well defined. There must be constant movement and nourishment of leaders and followers. Yes, leaders are followers just as followers are leaders. Succession planning in environmental health is also no exception and should be better handled.

This column is a call for quality environmental health leadership! With the threats on the environment, challenges surrounding our profession, politics against us, daily disasters, limits on funding, etc., we need better leaders and followers. Be a better follower to become a great leader. It takes time to reach the ultimate goal. Carry the torch well until it is time to pass the torch. Quality leadership allows leaders to develop and grow. There is also just so long that one can lead. Some have more time than others. Thus, the role of helping others to develop comes into play. Again, the reality of succession planning is also needed. We question, "Who will take the place of our current leaders?"

"You must wait for your turn," is often said. The plans and destiny are well laid. Leaders often know when it is their time to lead. You must know when to apply, run, produce, hold, and fold. Allow yourself the nourishing and growth that are needed. You must be able to withstand and be productive. No, you will not know all the answers. No one knows all the answers. Adversity and challenges often help us to grow.

Let us get ready for our future. One must develop the prerequisites of leaderships. The qualities of good leaders are many and not all are included here. I will mention a few. Leaders have vision, understand the mission of the organization, develop strategies, and exhibit passion toward the profession. They are professional and uphold and market the professionalism of environmental health. Commitment, creativity, innovation, purpose, and having a designed platform are in the fabric of a leader. Leaders know some history and are aware of the gossip and grapevine, too. Leaders are good speakers and writers. They inspire others to do their best and become a helpful member of the team. Working with them is not like work, instead it is a joy. The completed work is the measure of quality leadership, not the time spent as a leader. The spirit of leadership is overcoming, enchanting, and not easily measured in time.

Leaders, get ready for our future. Work to help yourself and remember others. Keep up your skills, attain new knowledge, and remember what was already learned. Knowledge often circles back in a new format and different name. Coordinate, collaborate, partner, and network to improve yourself and the profession. Do not be shy—express your ideas and work for the common good.

Let us sharpen up on some of the Ps and Bs. Thomas J. Sergiovanni has written about the Ten Principles of Leadership, which proposes a 10-P model of quality leadership—prerequisites, perspective, principles, platform, politics, purposing, planning, persisting, peopling, and patriotism (www.ascd.org/ASCD/pdf/journals/ed_lead/el_198202_sergiovanni.pdf). I would also add passion.

Be the example and model for others to follow. Be part of the buy-in. Be inclusive, not exclusive. Be labor law savvy and follow the proper procedures and rules. Be ethical and preserve your integrity. Be trustworthy. Be supportive of followers. Be present and attentive to the culture. Be a civil rights advocate and follow the procedures and rules with all staff. Again, be green, blue, and yellow. Be the recruiter of good people, resources, and funding. Be the change that is needed. Be a thoughtful servant leader. Be a good listener. Be yourself. Be a better you. Be relevant.

Another important quote to take note of is: "Leadership should be born out of the understanding of the needs of those who would be affected by it," Marian Anderson, singer.

As I finish my week of vacation in Galveston Island, Texas, I am reminded of the importance of plants, animals, land, air, water, and people. The order in which they all toil is very special. Birds respect leadership, flock together to make long and short trips, and take care of each other. The water and air continually replenish and remain useful to life. Ants and bees are so organized, builders of dwellings, and respect the order of leadership and work assignments. Trees and plants offer their support and just keep growing, offering us fresh air, beauty, and inspiration. People work and play daily. Nature teaches us so much, is a vital part of our profession, and gives us so many lessons on leadership.

Please join me in helping our profession with quality environmental health leadership. Our profession needs more student involvement, internships, expert training, progressive education, productive working conditions, advocacy, and inclusion for women and diverse groups. All of us should help leaders to lead. Let us lead and follow in environmental health with quality and understanding to ensure that we "Make America Green Again."

Priscilla

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Public Awareness and Perceptions Surrounding Radon Testing in a State With High Radon Emission Potential and Low Smoking Rates

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Abstract **Radon is the leading cause of lung cancer mortality among nonsmokers. Lung cancer leads cancer deaths in Utah, a state with <10% smokers and high radon emission potential. Understanding public awareness can help improve voluntary radon testing. The objective of this study was to identify patterns in radon awareness and testing in Utah. Utah's 2013 Behavioral Risk Factor Surveillance System included questions about radon awareness and testing. We examined differences by demographics and county (moderate versus high estimated radon, rural versus urban) using Rao–Scott chi-squared tests and logistic regression. In total, 75% of Utah residents never tested their home for radon and 80% could not identify radon as a risk factor for lung cancer. Of nontesters, 40% were unaware of radon itself or testing. Testing was slightly more common in moderate radon counties (17%) than in the high radon counties (14%). Women, Hispanics, renters, persons with annual incomes <$50,000, and persons without college degrees generally did not test for radon. People 55 years or older and living in rural counties were the least likely to identify radon as a risk factor for lung cancer. Radon testing and meaningful awareness of radon's link to lung cancer are low in Utah. Support is needed to improve radon education, awareness, and testing throughout the state.**

Introduction

In the U.S., lung cancer is a major cause of cancer death and radon is the leading cause of lung cancer mortality among nonsmokers (Peterson et al., 2013). The lack of recommended lung cancer screenings for low and nonsmoking populations might contribute to late stage diagnosis and low survival rates for lung cancer patients who fall into these groups (Ellis & Vandermeer, 2011). Early detection of lung cancer in nonsmokers is not currently feasible; thus, preventing exposure to carcinogens should be a priority to reduce lung cancer mortality in low and nonsmoking populations. Utah has the lowest smoking rate in the U.S., with less than 10% of the Utah population estimated to be smokers (Centers for Disease Control and Prevention [CDC], 2019a). Yet lung cancer is still the leading cause of cancer-related mortality in the state (CDC, 2019a; Utah Department of Health, 2018). Due to the high proportion of nonsmokers in Utah, preventing radon exposure through testing could have a major impact on the state's lung cancer mortality.

Voluntary radon testing in homes is largely driven by knowledge about radon as a carcinogen, information seeking, and the perception that radon poses a threat to health (Davis et al., 2018; Kennedy, Probart, & Dorman, 1991). Meaningful understanding of radon as a health hazard, however, has been declining nationwide (Laflamme & VanDerslice, 2004) and low radon awareness is correlated with lower income, minority status, older age, rural residence, and lower educational attainment (Halpern & Warner, 1994). A survey of New York residents reported that 82% of residents were aware of radon but only 21% of participants knew that radon was a carcinogen. Those with a meaningful awareness, indicating an understanding that radon is linked to lung cancer, had more

TABLE **1**

Demographic Characteristics by Residence in High and Moderate Radon Counties, 2013 Utah Behavioral Risk Factor Surveillance System (BRFSS)

Characteristic	High Radon County (>4 pCi/L)		Moderate Radon County (2–4 pCi/L)		High Versus Moderate County *p*-Value
	#[a]	%[b]	#[a]	%[b]	
Sex					
Female	303	54.7	3,424	49.9	.15
Male	191	45.3	2,735	50.1	
Age (years)					
18–34	77	29.9	1,336	39.5	<.01
35–54	100	23.0	1,548	25.3	
55–99	316	47.1	3,218	35.3	
Race					
Non-White	20	7.1	429	12.5	0.05
White	474	92.9	5,730	87.5	
Hispanic					
No	468	90.9	5,698	86.7	<.001
Yes	20	8.6	417	12.5	
Refused	6	0.5	44	0.8	
Education					
<High school	35	18.0	280	10.0	<.01
High school graduate	176	31.6	1,574	24.5	
Some college/technical school	177	37.7	2,047	39.3	
College/technical school graduate	106	12.8	2,258	26.2	
Employment					
Employed	246	54.8	3,368	62.1	.02
Unemployed	248	45.2	2,791	37.9	
Annual income					
<$15,000	50	12.1	377	6.6	<.01
$15,000–<$25,000	74	13.3	731	12.0	
$25,000–<$35,000	59	14.1	538	9.3	
$35,000–<$50,000	77	15.8	811	13.0	
≥$50,000	182	36.0	2,915	45.6	
Missing	52	8.8	787	13.5	

continued on page 10

education than those without a meaningful awareness (Wang, Ju, Stark, & Teresi, 2000). In Minnesota, where 25% of the sample reportedtesting for radon, testing in homes was more common among those with higher incomes and educational attainment (Nissen, Leach, Nissen, Swenson, & Kehn, 2012).

Radon awareness and testing practices in Western states with large rural populations, such as Utah, are understudied, even though these states have high radon emission potential (U.S. Environmental Protection Agency [U.S. EPA], 2019a). One assessment in Montana reported that 32% of homes have radon levels above the safe health standard of 4 pCi/L (Hill, Butterfield, & Larsson, 2006), which is comparable to Utah where an estimated 30% of homes have radon >4 pCi/L (Leonard, 2011). Rural Montanans severely underestimated the seriousness of radon exposure, with 52% unsure whether radon causes health problems. Similarly, in a small Utah survey, only 22% of participants could link radon exposure to lung cancer and only 8.6% had tested for radon in their homes (Akerley et al., 2011).

A radon level of 4 pCi/L in indoor air is recognized by multiple health agencies as harmful (CDC, 2019b; U.S. EPA, 2019b; World Health Organization [WHO], 2009). All of Utah's soils have the potential to emit moderate (2–4 pCi/L) to high (>4 pCi/L) levels of radon (Utah Department of Health, 2015; Utah Division of State History, 2018; Utah Geological Survey, n.d.), but the state does not mandate radon testing in homes or public spaces (Geltman, 2016). Identifying which populations are less aware of radon and its risks could aid in the development of targeted interventions to improve voluntary testing rates. At a national level, women, racial/ethnic minorities, less educated populations, and lower-income households tend to be the most uninformed about radon. Whether these trends will hold true in Western states with large rural populations, such as Utah, is unclear (Halpern & Warner, 1994).

State-specific assessments give valuable insight into specific populations and provide additional detail about awareness of radon and current radon testing practices in homes (Utah Department of Health, 2015). This state-specific evaluation of radon awareness and testing presents and assesses data collected through the Utah Behavioral Risk Factor Surveillance System (BRFSS). We identify disparities in radon awareness and testing practices by county, focusing on differences between counties with moderate and high radon emission potentials. In our state-specific analysis, it was possible to assess demographic differences by radon emission potential and to examine disparities in knowledge about testing radon in the context of these demographic and geological factors.

Methods

Datasets and Participants

Utah's 2013 BRFSS data are part of the Centers for Disease Control and Prevention's BRFSS system (Utah Department of Health, 2019), a complex population-based telephone survey that collects health data on a variety of health factors for U.S. residents ≥18 years. BRFSS uses random-digit telephone dialing methods to sample more than 400,000 noninstitutionalized adults each year. BRFSS contains core questions addressing demographic characteristics, health-related behaviors, disease prevalence, and optional modules to be included at a state's discretion.

As inclusion of the radon module is optional, the 2013 BRFSS is the most recent survey available that includes information about radon. The radon module was distributed to a subset of 2013 BRFSS respondents whose responses can be extrapolated to the general population using weights and strata provided by BRFSS. The design, sample characteristics, and surveys are available at www.cdc.gov/brfss and through the Utah Department of Health (2019).

TABLE **1** continued from page 9

Demographic Characteristics by Residence in High and Moderate Radon Counties, 2013 Utah Behavioral Risk Factor Surveillance System (BRFSS)

Characteristic	High Radon County (>4 pCi/L)		Moderate Radon County (2–4 pCi/L)		High Versus Moderate County *p*-Value
	#[a]	%[b]	#[a]	%[b]	
Home ownership					
Own	403	80.3	4,700	71.4	<.01
Rent	79	17.6	1,180	23.0	
Other	12	2.1	279	5.6	
Rural/urban ZIP code					
Rural	432	88.6	416	5.4	<.01
Urban	49	11.4	5,492	94.6	
Smoking status					
Current or former smoker	178	38.2	1,602	26.4	<.01
Current smoker[c]	60	39.8	503	36.3	
Never smoked	306	60.2	4,413	71.1	
Don't know/refused	10	1.6	144	2.5	

Note. Significant at $p \leq .05$.
[a]Raw frequencies presented.
[b]Percent weighted according to BRFSS-provided strata and weighting schema.
[c]Indicates a subset of current or former smokers, includes smoking every day and some days.

Radon Testing and Knowledge

The 2013 BRFSS radon module included questions on:

- **Radon testing:** Participants indicated if their house was tested for radon (yes, no, or never heard of radon/don't know). We grouped responses as either yes or no/never heard of radon/don't know.
- **Identifying lung cancer as an outcome of radon:** Participants were asked what health condition was associated with radon. They could select from 10 options. We indicated if answers were identified, not identified, or don't know/unsure.
- **Reason for not testing the home:** If testing was not carried out, participants could choose 1 of 20 reasons. We aggregated the reasons into five categories:
  1. not aware of radon or testing (don't know what radon is, don't know where to get test, don't know how testing is done/how test works, haven't thought about it);
  2. cost;
  3. not recommended or needed (not at risk/not needed, house tested by previous owner, not recommended);
  4. problems with test or age of the house (too many other problems with house, house is new, house is old, test doesn't work); and
  5. personal reasons/other (don't want to know, too lazy, no time, planning to do it soon, don't own home/renting, other, don't know/not sure).

For category five, the responses were aggregated into two categories: unaware of testing and all other responses for the regression analysis. Refused responses were considered missing.

Demographics and Smoking

BRFSS core questions provided information on demographics, home ownership, and smoking. Questions included sex, age (18–34, 35–54, 55–99 years), race (White, non-White), ethnicity (Hispanic, non-Hispanic), educational attainment (<high school, high school, some college/technical school, college/technical school graduate), home ownership (own, rent, other), income (<$15,000, $15,000–<$25,000, $25,000–<$35,000, $35,000–<$50,000, ≥$50,000), employment status (employed, unemployed), interview language (English, Spanish), and smoking status (current or former smoker, never smoked, don't know/refused).

Radon County Classification and Rural/Urban ZIP Codes

All counties in Utah have either high or moderate radon emission potential. BRFSS core questions asked participants about their county and ZIP code of residence. Based on their responses, we classified respondents as residing in either a moderate or high radon county. We were unable to assign participants who refused to report a county.

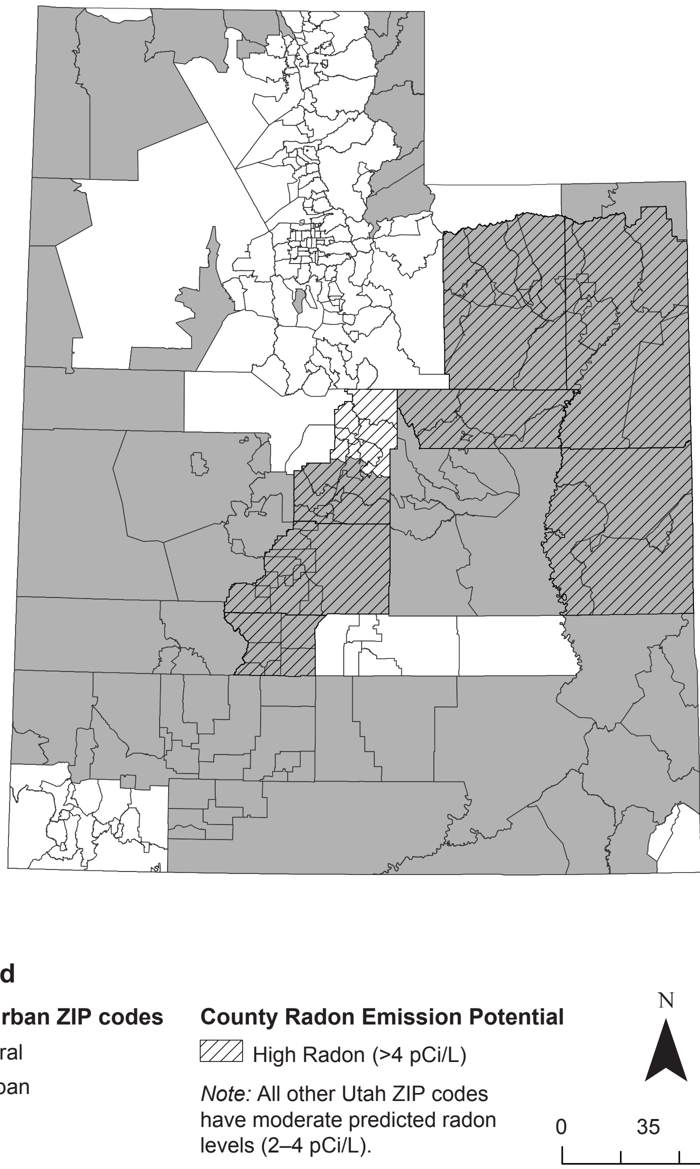
As we were also interested in rural/urban differences in radon awareness, we classified respondents as living in either a rural or urban area using ZIP codes based on rural/urban commuting (RUCA) codes (U.S. Department of Agriculture Economic Research Service, 2019). ZIP codes classified as any large rural, small rural, or isolated community were grouped together as rural.

Statistical Analysis

Descriptive analyses present the raw numbers and percentages weighted using the weights and strata supplied by BRFSS. Rao-Scott chi-

FIGURE **1**

County-Level Radon Emission Potential and ZIP Code-Level Rural/Urban Designation in Utah, 2013



squared tests and the appropriate stratification and weighting strategies were used to compare differences among counties. We assessed each radon outcome individually in sex- and age-adjusted logistic regression models. We also used logistic regression models to select variables for inclusion in the multivariable model. Variables that were significant at $p < .05$ were added to the multivariable model. The final multivariable model included variables that were significant and not correlated with each other. All models accounted for stratification and weighting strategies used in BRFSS. The University of Utah Institutional Review Board approved this study.

Results

Compared with moderate radon counties, high radon counties tended to have populations that were older, predominantly White, less educated, and more rural (Table 1). Only 9.9% of Utahns were current smokers, with significantly more current smokers living in high radon counties than in moderate radon counties. High radon counties largely overlapped with rural ZIP codes. The location of moderate and high radon counties with regard to rural and urban ZIP codes in Utah are shown in Figure 1.

Only 17% of Utahns reported ever testing their homes for radon (Table 2). There were no significant differences in testing between moderate and high radon counties ($p = .54$). Of people who reported testing for radon in their homes, more homes in moderate radon counties had high radon levels (>4 pCi/L) than homes in high radon counties. People in high radon counties, however, more frequently recalled the radon level from their home test. Lung cancer was identified as an outcome of radon exposure by only 21.9% of respondents, with no significant differences between moderate and high radon counties ($p = .23$). Nearly 40% of Utahns were unaware of radon testing, with no differences between moderate and high radon counties ($p = .16$). Of Utahns who were unaware of testing, 25% did not know what radon was and 65% had never thought about testing. Cost was reported as a barrier to testing more frequently in high radon counties than in moderate radon counties.

Results from sex- and age-adjusted models are summarized in Table 3. Women, respondents 35–54 years, those with less education, and renters were less likely to report carrying out radon testing in their homes. We found no significant differences in likelihood of testing for radon between moderate and high radon counties. Rural residents had a lower odds ratio of testing for radon than urban dwellers; however, this association was not significant. The odds of identifying lung cancer as an outcome of radon exposure increased with age >35 years, higher educational attainment, and higher income. Hispanic ethnicity, renting, and residence in a rural area were inversely associated with identification of lung cancer as an outcome of radon exposure. Women and respondents 35–54 years were the least likely to know about radon testing.

The multivariable model also identified women, those with less education, and renters as being least likely to carry out radon testing (Table 4). Women, those with less education,

TABLE **2**

Radon Testing and Awareness by Residence in High and Moderate Radon Counties, 2013 Utah Behavioral Risk Factor Surveillance System (BRFSS)

	All Counties		High Radon County (>4 pCi/L)		Moderate Radon County (2–4 pCi/L)		High Versus Moderate Radon County *p*-Value
	#[a]	%[b]	#[a]	%[b]	#[a]	%[b]	
Total	6,020		494		6,159		
Ever had home tested							
No	4,595	74.6	375	77.6	4,125	74.4	.54
Yes	1,071	17.0	55	13.9	1,005	17.2	
If tested, home tested high for radon (>4 pCi/L)							
Yes	101	8.1	3	4.5	98	8.4	
No	809	75.2	36	67.7	764	75.7	
Don't know	161	16.6	16	27.8	143	15.9	
Never heard of radon/don't know	354	8.4	22	8.4	323	8.4	
Identified radon as lung cancer risk							
Identified	1,352	21.9	84	17.2	1,252	22.2	.23
Not identified	1,036	20.5	74	20.8	943	20.6	
Don't know/unsure	3,613	57.4	294	62.0	3,239	57.2	
If home was not tested, reason home not tested (*N* = 4,593)							
Unaware of testing	1,800	39.9	152	39.1	1,607	40.0	.16
Don't know what radon is	349	25.1	25	24.6	316	25.2	
Don't know where to get test	94	4.4	10	5.3	79	4.3	
Haven't thought about it	1,262	65.4	111	65.8	1,125	65.3	
Don't know how testing is done/works	95	5.2	6	4.3	87	5.2	
Not recommended or needed	719	13.1	56	14.3	648	13.0	
Cost	175	4.0	16	7.4	157	3.8	
Problems with test or age of house	294	6.6	27	8.2	261	6.5	
Personal reasons/other	1,605	36.4	124	31.1	1,450	36.7	

Note. Some respondents did not report their county of residence and could not be categorized into high or moderate counties.
[a]Raw frequencies presented.
[b]Percent weighted according to BRFSS-provided strata and weighting schema.

and renters were also less likely to identify lung cancer as a health effect of radon as their respective reference groups. Compared with urban residents, rural residents were less likely both to test for radon and to identify radon as a risk factor for lung cancer; however, this association was not significant. In the multivariable model, awareness of radon testing remained lowest for women and respondents 35–54 years.

Discussion

Improving radon awareness and testing in Utah is of great importance as 75% of Utahns have never tested their homes for radon even though a large number of Utah counties are at risk for unsafe radon emissions. Further emphasizing the need for improvements in testing, we found that a lower percentage of respondents living in high radon counties tested for radon than residents of moderate radon counties. Residents of high radon counties also tended to have characteristics associated with decreased likelihood of testing for radon observed in both this and prior assessments, including less education, older age, and residence in a rural area (Halpern & Warner, 1994; Hill et al., 2006).

Voluntary radon testing is dependent on public awareness of radon and the health risks associated with its exposure (Davis et al., 2018; Kennedy et al., 1991). The general public, however, tends to underestimate the impact of radon exposure on lung cancer, which may deter widespread testing (Field, Kross, & Vust, 1993; Johnson & Luken, 1987). Utah is no exception as we found that 78% of Utahns do not know that radon is linked to lung cancer. Of these, 21% think that radon is not a risk factor for lung cancer and 57% report that they don't know if radon

TABLE **3**

Odds Ratios for the Associations Between Demographic Characteristics and Radon Outcomes Adjusted for Sex and Age, 2013 Utah Behavioral Risk Factor Surveillance System

Characteristic	Tested for Radon	Identify Radon as Lung Cancer Risk Factor	Unaware of Testing
	OR (95% *CI*)	*OR* (95% *CI*)	*OR* (95% *CI*)
Sex[a]			
Male (reference)	1	1	1
Female	**0.81** (0.68, 0.96)	0.68 (0.58, 0.79)	**1.46** (1.24, 1.71)
Age (years)[a]			
18–34 (reference)	1	1	1
35–54	**1.37** (1.07, 1.74)	**1.36** (1.10, 1.68)	**1.43** (1.15, 1.77)
55–99	1.19 (0.96, 1.48)	**1.25** (1.03, 1.52)	0.92 (0.76, 1.12)
Race			
White	1	1	1
Non-White	1.04 (0.73, 1.49)	**0.52** (0.36, 0.76)	1.23 (0.89, 1.69)
Hispanic			
No	1	1	1
Yes	0.84 (0.58, 1.21)	**0.57** (0.40, 0.81)	1.22 (0.90, 1.68)
Interview language			
English	1	1	1
Spanish	0.48 (0.22, 1.05)	**0.03** (0.01, 0.18)	1.26 (0.67, 2.39)
Education			
College/technical school graduate	1	1	1
Some college/technical school	**0.62** (0.51, 0.75)	**0.68** (0.57, 0.80)	0.99 (0.83, 1.19)
High school	**0.60** (0.47, 0.75)	**0.47** (0.38, 0.58)	1.14 (0.94, 1.39)
<High school	**0.45** (0.28, 0.72)	**0.10** (0.05, 0.20)	1.08 (0.74, 1.58)
Employment			
Employed	1	1	1
Unemployed	1.14 (0.94, 1.38)	0.87 (0.73, 1.05)	1.03 (0.87, 1.22)
Annual income			
<$15,000	1	1	1
$15,000–<$25,000	**1.80** (1.06, 3.05)	0.89 (0.56, 1.41)	1.20 (0.80, 1.80)
$25,000–<$35,000	1.39 (0.79, 2.43)	1.32 (0.81, 2.13)	1.40 (0.92, 2.13)
$35,000–<$50,000	1.27 (0.75, 2.15)	**1.55** (1.00, 2.40)[b]	0.94 (0.64, 1.40)
≥$50,000	**1.84** (1.15, 2.95)	**2.31** (1.57, 3.41)	1.04 (0.73, 1.49)

continued on page 14

is associated with a health effect. With 40% of Utahns reporting that they do not know about radon testing or how testing works, voluntary radon testing in Utah is accordingly low, with 17% of the state's population having ever tested for radon.

Although not directly comparable, these results are similar to assessments of radon awareness in the neighboring state of Montana; previous assessments of awareness and testing in New York, Iowa, and Minnesota (Field et al., 1993; Hill et al., 2006; Nissen et al., 2012; Wang et al., 2000); and support the observation that general awareness of radon and knowledge about radon's impact on cancer is eroding nationwide (Laflamme & VanDerslice, 2004). A small survey of Utahns identified that perceptions of radon as a health risk, self-efficacy, and knowledge about radon had significant associations with voluntary radon testing (Davis et al., 2018). Our findings suggest that a minority of Utah's population have the correct perceptions of and necessary knowledge about radon to trigger participation in voluntary radon testing. Similar to previous studies, this assessment found that Utahns who have the necessary information to take action tend to be White, non-Hispanic, have higher educational attainment (college graduates), and have higher incomes (Field et al., 1993; Hill et al., 2006; Nissen et al., 2012; Wang et al., 2000).

Even if homeowners do test for radon, the public's understanding may be so limited that radon testing might not result in mitigation due to incorrect interpretation of or failure to recall radon test results (Field et al., 1993). Of Utahns who tested for radon, 17% could not recall if the result of their radon test was >4 pCi/L. When stratified by county, nearly 30% of residents in high radon counties could not recall the result of their radon test result compared with 16% of residents who lived in moderate radon counties. As radon testing is less common and the recall of radon test results is worse in high radon than moderate radon counties, we suspect that the number of homes with radon >4 pCi/L in high radon counties might be underreported. Further, mitigation to reduce radon exposure is a voluntary practice dependent on the interpretation of radon test results. If homeowners cannot recall or interpret the radon test results, mitigation is not likely to occur. In a previous assessment in Iowa, less than 40% of participants whose homes tested >4 pCi/L planned on installing mitigation systems (Field et al., 1993).

Government-established guidelines and policies are key to improving radon awareness and testing through the provision of fiscal resources (Weinstein & Sandman, 1992). Utah law requires that the state maintain a public awareness/educational radon program (Geltman, 2016) but the legislation only mandates the development of a statewide electronic awareness campaign. Based on the results of this study, it does not appear that this policy alone is sufficient to promote meaningful radon awareness throughout the state, particularly among those with low incomes and less education. In addition, the policy's reliance on an electronic awareness campaign might not reach populations who do not speak English as their primary language and older populations who rarely use the Internet to gather information, preferring in-person communication (Chaudhuri, Le, White, Thompson, & Demiris, 2013).

Hispanic Utahns were significantly less likely to identify radon as a risk factor for lung cancer and generally were less aware about testing than non-Hispanic Utahns. As the Hispanic population in Utah has grown rapidly in the past decade and continues to expand (Utah Foundation, 2014), educating this population will consequently grow in importance. Older Utahns also were not likely to test their homes for radon or indicate awareness about radon testing. Electronic campaigns might not be reaching this population who also tends to live in rural areas (Utah Department of Workforce Services, 2017). Accordingly, we found that residents of rural counties were less likely than urban residents to identify radon as a lung carcinogen. Based on this assessment, policies that allocate resources for outreach to minority and rural populations will likely be needed to provide additional education to these groups.

Providing adequate funding to radon-focused programs could be one avenue to raise public awareness; improve testing for radon; and target low-resource, rural, and minority populations. Only 27 (42%) of 65 Comprehensive Cancer Control programs in the U.S. include activities to increase radon awareness or evaluate local radon policies (Neri, Stewart, & Angell, 2013). Currently, Utah's 2016–2022 Comprehensive Cancer Control Program includes a plan to establish a statewide radon surveillance program, provide radon awareness activities, and increase radon testing and subsequent mitigation (Utah Cancer Action Network, 2016). These activities largely are conducted through the Utah state radon program that specifically focuses on radon education and improving radon testing in the general public. Although it has been suggested that radon testing programs would be most cost-effective if targeted at smokers (Lantz, Mendez, & Philbert, 2013), this approach may not work because of the small population of smokers in Utah, estimated at less than 10% of the total population (CDC, 2019a). Considering the state's widespread potential for unsafe radon emissions (U.S. EPA, 2019a), a radon-focused public awareness and education campaign is needed to educate the state's large nonsmoking population. Radon programs that use multipronged methods (e.g., social and earned media, community-based projects, in-person education) to raise awareness, empower the public with a meaningful understanding of radon's influence on lung cancer, and explain the testing and mitigation process have proven effective in other contexts (Bain, Abbott, & Miller, 2016). Adequate funding of state radon programs and widespread adoption of these multipronged educational methods might produce the meaningful awareness needed to increase voluntary testing in Utah.

The home purchasing process is one potential avenue to introduce policies enforcing radon testing and disclosure of results. In 2014, the Utah Association of Realtors (UAR) voluntarily included radon on their "Buyer Due Diligence Checklist" provided to homebuyers (Utah Department of Health, 2015). UAR, however, carries no legal weight. Utah could benefit from policies that require people who sell their homes to contact an independent, licensed third-party (e.g., Utah Department of Environmental Quality) to test for and disclose the results of radon tests during the purchasing process (Bain et al., 2016). Sellers and realtors, however, might need to be educated regarding the influence of radon mitigation and testing on property values and sales. Similarly, long-term homeowners might need education to inform them about the benefits of radon testing to their health, as well as the impact on their property value. Without a financial transaction to enforce testing and mitigation, however, voluntary testing relies on the effectiveness of awareness/educational programs, as discussed previously.

Utah requires radon mitigators to be certified and that mitigation is carried out accord-

TABLE **3** continued from page 13

Odds Ratios for the Associations Between Demographic Characteristics and Radon Outcomes Adjusted for Sex and Age, 2013 Utah Behavioral Risk Factor Surveillance System

Characteristic	Tested for Radon	Identify Radon as Lung Cancer Risk Factor	Unaware of Testing
	OR (95% *CI*)	*OR* (95% *CI*)	*OR* (95% *CI*)
Home ownership			
Own	1	1	1
Other	0.88 (0.55, 1.40)	0.92 (0.59, 1.41)	**0.52** (0.32, 0.83)
Rent	**0.42** (0.31, 0.57)	**0.61** (0.49, 0.76)	0.89 (0.71, 1.11)
Current smoker			
No	1	1	1
Yes	1.04 (0.85, 1.28)	0.86 (0.72, 1.03)	1.07 (0.89, 1.27)
County radon level			
Moderate (2–4 pCi/L)	1	1	1
High (≥4 pCi/L)	0.79 (0.52, 1.19)	0.73 (0.53, 1.01)	0.96 (0.71, 1.30)
Rural/urban ZIP code			
Urban	1	1	1
Rural	0.75 (0.56, 1.01)	**0.78** (0.61, 1.00)[b]	0.95 (0.75, 1.19)

Note. Bolded values are significant at $p \leq .05$.
CI = confidence interval; *OR* = odds ratio.
[a]Estimates for sex and age were obtained separately.
[b]95% *CI* was rounded to nearest hundredth.

TABLE **4**

Odds Ratios for the Multivariable Associations Between Selected Demographic Characteristics and Radon Outcomes, 2013 Utah Behavioral Risk Factor Surveillance System

Characteristic	Tested for Radon	Identify Radon as Lung Cancer Risk Factor	Unaware of Testing
	OR (95% *CI*)	*OR* (95% *CI*)	*OR* (95% *CI*)
Sex			
Male	1	1	1
Female	**0.83** (0.69, 1.00)	**0.67** (0.57, 0.78)	**1.44** (1.23, 1.70)
Age (years)			
18–34	1	1	1
35–54	1.09 (0.84, 1.42)	1.21 (0.96, 1.52)	**1.37** (1.09, 1.73)
55–99	0.90 (0.71, 1.15)	1.11 (0.89, 1.37)	0.91 (0.74, 1.14)
Hispanic			
No	1	1	1
Yes	1.09 (0.74, 1.63)	0.82 (0.56, 1.20)	1.23 (0.88, 1.70)
Education			
College/technical school graduate	1	1	–
Some college/technical school	**0.62** (0.51, 0.76)	**0.68** (0.59, 0.82)	–
High school	**0.63** (0.50, 0.80)	**0.48** (0.38, 0.60)	–
<High school	**0.54** (0.34, 0.86)	**0.12** (0.06, 0.24)	–
Home ownership			
Own	1	1	1
Rent	**0.43** (0.32, 0.58)	**0.77** (0.61, 0.99)	0.89 (0.71, 1.13)
Other	0.92 (0.56, 1.49)	1.05 (0.68, 1.66)	0.53 (0.33, 0.87)
Rural/urban ZIP code			
Urban	1	1	1
Rural	0.79 (0.58, 1.06)	0.87 (0.68, 1.12)	0.94 (0.74, 1.18)

Note. Bolded values are significant at $p \leq .05$.
CI = confidence interval; *OR* = odds ratio.

ing to International Residential Code (IRC) standard; however, radon testing is not explicitly mentioned in any policy related to inspections or health codes enforced in public and private buildings (Geltman, 2016; Utah Department of Health, 2015). With respect to housing codes, the Utah Fit Premises Act mandates that landlords provide tenants with "safe [and] sanitary" rental housing and that landlords must "protect the…health and safety of…[renters]" (Utah Department of Health, 2015). The Fit Premises Act has been used to protect renters from other home-based health hazards and has also been applied to protecting employees from unsafe workplace contaminants (e.g., mold, lead, asbestos).

Despite a well-established scientific relationship between radon and lung cancer, and the establishment of a health standard for radon (Krewski et al., 2006; WHO, 2009), radon does not appear to have been interpreted as a safety hazard or a toxic substance under any Utah policies related to home safety or sanitation. Utah landlords are not required to test for radon, disclose radon levels to tenants, or mitigate rental properties for radon (Geltman, 2016). In this study, renters were significantly less likely to test their homes for radon or know about the link between radon and lung cancer. Interpreting radon as a safety hazard and toxic substance under policies such as the Fit Premises Act could provide the legal basis for including radon in other policies related to building safety. Further clarification about why radon has not previously been interpreted by state law as a safety or health hazard is needed.

New policies and partnerships could also provide incentives for radon-resistant new construction (RRNC) practices and radon mitigation. RRNC builds radon-resistant systems into homes using the same techniques as moisture control systems (U.S. EPA, 2019b). It is easier and more cost-effective to install radon reduction systems into homes under construction than to retrofit radon reduction systems in already built homes. The IRC discusses using RRNC techniques in high radon emission jurisdictions (U.S. EPA, 2019b). Although IRC construction codes are law in Utah, Utah does not require construction to comply with IRC radon control measures in high radon counties.

Cost was not a large barrier to testing, with only 4% of participants noting cost as a reason for not testing in our study. It is unclear if respondents were referring to the cost of the test itself or to the cost of mitigation, which is something that will need to be clarified in future surveys. If concerns about the cost of mitigation are the primary barrier, one potential solution is the development of partnerships with local banks to provide access to unsecured low-interest loans for radon mitigation. These partnerships have been successfully built in an Iowa-based assessment, leading to an increase in mitigation levels (Bain et al., 2016). Government grants for qualifying low-income populations could also provide an avenue to finance mitigation. State-based assistance to fund mitigation in low-income households has already been established in Colorado (Colorado Department of Public Health and Environment, 2019).

Limitations

The highest bracket of annual household income available to us for analysis was the ≥$50,000 category. Therefore, we could not stratify income any higher than $50,000. As such, we were unable to determine if persons at the highest income levels are driving the association between income and testing and furthermore, we could not group and assess households that fall above or below Utah's median income of $60,000 (Feinauer, 2015).

Conclusion

Radon is a carcinogen for which voluntary testing and meaningful awareness are low throughout Utah. Testing and awareness are particularly low among populations who are Hispanic, >55 years, rural, less educated, and of lower incomes. Few Utahns appear to have the information needed to spur voluntary testing for radon and few can recall the results of their radon tests. Policies supporting a multipronged approach to increase public awareness, education, and improve testing are needed, as well as policies that promote testing in public and private spaces.

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References

Akerley, W., Keyser, C., Edwards, S., Wilson, R., Van Duren, T., Akerley, D., . . . Sharry, S. (2011). Awareness of radon-associated health risks in Utah. *Utah's Health: An Annual Review, 16,* 58–60. Retrieved from https://collections.lib.utah.edu/details?id=1052339&q=*&page=1&rows=25&fd=title_t,setname_s,type_t&facet_setname_s=uu_uhr&facet_type_t=%27Text%27

Bain, A.A., Abbott, A.L., & Miller, L.L. (2016). Successes and challenges in implementation of radon control activities in Iowa, 2010–2015. *Preventing Chronic Disease*, *13*, E50.

Centers for Disease Control and Prevention. (2019a). *Current cigarette smoking among adults in the United States*. Retrieved from https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/

Centers for Disease Control and Prevention. (2019b). *Protect yourself and your family from radon*. Retrieved from https://www.cdc.gov/features/protect-home-radon/index.html

Chaudhuri, S., Le, T., White, C., Thompson, H., & Demiris, G. (2013). Examining health information-seeking behaviors of older adults. *Computers, Informatics, Nursing*, *31*(11), 547–553.

Colorado Department of Public Health & Environment. (2019). *Financial assistance to reduce radon in your home: CDPHE Low Income Radon Mitigation Assistance program*. Retrieved from https://www.colorado.gov/pacific/cdphe/low-income-radon-mitigation-assistance

Davis, S.F., Johnston, J.D., Magnusson, B.M., Novilla, M.L.B., Torgersen, B.K., Schnell, A.J., & Crandall, A. (2018). Predictors of radon testing among Utah residents using a theory-based approach. *Journal of Environmental Health*, *80*(6), 20–27.

Ellis, P.M., & Vandermeer, R. (2011). Delays in the diagnosis of lung cancer. *Journal of Thoracic Disease*, *3*(3), 183–188.

Feinauer, J.J. (2015, April 21). What it takes to be middle class in each state. *Deseret News*. Retrieved from https://www.deseretnews.com/top/3184/12/Utah-What-it-takes-to-be-middle-class-in-each-state.html

Field, R.W., Kross, B.C., & Vust, L.J. (1993). Radon testing behavior in a sample of individuals with high home radon screening measurements. *Risk Analysis*, *13*(4), 441–447.

Geltman, E.A.G. (2016). State radon laws: Utah. *The Policy Surveillance Program: A LawAtlas Project*. Retrieved from http://lawatlas.org/datasets/state-radon-laws

Halpern, M.T., & Warner, K.E. (1994). Radon risk perception and testing: Sociodemographic correlates. *Journal of Environmental Health*, *56*(7), 31–35.

Hill, W.G., Butterfield, P., & Larsson, L.S. (2006). Rural parents' perceptions of risks associated with their children's exposure to radon. *Public Health Nursing*, *23*(5), 392–399.

Johnson, F.R., & Luken, R.A. (1987). Radon risk information and voluntary protection: Evidence from a natural experiment. *Risk Analysis*, *7*(1), 97–107.

Kennedy, C.J., Probart, C.K., & Dorman, S.M. (1991). The relationship between radon knowledge, concern and behavior, and health values, health locus of control and preventive health behaviors. *Health Education Quarterly*, *18*(3), 319–329.

Krewski, D., Lubin, J.H., Zielinski, J.M., Alavanja, M., Catalan, V.S., Field, R.W., . . . Wilcox, H.B. (2006). A combined analysis of North American case-control studies of residential radon and lung cancer. *Journal of Toxicology and Environmental Health. Part A*, *69*(7), 533–597.

Laflamme, D.M., & VanDerslice, J.A. (2004). Using the Behavioral Risk Factor Surveillance System (BRFSS) for exposure tracking: Experiences from Washington state. *Environmental Health Perspectives*, *112*(14), 1428–1433.

Lantz, P.M., Mendez, D., & Philbert, M.A. (2013). Radon, smoking, and lung cancer: The need to refocus radon control policy. *American Journal of Public Health*, *103*(3), 443–447.

Leonard, W. (2011, December 6). 1 in 3 Utah homes has cancer-causing radon at potentially harmful levels. *KSL Broadcasting*. Retrieved from http://www.ksl.com/?nid=960&sid=18373214

Neri, A., Stewart, S.L., & Angell, W. (2013). Radon control activities for lung cancer prevention in national Comprehensive Cancer Control program plans, 2005–2011. *Preventing Chronic Disease*, *10*, E132.

Nissen, M.J., Leach, J.W., Nissen, J.A., Swenson, K.K., & Kehn, H. (2012). Radon testing and mitigation: An intervention in a primary care setting. *Journal of Cancer Education*, *27*(3), 566–572.

Peterson, E., Aker, A., Kim, J., Li, Y., Brand, K., & Copes, R. (2013). Lung cancer risk from radon in Ontario, Canada: How many lung cancers can we prevent? *Cancer Causes & Control*, *24*(11), 2013–2020.

U.S. Department of Agriculture Economic Research Service. (2019). *Rural–urban commuting area codes*. Retrieved from http://

References

www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx

U.S. Environmental Protection Agency. (2019a). *EPA map of radon zones*. Retrieved from https://www.epa.gov/radon/epa-map-radon-zones

U.S. Environmental Protection Agency. (2019b). *Publications about radon*. Retrieved from https://www.epa.gov/radon/publications-about-radon

Utah Cancer Action Network. (2016). *2016–2020 Utah comprehensive cancer prevention and control plan*. Retrieved from http://www.ucan.cc/wp-content/uploads/2015/12/State-Cancer-Plan-Revision-2.pdf

Utah Department of Health. (2015). *Radon in Utah*. Retrieved from http://www.health.utah.gov/enviroepi/healthyhomes/epht/Radon_in_Utah.pdf

Utah Department of Health. (2018). *Complete health indicator report of lung cancer deaths*. Retrieved from https://ibis.health.utah.gov/indicator/complete_profile/LungCADth.html

Utah Department of Health. (2019). *Office of Public Health Assessment: Utah Behavioral Risk Factor Surveillance System (BRFSS)*. Retrieved from http://health.utah.gov/opha/OPHA_BRFSS.htm

Utah Department of Workforce Services. (2017). 2017 *state of rural Utah: Current analysis and long-term trends*. Retrieved from http://www.ruralplanning.org/assets/soru-report.pdf

Utah Division of State History. (2018). Utah History to Go: Utah's uranium boom [Blog post]. Retrieved from https://historytogo.utah.gov/utahs-uranium-boom/

Utah Foundation. (2014). *A snapshot of 2050: An analysis of projected population change in Utah*. Salt Lake City, UT: Author. Retrieved from http://www.utahfoundation.org/uploads/rr720.pdf

Utah Geological Survey. (n.d.). *Geologic hazards: Radon gas hazards*. Retrieved from https://geology.utah.gov/hazards/problem-soils/radon

Wang, Y., Ju, C., Stark, A.D., & Teresi, N. (2000). Radon awareness, testing, and remediation survey among New York State residents. *Health Physics*, *78*(6), 641–647.

Weinstein, N.D., & Sandman, P.M. (1992). Predicting homeowners' mitigation responses to radon test data. *Journal of Social Issues*, *48*(4), 63–83.

World Health Organization. (2009). *WHO handbook on indoor radon: A public health perspective*. Geneva, Switzerland: Author. Retrieved from https://www.who.int/ionizing_radiation/env/9789241547673/en/

Geographic Analysis of Blood Lead Levels and Neighborhood-Level Risk Factors Among Children Born in 2008–2010

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Abstract **Childhood lead exposure remains a public health concern, as it can lower a child's intelligence quotient and cause permanent neurological damage. The objective of this study was to identify census tracts with the highest risk for blood lead levels (BLLs) ≥5 µg/dL in Philadelphia, Pennsylvania. We analyzed BLLs among children born in 2008–2010 who had at least one venous BLL test. A multivariable mixed effects logistic regression model was used to create risk scores and estimate adjusted odds ratios (*OR*) for BLLs ≥5 µg/dL and census tract-level characteristics, including median age of housing, percent of Black residents, vacant properties, rental properties, adults living in poverty, and adults with a high school education. Of 49,246 children, 14.37% had more than one BLL ≥5 µg/dL. Census tracts with a higher percentage of pre-1950 housing (*OR* = 1.82, 95% confidence interval [*CI*] [1.63, 2.04]), Black residents (*OR* = 3.22, 95% *CI* [2.70, 3.84]), vacant properties (*OR* = 1.45, 95% *CI* [1.23, 1.72]), and poverty (*OR* = 1.49, 95% *CI* [1.18, 1.89]) were associated with the highest risk. The mean risk score was 0.12 (range: 0.02–0.35). Our findings show that risk scores can help target prevention activities.**

Introduction

Childhood lead exposure remains a widespread, yet preventable public health problem despite community-level interventions (Campbell et al., 2013; Raymond & Brown, 2017; Rogers et al., 2014). The Advisory Committee on Childhood Lead Poisoning Prevention (2012) recognized that no level of lead exposure is safe. For a point of clinical reference, however, the Centers for Disease Control and Prevention (CDC) established the reference range for an elevated blood lead level (BLL) in children to be ≥5 µg/dL (CDC, 2015). It is well documented that lead exposure in children, even at BLL concentrations <5 µg/dL, can result in adverse health outcomes such as learning disabilities, lowered intelligence quotient, permanent neurological damage, and behavioral problems such as attention deficit hyperactivity disorder (Lanphear et al., 2005; Needleman, Schell, Bellinger, Leviton, & Allred, 1990; Nigg, Nikolas, Knottnerus, Cavanagh, & Friderici, 2010; Raymond & Brown, 2017).

As a result of more stringent government policy, the severity and scope of the problem has significantly decreased in recent decades in the U.S. (Bridbord & Hanson, 2009). In the late 1970s, the national average BLL of children 1–5 years was 15 µg/dL, while in 2010, it had declined to 1.3 µg/dL (CDC, 2013). In Philadelphia, lead elevation has declined significantly since the early 2000s; however, the percentage of children with a newly identified elevated BLL remained stable from 2011 through 2015 (Philadelphia Department of Public Health [PDPH], 2017).

Lead-based paint and its dust in pre-1950 housing are known to be the most common sources of lead exposure in homes (Chandran & Cataldo, 2010). Other sources of lead exposure include contaminated soil, food, water, jewelry, toys, and folk medicine (Chandran & Cataldo, 2010). Pre-1950 housing, poverty, education, and race have been consistently reported in previous studies as common risk factors (Akkus & Ozdenerol, 2014; Brown & Longoria, 2010; Jones et al., 2009).

The use of GIS has become a valuable tool in identifying areas with high rates of elevated BLLs, assessing geographical risk factors, and monitoring screening rates. Although other studies have addressed community-level risk factors for BLLs ≥10 µg/dL (the recommended reference range prior to 2012), a large-scale risk factor analysis has not been carried out recently in Philadelphia (Akkus & Ozdenerol, 2014).

We conducted a census tract-level analysis of elevated BLLs in children in Phila-

TABLE 1

Total Number of Children in Each Birth Cohort and Distribution of Blood Lead Levels (BLLs) (*N* = 49,246)

	# (%)
Birth cohorts	
2008	16,876 (34.27)
2009	16,518 (33.54)
2010	15,852 (32.19)
BLLs	
<5 µg/dL	42,171 (85.63)
≥5 µg/dL	7,075 (14.37)
5–9 µg/dL	5,583 (78.91)
>10 µg/dL	1,492 (21.09)
Mean ± *SD* of maximum BLL	2.2 ± 3.50 µg/dL
Mean ± *SD* of maximum BLL among those ≥5 µg/dL	8.35 ± 5.35 µg/dL
Children tested per census tract	
Mean	130
Minimum	1
Maximum	487

delphia to 1) determine the associations of community-level housing characteristics and socioeconomic status as risk factors and 2) develop a risk score for each census tract. This study will contribute to the literature from the perspective of a large urban environment with high poverty and old housing by using 5 µg/dL to define lead elevation. The results can help guide public health officials to judiciously allocate resources in urban areas with a high prevalence of risk factors.

Methods

Blood Lead Level Data and Study Population

In Pennsylvania, all BLL test results for children <16 years, regardless of the test result, are reported to the Pennsylvania Department of Health through the state's National Electronic Disease Surveillance System. The Philadelphia Department of Public Health (PDPH) uses these data to conduct surveillance in Philadelphia to identify children with lead elevation and assess the trends and screening rates over time. Each BLL test result includes the child's name, an identification number specific to each child, home address, contact information, specimen collection date, BLL in µg/dL, and blood specimen source (i.e., venous, capillary, or unknown).

Our study population consisted of a cohort of children born in 2008, 2009, and 2010 who had a Philadelphia home address and at least one previous venous BLL test. We excluded from our analysis children with only capillary and unknown specimen sources due to the increased likelihood of false positives (Parsons, Reilly, & Esernio-Jenssen, 1997). Children with at least one BLL ≥5 µg/dL were classified as having lead elevation. Children with all test results <5 µg/dL were classified as having no lead elevation.

To determine how representative the study sample was of the total birth cohort population, we calculated the total number of children in each birth cohort using birth certificates and then divided the sample population by the total birth cohort population.

Census Tract Characteristics

Census tracts were used to represent geographic areas throughout Philadelphia. The U.S. Census Bureau conducts the American Community Survey (ACS) annually to collect a wide range of information including, but not limited to, household demographics, occupations, and education levels. Data from the 2011–2015 ACS 5-year estimates were extracted for each Philadelphia census tract (U.S. Census Bureau 2015a, b, c, d, e).

The covariates selected for the model were based on findings of previous studies on risk factors of elevated BLLs in children (Akkus & Ozdenerol, 2014). Census tract parameters included median age of housing, percent of housing units that were rental properties, percent of properties that were vacant, percent of people ≥25 years with a high school diploma, percent of people living below the poverty line, and percent of Black residents. Census tract-level median age of housing was categorized as either before or after 1950. Pre-1950 housing and vacant properties were intended to capture potential exposure to lead-based paint in the home and indicators of overall housing quality. For all covariates, the continuous variables (i.e., percentages) were categorized into quartiles.

Geocoding and Data Selection

Each child's home address was geocoded and assigned to its respective census tract. Children were excluded from the analysis if their addresses were missing or unable to be geocoded. Only census tracts with at least one child tested were included. The geocoded dataset of individual children was merged with the aggregate census tract-level data from ACS based on census tract number.

Statistical Analyses

Pearson's chi-square tests and mixed effects logistic regression models were used to assess bivariate associations between individual covariates and binary outcome of lead elevation. We used a mixed effects multivariable logistic regression based on census tract characteristics to estimate adjusted associations between covariates and the binary outcome of lead elevation. The models included random intercepts for census tracts to model differences between census tracts not explained by the covariates. The threshold for statistical significance was set at .05.

We used cross validation to assess the predictive ability of the model and the robustness of our model selection choice. Predictions for each cohort were generated using a model fit to the other cohorts. The mean squared prediction error was calculated for each cohort as an estimate of the out-of-cohort prediction error for our model.

To determine which census tracts have the highest likelihood of having BLLs ≥5 µg/dL based on the six selected risk factors, the predicted probabilities from the logistic regression model were used to produce risk scores for each census tract. We used SAS version 9.3 for the analyses and ArcGIS10 to create maps to display the predicted risk for each census tract. The PDPH institutional review board approved this study and waived informed consent because we used previously collected surveillance data.

Results

Among the 70,213 children born in 2008, 2009, or 2010, 50,854 (72.43%) had at least one venous sample drawn to test for lead between January 1, 2008–December 31, 2015. Of those, 49,246 (96.84%) had address information that could be geocoded and were thus included in the final analysis dataset. Of the 384 census tracts in Philadelphia, 377 (98.18%) were included in the analysis and 7 were excluded because no resident children were tested. Of the children tested, 7,075 (14.37%) had a measured BLL ≥5 µg/dL at least once before they turned 6 years (Table 1). The average number of children tested per census tract was 130 children (range: 1–487).

Results of Pearson's chi-square tests show significant differences between children with lead elevation and children without lead elevation with respect to census tract-level covariates. Among children with lead elevation, 84.20% lived in census tracts with pre-1950 median age of housing compared with 67.59% of children without lead elevation ($p < .0001$). Among children with lead elevation, 44.23% lived in census tracts in the highest quartile for percent poverty compared with 33.30% of children without lead elevation ($p < .0001$). Among children with lead elevation, 45.30% lived in census tracts in the highest quartile for percent of vacant properties compared with 28.02% of children without lead elevation ($p < .0001$). Similarly, a larger proportion of children with lead elevation lived in census tracts in the highest quartile of percent of Black residents compared with children without lead elevation (47.31% versus 28.33%, respectively, $p < .0001$) (Table 2).

In the mixed effects logistic regression analyses adjusted only for census tract-level random effects, the six covariates were each independently associated with lead elevation (Table 3). After controlling for other covariates in the multivariable mixed effects logistic regression model, pre-1950 census-tract median age of housing (odds ratio [*OR*] = 1.82, 95% confidence interval [*CI*] [1.63, 2.04]), poverty (*OR* comparing highest quartile with lowest quartile = 1.49, 95% *CI* [1.18, 1.89]), vacant properties (*OR* = 1.45, 95% *CI* [1.22, 1.72]), and Black race (*OR* = 3.22, 95% *CI* [2.70, 3.84]) were significantly associated with lead elevation.

Children living in census tracts in the lowest quartile of high school completion rates had increased risk of lead elevation as compared

TABLE **2**

Frequencies of Census Tract-Level Risk Factors in Quartiles Among Individual Children by Lead Elevation Status

Risk Factor	No Lead Elevation (<5 µg/dL) # (%)	Lead Elevation ≥5 µg/dL # (%)	*p*-Value*
Median age of housing			
Pre-1950	28,504 (67.59)	5,957 (84.20)	**<.0001**
Post-1950	13,667 (32.41)	1,118 (15.80)	
Below the poverty line (%)			
≤13.23	5,565 (13.20)	262 (3.70)	**<.0001**
13.24–24.91	9,609 (22.79)	1,029 (14.54)	
24.92–37.12	12,955 (30.72)	2,645 (37.39)	
>37.12	14,042 (33.30)	3,139 (44.23)	
Vacant properties (%)			
≤7.84	8,090 (19.18)	620 (8.76)	**<.0001**
7.85–11.65	10,914 (25.88)	1,218 (17.22)	
11.66–17.79	11,352 (26.92)	2,032 (28.72)	
>17.79	11,815 (28.02)	3,205 (45.30)	
High school diploma (%)			
≤75.40	17,059 (40.45)	3,212 (45.40)	**<.0001**
75.41–83.70	11,427 (27.10)	2,284 (32.28)	
83.71–90.10	8,910 (21.13)	1,168 (16.51)	
>90.10	4,775 (11.32)	411 (5.81)	
Black race (%)			
≤10.00	7,083 (16.80)	386 (5.46)	**<.0001**
10.01–32.00	11,332 (26.87)	1,219 (17.23)	
32.01–82.30	11,811 (28.01)	2,123 (30.01)	
>82.30	11,945 (28.33)	3,347 (47.31)	
Rental properties (%)			
≤35.40	8,861 (21.01)	973 (13.75)	**<.0001**
35.41–47.60	11,672 (27.68)	1,777 (25.12)	
47.61–60.80	13,551 (32.13)	2,782 (39.32)	
>60.80	8,087 (19.18)	1,543 (21.81)	

Note. Numbers in bold are statistically significant.
*Pearson's chi-square test.

TABLE **3**

Associations Between Quartiles of Census Tract-Level Risk Factors and Lead Elevation (Blood Lead Level ≥5 µg/dL)

Risk Factor	Unadjusted *OR* (95% *CI*)[a]	Adjusted *OR* (95% *CI*)[a]	*p*-Value[b]
Median age of housing			
Pre-1950	2.89 (2.45, 3.42)	1.82 (1.63, 2.04)	**<.0001**
Post-1950	Reference	Reference	–
Below poverty line (%)			
≤13.23	Reference	Reference	–
13.24–24.91	2.00 (1.58, 2.53)	1.16 (0.95, 1.41)	.1394
24.92–37.12	4.10 (3.26, 5.14)	1.42 (1.14, 1.77)	**.0016**
>37.12	4.96 (3.95, 6.23)	1.49 (1.18, 1.89)	**.0009**
Vacant properties (%)			
≤7.84	Reference	Reference	–
7.85–11.65	1.54 (1.24, 1.93)	1.17 (1.00, 1.37)	**.0440**
11.66–17.79	2.48 (2.00, 3.08)	1.24 (1.06, 1.45)	**.0078**
>17.79	4.37 (3.54, 5.40)	1.45 (1.23, 1.72)	**<.0001**
High school diploma (%)			
≤75.40	2.83 (2.18, 3.68)	1.23 (1.03, 1.48)	**.0258**
75.41–83.70	2.49 (1.91, 3.24)	1.09 (0.91, 1.30)	.3368
83.71–90.10	1.39 (1.06, 1.82)	0.96 (0.80, 1.14)	.6062
>90.10	Reference	Reference	–
Black race (%)			
≤10.00	Reference	Reference	–
10.01–32.00	1.99 (1.61, 2.45)	1.48 (1.24, 1.77)	**<.0001**
32.01–82.30	3.63 (2.97, 4.44)	2.31 (1.94, 2.75)	**<.0001**
>82.30	5.96 (4.89, 7.25)	3.22 (2.70, 3.84)	**<.0001**
Rental properties (%)			
≤35.40	Reference	Reference	–
35.41–47.60	1.54 (1.20, 1.99)	1.08 (0.93, 1.25)	.3049
47.61–60.80	2.37 (1.85, 3.04)	1.11 (0.95, 1.29)	.1877
>60.80	1.87 (1.45, 2.43)	1.13 (0.96, 1.33)	.1575

Note. Numbers in bold are statistically significant.
CI = confidence interval; *OR* = odds ratio.
[a]Blood lead level <5 µg/dL used as comparison group.
[b]Adjusted multivariate mixed effects logistic regression model.

with the highest quartile, but with a smaller estimated magnitude of effect (*OR* = 1.23, 95% *CI* [1.03, 1.48]) than the previously discussed risk factors (p = .0258). After adjusting for other covariates, the percentage of rental properties was not associated with lead elevation. *OR*s for lead elevation comparing each quartile with the reference are presented in Table 3.

Risk scores were mapped using ArcGIS10 to present the highest decile (N = 37) of census tracts with the greatest risk based on the predicted probabilities of the multivariable logistic regression model (Figure 1). Risk scores demonstrate the average probability of a child in a census tract having at least one BLL ≥5 µg/dL, given that the child had at least one venous sample drawn. Across census tracts, the risk scores ranged from 0.02–0.35, with an average of 0.12. The median risk score was 0.10. There were 33 (8.7%) census tracts with a risk score >0.25. The average mean squared prediction error based on cross validation across all three birth cohorts was 0.02 (range: 0.01–0.04).

Discussion

This study is the first large-scale risk factor analysis of childhood lead elevation in Philadelphia. The overall high prevalence of old housing stock and poverty in Philadelphia creates a unique challenge for public health officials in combating lead exposure (Campbell et al., 2013; U.S. Census Bureau, 2015c, e). Lead exposure varies greatly, however, across Philadelphia neighborhoods and some geographic areas are disproportionately affected. According to our model, children in 33 census tracts had a >0.25 predicted risk of at least one BLL ≥5 µg/dL. Using elevated BLL rates is a practical approach for targeting intervention but it ultimately fails to account for underlying social and environmental risk factors in particular neighborhoods. Geospatial risk models can allow health organizations to target high-risk areas for primary prevention efforts.

When adjusting for differences between census tracts, pre-1950 housing, poverty, Black race, and vacant properties were all positively and independently associated with an increased risk of childhood lead elevation. These variables suggest that the lack of socioeconomic means to appropriately maintain or renovate old housing can lead to a higher risk for lead elevation.

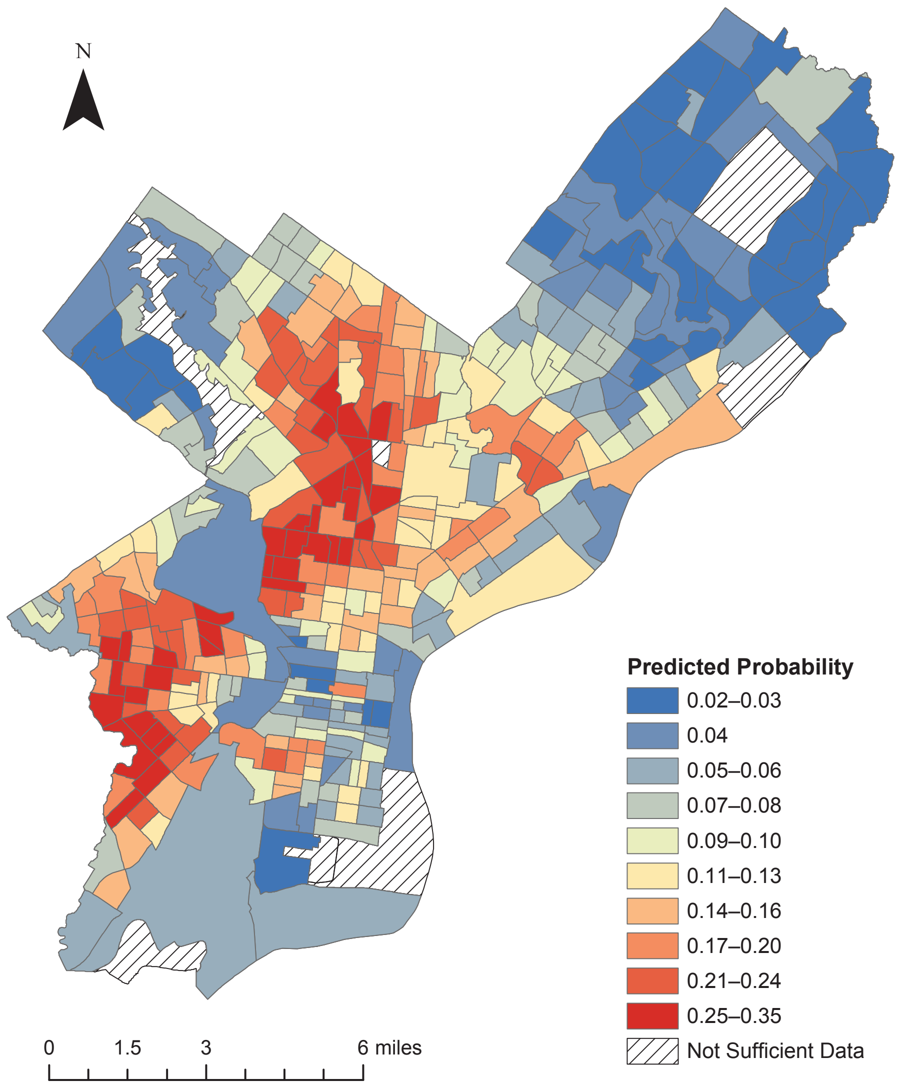
Racial disparities in lead elevation remained even after controlling for other factors often associated with socioeconomic status such as education, poverty, and vacant properties. Furthermore, the race covariate, the highest quartile of percent Black residents, had the greatest *OR* in the analysis. One study found comparable results in an analysis of Chicago neighborhoods from 1995–2003 where areas with a higher percent of Black residents were more likely to have children with lead elevation after controlling for potential neighborhood-level confounders (Sampson & Winter, 2016). Underlying issues such as segregation, inequality, and discrimination might explain racial differences in risk of childhood lead elevation (Sampson & Winter, 2016). Housing quality differs among minorities and low-income people; these factors can have a significant effect on lead exposure (Memken & Canabal, 1994). These factors, however, were not captured in the variables included in our analysis. Our results, combined with past published studies, add evidence that supports more investigation is needed to understand sources of racial disparities contributing to lead elevation.

Our findings are similar to other studies that have used geospatial models to characterize risk of lead elevation in neighborhoods. Several studies also have demonstrated a relationship between lead elevation in children and the following: neighborhood-level age of housing, Black race, education, poverty, and vacant properties (Kaplowitz, Perlstadt, & Post, 2010; Kim, Galeano, Hull, & Miranda, 2008; Raymond, Anderson, Feingold, Homa, & Brown, 2009; Sargent, Bailey, Simon, Blake, & Dalton, 1997). While many of these studies relied on the previously recommended reference of BLL ≥10 µg/dL, Griffith and coauthors (2007) also found a significant association between percent of Black population and elevated child BLL rates using the new recommended reference level of ≥5 µg/dL. Additionally, other studies by Haley and coauthor (2004) and Kaplowitz and coauthors (2010) did not find a significant relationship between percent of rental properties at the neighborhood-level and elevated BLL rates.

While our study introduces a detailed model to identify the highest-risk neighborhoods, it faces a number of limitations. Several known risk factors were not included. For example, countries of birth, Hispanic ethnicity, proximity to former industrial sites or construction/demolition, and potential exposure via contaminated water or soil were not readily available for analysis. Our sample did not include children who had lead testing done by using capillary blood samples or children who were never tested for lead elevation. It is possible that these children represent different populations and therefore our more limited sample was potentially biased by leaving out these two other populations. Additionally, our explanatory variables were census tract-level estimates and apply only to the relationship with the neighborhood-level factors. As an ecologic study, while likely an indication, our findings do not confirm a direct causal relationship of

FIGURE **1**

Map of Philadelphia Census Tract Risk Scores Based on Predicted Probabilities of Multivariable Mixed Effects Logistic Regression Model



Note. Red areas represent the highest decile (*N* = 37) of risk and blue areas represent lowest-risk census tracts.

these factors at the individual and lead elevation outcome levels. Lastly, there is variability in lead elevation over time as incidence generally is decreasing and risk of lead elevation might vary for children in more recent birth cohorts. Therefore, risk factors and risk scores can change over time.

Our study has several strengths. The sample size was large, with over 49,000 children, and because of high screening rates it is generally reflective of the population. This type of analysis had not been previously conducted in Philadelphia and will contribute to future work. We addressed several of the well-established risk factors put forth in other studies. We calculated census tract-level estimates, which will be meaningful for informing public health interventions. Results presented at the census tract-level are not intended to attribute risk factors for lead elevation to individual children but rather to identify which neighborhoods are at highest risk based on their characteristics. The model should be reassessed as characteristics, like demographics, change within a neighborhood.

Conclusion

This lead elevation risk analysis will aid in directing use of resources most effectively to address this preventable public health problem. If successful interventions can be documented in these high-risk areas, they could be replicated in other areas of the city as well. With such large variability of risk identified for lead elevation across the city, the methods in this analysis could also be useful in identifying risk for other environmental health issues such as asthma and injuries. The plight of these neighborhoods, in general, often is accompanied by a cluster of social determinants of health instead of a single factor. Rather than reporting aggregated risk factors and their magnitude, the unique benefit of this analysis is the geospatial depiction of risk.

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References

Advisory Committee on Childhood Lead Poisoning Prevention. (2012). *Low level lead exposure harms children: A renewed call for primary prevention*. Atlanta, GA: Centers for Disease Control and Prevention. Retrieved from http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_030712.pdf

Akkus, C., & Ozdenerol, E. (2014). Exploring childhood lead exposure through GIS: A review of the recent literature. *International Journal of Environmental Research and Public Health*, *11*(6), 6314–6334.

Bridbord, K., & Hanson, D. (2009). A personal perspective on the initial federal health-based regulation to remove lead from gasoline. *Environmental Health Perspectives*, *117*(8), 1195–1201.

Brown, R.W., & Longoria, T. (2010). Multiple risk factors for lead poisoning in Hispanic sub-populations: A review. *Journal of Immigrant and Minority Health*, *12*(5), 715–725.

Campbell, C., Gracely, E., Pan, S., Cummings, C., Palermo, P., & Gould, G. (2013). Public health and law collaboration: The Philadelphia Lead Court study. *American Journal of Public Health*, *103*(7), 1271–1277.

Chandran, L., & Cataldo, R. (2010). Lead poisoning: Basics and new developments. *Pediatrics in Review*, *31*(10), 399–405.

Centers for Disease Control and Prevention. (2013). Blood lead levels in children aged 1–5 years—United States, 1999–2010. *Morbidity and Mortality Weekly Report*, *62*(13), 245–248.

Centers for Disease Control and Prevention. (2015). Childhood blood lead levels—United States, 2007–2012. *Morbidity and Mortality Weekly Report*, *62*(54), 76–80.

Griffith, D.A., Millones, M., Vincent, M., Johnson, D.L., & Hunt, A. (2007). Impacts of positional error on spatial regression analysis: A case study of address locations in Syracuse, New York. *Transactions in GIS*, *11*(5), 655–679.

Haley, V.B., & Talbot, T.O. (2004). Geographic analysis of blood lead levels in New York state children born 1994–1997. *Environmental Health Perspectives*, *112*(15), 1577–1582.

Jones, R.L., Homa, D.M., Meyer, P.A., Brody, D.J., Caldwell, K.L., Pirkle, J.L., & Brown, M.J. (2009). Trends in blood lead levels and blood lead testing among U.S. children aged 1 to 5 years, 1988–2004. *Pediatrics, 123*(3), e376–e385.

Kaplowitz, S.A., Perlstadt, H., & Post, L.A. (2010). Comparing lead poisoning risk assessment methods: Census block group characteristics vs. zip codes as predictors. *Public Health Reports*, *125*(2), 234–245.

Kim, D., Galeano, M.A., Hull, A.P., & Miranda, M.L. (2008). A framework for widespread replication of a highly spatially resolved childhood lead exposure risk model. *Environmental Health Perspectives*, *116*(12), 1735–1739.

Lanphear, B.P., Hornung, R., Khoury, J., Yolton, K., Baghurst, P., Bellinger, D.C., . . . Roberts, R. (2005). Low-level environmental lead exposure and children's intellectual function: An international pooled analysis. *Environmental Health Perspectives*, *113*(7), 894–899.

Memken, J., & Canabal, M. (1994). Determinants of housing quality among minorities. *Housing and Society*, *21*(2), 5–15.

Needleman, H.L., Schell, A., Bellinger, D., Leviton, A., & Allred, E.N. (1990). The long-term effects of exposure to low doses of lead in childhood: An 11-year follow-up report. *New England Journal of Medicine*, *322*(2), 83–88.

Nigg, J.T., Nikolas, M., Knottnerus, G.M., Cavanagh, K., & Friderici, K. (2010). Confirmation and extension of association of blood lead with attention-deficit/hyperactivity disorder (ADHD) and ADHD symptom domains at population-typical exposure levels. *Journal of Child Psychology and Psychiatry*, *51*(1), 58–65.

Parsons, P.J., Reilly, A.A., & Esernio-Jenssen, D. (1997). Screening children exposed to lead: An assessment of the capillary blood lead fingerstick test. *Clinical Chemistry*, *43*(2), 302–311.

Philadelphia Department of Public Health. (2017). *2016 childhood lead poisoning surveillance report*. Retrieved from https://www.phila.gov/press-releases/health/2016-childhood-lead-poisoning-surveillance-report/

Raymond, J., & Brown, M.J. (2017). Blood lead levels in children aged <5 years—United States, 2009–2014. *Morbidity and Mortality Weekly Report Surveillance Summaries*, *66*(3), 1–10.

Raymond, J.S., Anderson, R., Feingold, M., Homa, D., & Brown, M.J. (2009). Risk for elevated blood lead levels in 3- and 4-year-old children. *Maternal and Child Health Journal*, *13*(1), 40–47.

continued on page 24

References *continued from page 23*

Rogers, M.L., Lucht, J.A., Sylvaria, A.J., Cigna, J., Vanderslice, R., & Vivier, P.M. (2014). Primary prevention of lead poisoning: Protecting children from unsafe housing. *American Journal of Public Health*, *104*(8), e119–e124.

Sampson, R.J., & Winter, A.S. (2016). The racial ecology of lead poisoning: Toxic inequality in Chicago neighborhoods, 1995–2013. *Du Bois Review: Social Science Research on Race*, *13*(2), 261–283.

Sargent, J.D., Bailey, A., Simon, P., Blake, M., & Dalton, M.A. (1997). Census tract analysis of lead exposure in Rhode Island children. *Environmental Research*, *74*(2), 159–168.

U.S. Census Bureau. (2015a). *Educational attainment, 2011–2015 American Community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_S1501&prodType=table

U.S. Census Bureau. (2015b). *Race, Universe: Total population, 2011–2015 American Community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_B02001&prodType=table

U.S. Census Bureau. (2015c). *Selected economic characteristics, 2011–2015 American Community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_DP03&prodType=table

U.S. Census Bureau. (2015d). *Selected housing characteristics, 2011–2015 American Community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_DP04&prodType=table

U.S. Census Bureau. (2015e). *Year structure built, Universe: Housing units, 2011–2015 American Community Survey 5-year estimates*. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_B25034&prodType=table

Did You Know?

October 10 is Children's Environmental Health Day. The Children's Environmental Health Network established the observance in 2016 as a way to raise awareness about how environmental exposures impact children's health. It is also a day of action that can be used to mobilize individuals, families, organizations, and communities to champion children's rights to clean air and water, safer food and products, and healthy places in which to live, learn, and play. Learn more at https://cehn.org/ceh-movement/cehday.

"If Providers Had Recommended It, We Would Have Had It Tested": Rural Mothers' Perspectives on Barriers and Facilitators to Testing for Arsenic in Their Well Water

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Abstract **Arsenic in well water is associated with risk of cancer, cardiovascular disease, diabetes, and adverse pregnancy and childhood outcomes. More than 1 in 10 private water wells in New Hampshire contain arsenic concentrations exceeding the U.S. Environmental Protection Agency's maximum contaminant level of 10 µg/L arsenic. In July 2019, New Hampshire became the second state in the country to reduce the maximum contaminant level for arsenic in public water to 5 ppb through the signing into law of HB 261. Testing is the only way to identify whether well water contains arsenic, as arsenic is odorless, colorless, and tasteless; however, private well water testing often does not occur as recommended. Therefore, we sought to determine perspectives of pregnant women about testing their well water. We conducted three focus groups with a total of 12 mothers of young children. Most knew of the need to test for radon and some talked about fluoride but they had not been aware of the need to regularly test for arsenic in well water. Most reported that their healthcare providers had not asked them whether they had tested their water for arsenic; however, the mothers reported that they thought the recommendation would have motivated them to pursue testing. Other barriers included cost and perception of testing as a complicated and time-consuming task. In conclusion, rural mothers of young children are willing to test for arsenic in their well water if their healthcare providers recommend it.**

Introduction

Studies of populations with high exposure to arsenic in well water raise multiple public health concerns, including associations with cancer (e.g., skin, bladder, pancreatic, liver, lung, kidney) (Ayotte et al., 2006; Celik et al., 2008; Chen, Chen, Wu, & Kuo, 1992; Chiou et al., 1995; Gilbert-Diamond et al., 2013; Liaw et al., 2008; Liu-Mares et al., 2013) and other health impairments (Chen et al., 2011; McClintock et al., 2014; Mosaferi, Yunesian, Dastgiri, Mesdaghinia, & Esmailnasab, 2008; Rocha-Amador, Navarro, Carrizales, Morales, & Calderón, 2007; Smith et al., 2011; von Ehrenstein et al., 2007; Wasserman et al., 2014). Exposures that occur in utero and in early life can have distinct impacts on child growth and development, in particular related to immune function and neurodevelopment (Farzan, Karagas, & Chen, 2013). As an odorless, colorless, and tasteless metalloid, the only way to determine the presence of arsenic in well water is to test for it. In spite of global recommendations to regularly test well water and potential health risks, however, most residents with private water wells do not routinely test their well water for arsenic (Flanagan, Marvinney, & Zheng, 2015).

In the state of New Hampshire, arsenic occurs naturally in the groundwater and is prevalent in the drinking water supply. Due to increasing evidence of adverse human health effects related to arsenic exposure, in 2002 the U.S. Environmental Protection Agency (U.S. EPA) reduced the amount of arsenic that could be present in public drinking water systems from 50 µg/L to 10 µg/L. In July 2019, New Hampshire HB 261 was signed into law and the state become the second in the country to reduce the maximum contaminant level for arsenic in public water to 5 ppb. This regulatory limit, however, does not apply to private water wells, which provide drinking water for nearly 40% of households in New Hampshire. The U.S. Geological Survey (USGS) estimates that 20–30% of New Hampshire private water wells exceed this 10 µg/L U.S. EPA maximum contaminant level (MCL) for arsenic (Ayotte, Cahillane, Hayes, & Robinson, 2012). The burden of testing well water falls on the well owner. Testing for arsenic in well water can range in cost from approximately $15 for arsenic alone to $80 and higher for more comprehensive water quality testing (New Hampshire Department of Environmental Services, 2017).

The prevalence of elevated arsenic in groundwater in New Hampshire and the high percentage of the population on private

TABLE **1**

Study Sample Demographics (*N* = 12)

Demographic	Mean (Range) or Sample Size (%)
Age	
Mother	33.6 years (25.2–41.9 years)
Child	12.9 months (1.0–21.0 months)
Family size	4.8 people (3–8 people)
Sex of the child	
Boy	8 (67)
Girl	4 (33)
Ethnicity	
White non-Hispanic/Latino	12 (100)
Marital status	
Married	12 (100)
Educational attainment	
High school graduate or equivalent	2 (17)
Junior college graduate, some college, or technical school	1 (8)
College graduate	5 (42)
Any postgraduate schooling	4 (33)

water systems offer an ideal setting to study the health effects of arsenic exposure in a U.S. population. The New Hampshire Birth Cohort Study (NHBCS) was designed specifically to explore the mechanism of effects of arsenic in drinking water on pregnant women and their children and to address potential in utero and early life effects that had been reported in other studies. Women were eligible for NHBCS if they live in a New Hampshire residence that relies on a private water well. Upon entry into the study, families engaged in comprehensive well water testing at the mother's 24- to 28-week gestation point, approximately, and results were shared with the participants. Consistent with USGS survey estimates, approximately 14% of the birth cohort participants had wells that exceeded the U.S. EPA arsenic MCL (Gilbert-Diamond et al., 2011).

We used the opportunity of the existing NHBCS study to conduct focus groups with a subset of participants to determine their knowledge and perspectives on testing for arsenic in their well water. Our goal was to identify rural mothers' perceived barriers and facilitators to testing for arsenic in well water. In this article, we convey focus group findings, share lessons learned from the focus groups, and offer suggestions for next steps. Our ultimate aim is to inform future public health initiatives promoting testing for arsenic and other contaminants in well water, particularly for programs geared toward rural mothers.

Methods

We recruited participants from enrolled study subjects within NHBCS. Eligibility for enrollment in NHBCS included relying on a private water well for their drinking water and willingness to provide a water sample. We recruited participants for this study from NHBCS enrollees who had enrolled in the study in the previous 6–12 months. This study was approved by the Dartmouth Committee for the Protection of Human Subjects. We obtained written informed consent from each participant prior to participation.

Data Collection Procedure and Analysis

We used the qualitative method of conducting focus groups to understand perspectives of mothers on testing for arsenic in well water. Through e-mail, we invited 97 mothers to participate in the focus groups. Of those, 33 expressed an interest in participating in a focus group. Our final sample size was 12 mothers. We held three focus groups: one in person and two by webinar. Each mother participated in a single focus group. For the first focus group held in person, four attended. Of those, three brought their babies to the group. The two subsequent focus groups were held using an online teleconferencing platform. For the focus groups conducted this way, mothers spoke on the phone or through their computer and reviewed materials online or on their own from handouts received by e-mail. The focus group duration ranged from 47 min to 1 hr and 16 min. All participants were given a $25 Visa gift card as a thank you for their participation.

A trained and experienced focus group facilitator led all focus groups using a structured interview guide that addressed the major questions of interest. The facilitator reminded participants of confidentiality procedures and set the ground rules for discussion, which included that there were no right or wrong answers to set the expectation that different points of view were acceptable. Questions included participant past experiences with having well water tested, learning about the results, and any related resultant actions taken; thoughts about the potential influence on their behavior if their healthcare provider made recommendations to obtain well water testing; barriers to well water testing; knowledge about arsenic; and suggestions for information types and modalities to best help mothers of young children.

The focus groups were audio recorded and transcribed. Transcripts were then coded and analyzed for emergent themes (Krueger, 1998). An additional study investigator attended all focus groups along with the focus group leader, took handwritten notes during the sessions, and later discussed the emergent themes with the research team.

Results

Characteristics of the 12 mothers in our sample are described in Table 1. Barriers and facilitators to testing for arsenic in well water include themes about messaging from providers, cost, and access to information. These themes are summarized in Table 2 and described in greater detail.

The Key Role of Providers

Mothers described healthcare providers as playing a key role in motivating pregnant women to test for arsenic in their well water. In general, mothers reported that their healthcare providers did not use the opportunity of the prenatal visit to screen for and discuss the importance of testing for arsenic in well water; only one mother said that a provider (her midwife) had asked her about arsenic in her well water. Five mothers talked about being asked about their water source in the context of preventing tooth decay from fluoride, either from a healthcare provider or at the dentist's office. One mother said that a healthcare provider had asked about bottled water in the context of pregnancy concerns due to potential leaching of chemicals from the plastic bottles.

They concurred that if a physician had recommended that they test for arsenic in well water, they would have done it:

> "Absolutely, yes. If they had recommended it, I would have in a second."
>
> "We definitely would have tested had it been recommended."

Mothers also talked about having their physician's office provide the kits for testing their well water to elevate the perceived importance of testing and to create a sense of urgency:

> "I think it would have shown that it was a higher priority than I would have placed on it, if the doctor said okay we're going to cover it, it is that important, then I would have said, this is really important."

Similarly, mothers expressed support for the idea of having insurance covering the cost of the kits:

> "It seems like if it was something that they covered, or that would make a big difference. I don't know, it almost seems like something, that in some parts of the country insurance companies should cover it, like at least when you are pregnant."

The role of a healthcare provider conveying the importance of testing carries great weight and could help overcome the barrier of the perceived cost of testing, which is further discussed in the next section.

TABLE **2**

Emergent Themes

Theme	Description
Testing	Most were not previously aware of the need to test for arsenic in well water: "It never crossed our minds."
Screening	Healthcare providers, if they asked about water sources, focused on fluoride, not arsenic.
Barriers to testing	Cost. Fear of being pressured to purchase a water filtration system. Not knowing how. Perceived it as complicated. Perceived it as time consuming.
Facilitators to testing	Mothers agreed that having a physician recommend well water testing for arsenic would help overcome their barriers, especially if physicians provided the kits. Pregnancy was cited as a motivator to testing their well water.
Mode of information delivery	Mothers would like to receive information about arsenic and well water testing through their healthcare provider and delivered via e-mail and postal mail.

Cost and Time

Participants described cost as a barrier to testing well water for arsenic in terms of the initial cost of testing, as well as fears about possible additional subsequent costs in the event the testing indicated a need for treatment, such as a filtration system:

> "I think cost would be prohibitive… People just want it to be tested and then not be kind of pressured into buying a whole filtration system and something like that. That might be another reason they might avoid it."

Mothers also described cost in the context of gravity of need. They described how having a healthcare provider emphasize the importance of well water testing would diminish the perceived cost burden:

> "People might be afraid of cost, that if they thought it was something that was costly, that it may not necessarily be needed. But finding out that it might not be too costly might be important to have the doctor emphasize that if it isn't going to be too costly and it could really affect your baby's health, of course you would want to do it."

Perceived time needed to complete the kits was another barrier:

> "I didn't know until recently that you can actually do some of the testing yourself and send it to somebody to do the analysis. So, in my mind it would have meant a day home from work. Both my husband and I work full-time and just the hassle of doing that would have also been something that would have made me think twice about it."

Access to Information

Mothers expressed limited knowledge of arsenic naturally occurring in well water. They described being aware of arsenic as a potential health hazard in the context of hearing about it associated with rat poison and homicides. In addition, they mentioned hearing about it being present in apple seeds and in rice. They had not heard about arsenic being present potentially in well water:

> "I didn't know anything about it being common in water, especially in…New Hampshire."
>
> "I thought that arsenic, when you had arsenic in the well somebody added it to it. You hear these old stories when people poisoned wells. So I didn't know."

Most said that testing for arsenic in their well water did not occur to them: it "never crossed our minds." A few talked about how they assumed it had been done through the standard tests that occurred with a new home purchase or that the landlord automatically tested the water. Most mothers talked about knowing about the recommendation to test for radon and had not been aware of the recommendation to regularly test for arsenic in well water.

TABLE **3**

Mothers' Questions About Best Practices for Cooking With Well Water That Might Have Arsenic

Theme	Question
Accumulation	If water is at a safe level but you use a lot, does the arsenic build up/accumulate? If arsenic is in someone's water, what other things are they eating that are adding additional arsenic into their bodies?
Amount in food	How much arsenic is in rice and other foods?
Pets	Can dogs drink well water with arsenic?
Health-related issues	What are the health-related issues of arsenic?
Measurement	How do you measure arsenic exposure?

They learned of this latter recommendation primarily through enrolling in NHBCS. The few who had previously experienced well water testing for arsenic talked about how those tests had been triggered by a broken water pump or a home inspection. Other new homeowners said that prior to enrolling in the study, they had not been aware of the recommendation for additional testing and/or assumed that testing for arsenic was part of the standard water test package:

> "It wasn't until I read the materials for the [NHBCS] study that I realized that arsenic isn't included in a lot of the standard tests. Like when you hire an inspector to come and run water tests. You know, as part of the purchase process, it is often not included. That is part of the reason why I was interested in being part of a study."

Participants were aware of the recommendations to test for radon, suggesting that in addition to the possibility of adding on to the recommendation for fluoride, the mode of information access about radon might also be ideal for getting the word out about arsenic:

> "I had heard it was about every three to four or five years, I thought for the radon. That is what was on my radar of when we would next test again."

One group of mothers asked many questions about cooking and using well water; they wanted to learn more about specific cooking approaches and conditions (Table 3). The topic areas included using bottled water for cooking and drinking, and individual choices as to when they use bottled versus tap water. For example, one mother talked about how she felt more comfortable using bottled water because it tasted better. Another talked about using bottled water for drinking and tap water for cooking, making coffee, brushing teeth, and showering. Another talked about using different water sources for cooking (specifically mentioning coffee, rice, and pasta) versus brushing her teeth. The latter talked about how she perceived rice as soaking in the water and pasta not soaking in as much water as rice.

Across all of the focus groups, participants expressed an interest in receiving information about arsenic and testing for arsenic in well water. Mothers talked about wanting this information through multimodal channels such as from both e-mail and postal mail, because they preferred e-mail for immediate information and postal mail to have on hand to file away. They asked for website resources and were enthusiastic about the idea of receiving a brochure that contained information about arsenic risks. They also expressed interest in receiving information through multiple channels, including through school and work:

> "The other thing that is helpful is I do read things when my kids bring home various health notices and stuff from school. They aren't always just life related. You know, there was swine flu and there was some other health thing that went around and we got sort of a little pamphlet that came home from school and the kids brought it home from school and I read it."
>
> "[At my work] they put up a whole bunch of things, like you know, domestic violence awareness, and health and fitness things, some flyers in our bathrooms, and I never miss those! It wouldn't be that hard [to post information]."

Discussion

Our study revealed that mothers of young children who rely on private water wells for their drinking water in New Hampshire were largely unaware of 1) the prevalence of elevated groundwater arsenic in the region and 2) recommendations to test for arsenic in their well water. Other barriers included not having been asked by their healthcare provider about arsenic, assuming that tests for arsenic were rolled into other standard tests such as radon, and perceptions that testing was an expensive and time-consuming process.

Mothers also talked about how specific facilitators would help to overcome those barriers, including 1) being asked by their healthcare provider, 2) having test kits provided at the doctor's office, and 3) having insurance cover the testing cost. Other facilitators include receiving information such as brochures through multiple modes such as e-mail and postal delivery, as well other overlapping channels such as schools, worksite bulletin boards, and websites that expectant mothers frequent such as BabyCenter (www.babycenter.com).

Agencies, including U.S. EPA, departments of environmental services of state health departments, and national and international medical organizations such as the American Academy of Pediatrics and the World Health Organization, recommend regular testing of private water wells to ensure drinking water safety (Committee on Environmental Health and Committee on Infectious Diseases, 2009). Wide variation exists, however, within and across states on how this recommendation is delivered, the content of the communication, and resource availability for consumers regarding testing well water. Regulations vary between states and localities, and generally focus on initial permitting and real estate transactions. Contaminants such as arsenic are not typically tested and are not part of the minimal panel performed at the time of home purchase.

Our study suggests that consumers are largely unaware of recommendations and regulations surrounding arsenic in water. In general, state health departments, regional health departments, and environmental health agencies have been the primary source of specific recommendations for consumer guidance related to testing of private water wells. Aside from inquiries related to fluoride, healthcare providers have not been actively engaged in promoting this intervention.

Our study highlights the need for this preventive health activity to be in partnership between the public health and healthcare sectors so that healthcare providers can play a more active role in promoting screening activities. A review of the literature found no studies that addressed compliance with these recommendations in clinical settings, nor specific strategies for promoting this screening activity as part of routine preventive care (Committee on Environmental Health and Committee on Infectious Diseases, 2009).

Studies of private well owners in the environmental health literature have identified barriers to regular testing that include inconvenience, complacency, and lack of a perceived problem (Flanagan et al., 2015; Imgrund, Kreutzwiser, & de Loë, 2011). Our study found similar findings, particularly lack of a perceived problem and perception of inconvenience. To date, public health-based interventions to raise private well owner knowledge about the importance of well testing and information about health-related issues regarding water quality have not been shown to consistently impact well testing behaviors (Severtson, Baumann, & Brown, 2008; Shaw, Walker, & Benson, 2005).

Nonetheless, our study suggests that pregnant women and mothers of young children are motivated to reduce their children's exposure to environmental contaminants that could adversely affect their health. Moreover, our focus groups revealed specific opportunities for community–clinical linkages for public health and prevention by addressing the following steps to:

- promote clinical practice education regarding where and how to screen;
- communicate with parents/guardians on the recommendation for testing for arsenic and other contaminants in well water;
- have the healthcare and/or dental provider screen for source of drinking water, and if a private source, whether the family has tested for arsenic;
- communicate the frequency of testing needed (every 3–5 years);
- communicate where and how to screen; and
- communicate the simplicity of steps needed to accomplish the testing (e.g., that one would not have to take a full day off of work to conduct the test).

These communications could be delivered in parallel with other screening areas that the mothers in our study did have relatively greater awareness of compared with arsenic, such as fluoride and radon testing. Given that American Academy of Pediatrics guidelines recommend that parents test their private water wells for fluoride prior to their child's 6-month well baby visit to determine if supplementation is indicated for oral health promotion, it might be an efficient opportunity to additionally screen for arsenic.

Screening for arsenic testing in well water could be added to the electronic health record. In addition to communicating the message through the healthcare provider's office (e.g., prenatal team, midwife team, obstetric practice, primary care provider, pediatrician), the dentist office is another potential source for arsenic education. Further, given that mothers reported being asked about their water source in the context of using fluoride to prevent tooth decay, the dentist office is a possible untapped resource to screen for and discuss the importance of testing for arsenic in well water as part of the discussion of well water testing in general. Other possibilities of avenues for communication include the schools, realtors, and websites that expectant mothers visit.

Another helpful finding from this study is the usefulness of offering teleconferencing for the focus group to hear the perspectives of rural mothers of young children. We learned that mothers of young children are enthusiastic about offering their insights and are more likely to do so if they are able to attend a focus group with their children or to attend a group meeting by webinar/telephone. Mothers of young children who live in rural areas are busy managing a new baby and they have long distances to drive to participate in a research study such as this one.

To overcome accessibility challenges of time and distance, offering a teleconferencing option to enable mothers to participate in a focus group through their computer or telephone might be an ideal option for other studies looking to hear from this specific group of participants. Alternatively, offering babysitting during an in-person focus group could also help to increase the possibility that mothers might attend.

Our study was limited in that it featured a small sample size of predominantly white mothers with a relatively high level of education. In spite of this limitation, however, respondents raised many questions about testing and subsequent recommended actions that could be useful for healthcare providers and public health practitioners. Future studies could investigate more deeply specific types of behaviors to uncover pathways to water use: when do they start drinking bottled water (if they do) and under what conditions, and in what ways do they use water in their homes, including specific cooking/preparation habits (e.g., how do they prepare ice, coffee, pasta, rice). Future studies could also determine what is a reasonable threshold, if any, for families with limited resources to pay for an arsenic test.

Conclusion

Based on our findings, we recommend that providers in obstetric, pediatric, primary care, and dental practices ask expectant mothers and parents/guardians of young children about their source of water and their experience with well water testing. In addition to the clinical setting, suggested modes of information delivery include electronic and paper communication through schools and media outlets aimed at expectant mothers. In spite of the potential barriers to testing well water for arsenic or other contaminants, our study found that mothers of young children are motivated and interested in learning more about recommendations that would decrease harmful environmental exposures to their families.

Although water quality has been recognized as a key determinant of health since the time of Hippocrates (Pappas, Kiriaze, & Falagas, 2008), it still is not a standard aspect of the practice of medicine. The current public health challenge regarding identifying and reducing exposure to arsenic in private water systems illustrates a role for the healthcare system and the public health workforce to help promote testing and exposure reduction.

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References

Ayotte, J.D., Baris, D., Cantor, K.P., Colt, J., Robinson, G.R., Jr., Lubin, J.H., . . . Silverman, D.T. (2006). Bladder cancer mortality and private well use in New England: An ecological study. *Journal of Epidemiology & Community Health*, *60*(2), 168–172.

Ayotte, J.D., Cahillane, M., Hayes, L., & Robinson, K.W. (2012). Estimated probability of arsenic in groundwater from bedrock aquifers in New Hampshire, 2011. *U.S. Geological Survey Scientific Investigations Report 2012–5156*. Retrieved from http://pubs.usgs.gov/sir/2012/5156/

Celik, I., Gallicchio, L., Boyd, K., Lam, T.K., Matanoski, G., Tao, X., . . . Alberg, A.J. (2008). Arsenic in drinking water and lung cancer: A systematic review. *Environmental Research*, *108*(1), 48–55.

Chen, C.J., Chen, C.W., Wu, M.M., & Kuo, T.L. (1992). Cancer potential in liver, lung, bladder and kidney due to ingested inorganic arsenic in drinking water. *British Journal of Cancer*, *66*(5), 888–892.

Chen, Y., Parvez, F., Liu, M., Pesola, G.R., Gamble, M.V., Slavkovich, V., . . . Ahsan, H. (2011). Association between arsenic exposure from drinking water and proteinuria: Results from the Health Effects of Arsenic Longitudinal Study. *International Journal of Epidemiology*, *40*(3), 828–835.

Chiou, H.Y., Hsueh, Y.M., Liaw, K.F., Horng, S.F., Chiang, M.H., Pu, Y.S., . . . Chen, C.J. (1995). Incidence of internal cancers and ingested inorganic arsenic: A seven-year follow-up study in Taiwan. *Cancer Research*, *55*(6), 1296–1300.

Committee on Environmental Health and Committee on Infectious Diseases. (2009). Drinking water from private wells and risks to children (Policy statement). *Pediatrics*, *123*(6), 1599–1605.

Farzan, S.F., Karagas, M.R., & Chen, Y. (2013). In utero and early life arsenic exposure in relation to long-term health and disease. *Toxicology and Applied Pharmacology*, *272*(2), 384–390.

Flanagan, S.V., Marvinney, R.G., & Zheng, Y. (2015). Influences on domestic well water testing behavior in a Central Maine area with frequent groundwater arsenic occurrence. *The Science of the Total Environment*, *505*, 1274–1281.

Gilbert-Diamond, D., Cottingham, K.L., Gruber, J.F., Punshon, T., Sayarath, V., Gandolfi, A.J., . . . Karagas, M.R. (2011). Rice consumption contributes to arsenic exposure in U.S. women. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(51), 20656–20660.

Gilbert-Diamond, D., Li, Z., Perry, A.E., Spencer, S.K., Gandolfi, A.J., & Karagas, M.R. (2013). A population-based case–control study of urinary arsenic species and squamous cell carcinoma in New Hampshire, USA. *Environmental Health Perspectives*, *121*(10), 1154–1160.

Imgrund, K., Kreutzwiser, R., & de Loë, R. (2011). Influences on the water testing behaviors of private well owners. *Journal of Water and Health*, *9*(2), 241–252.

Krueger, R.A. (1998). *Analyzing and reporting focus group results: Volume 6 of the focus group kit*. Thousand Oaks, CA: SAGE Publications, Inc.

Liaw, J., Marshall, G., Yuan, Y., Ferreccio, C., Steinmaus, C., & Smith, A.H. (2008). Increased childhood liver cancer mortality and arsenic in drinking water in northern Chile. *Cancer Epidemiology, Biomarkers & Prevention*, *17*(8), 1982–1987.

Liu-Mares, W., Mackinnon, J.A., Sherman, R., Fleming, L.E., Rocha-Lima, C., Hu, J.J., & Lee, D.J. (2013). Pancreatic cancer clusters and arsenic-contaminated drinking water wells in Florida. *BMC Cancer*, *13*, 111.

McClintock, T.R., Chen, Y., Parvez, F., Makarov, D.V., Ge, W., Islam, T., . . . Ahsan, H. (2014). Association between arsenic exposure from drinking water and hematuria: Results from the Health Effects of Arsenic Longitudinal Study. *Toxicology and Applied Pharmacology*, *276*(1), 21–27.

Mosaferi, M., Yunesian, M., Dastgiri, S., Mesdaghinia, A., & Esmailnasab, N. (2008). Prevalence of skin lesions and exposure to arsenic in drinking water in Iran. *The Science of the Total Environment*, *390*(1), 69–76.

New Hampshire Department of Environmental Services. (2017). *Arsenic information*. Retrieved from http://des.nh.gov/organization/divisions/water/dwgb/capacity/arsenic.htm

Pappas, G., Kiriaze, I.J., & Falagas, M.E. (2008). Insights into infectious disease in the era of Hippocrates. *International Journal of Infectious Diseases*, *12*(4), 347–350.

Rocha-Amador, D., Navarro, M.E., Carrizales, L., Morales, R., & Calderón, J. (2007). Decreased intelligence in children and exposure to fluoride and arsenic in drinking water. *Cadernos de Saude Publica*, *23*(Suppl. 4), S579–S587.

continued on page 32

References *continued from page 31*

Severtson, D.J., Baumann, L.C., & Brown, R.L. (2008). Applying the common sense model to measure representations of arsenic contaminated well water. *Journal of Health Communication*, *13*(6), 538–554.

Shaw, W.D., Walker, M., & Benson, M. (2005). Treating and drinking well water in the presence of health risks from arsenic contamination: Results from a U.S. hot spot. *Risk Analysis*, *25*(6), 1531–1543.

Smith, A.H., Marshall, G., Yuan, Y., Liaw, J., Ferreccio, C., & Steinmaus, C. (2011). Evidence from Chile that arsenic in drinking water may increase mortality from pulmonary tuberculosis. *American Journal of Epidemiology*, *173*(4), 414–420.

von Ehrenstein, O.S., Poddar, S., Yuan, Y., Mazumder, D.G., Eskenazi, B., Basu, A., . . . Smith, A.H. (2007). Children's intellectual function in relation to arsenic exposure. *Epidemiology*, *18*(1), 44–51.

Wasserman, G.A., Liu, X., Loiacono, N.J., Kline, J., Factor-Litvak, P., van Geen, A., . . . Graziano, J.H. (2014). A cross-sectional study of well water arsenic and child IQ in Maine schoolchildren. *Environmental Health*, *13*(1), 23.

Did You Know?

NEHA is pleased to announce the release of the Food Safety Instructor Directory—an interactive map that allows users to find certified food safety instructors in their geographic areas. NEHA's Food Safety Training program maintains a network of hundreds of registered food safety instructors from across the globe who provide valuable training for the food service industry. Check out the map at www.neha.org/trainer-directory.

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Private Well Water Practices Among Environmental Health Professionals in Kansas

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Abstract **There are significant regulatory gaps that affect 43.5 million people in the U.S. who rely on groundwater from private water wells for their drinking water. Although some local environmental health agencies provide support to private water well owners, individual private water well owners must protect themselves. This study assessed the local practices of environmental health professionals in Kansas regarding private water wells. An 18-item survey was distributed to all 61 members of the Kansas Environmental Health Association in 2016. A 90% survey response rate was achieved. In local Kansas communities, sampling of private well water occurs most frequently as a result of a homeowner's request (57%) or at the time of a real estate transaction (54%). Nearly one third of respondents reported that their jurisdictions neither inspect wells nor sample well water. Most respondents indicated their organizations did not have the capability to analyze samples for common contaminants such as pesticides (76%) or volatile organic compounds (71%). In Kansas, there appears to be a lack of uniformity in inspection, sampling, and analysis practices and policies for private water wells. Additional research is needed to determine if these results are consistent across the U.S.**

Introduction

Approximately 15% of U.S. households, which encompass 43.5 million people, rely on private water supplies (defined for this article as water wells that are not part of a public water system) such as private wells for drinking water (Belitz, Jurgens, & Johnson, 2016; U.S. Environmental Protection Agency [U.S. EPA], 2018). In Kansas, between 151,000 and 177,000 individuals are supplied by approximately 70,000 private water wells (Belitz et al., 2016; Kansas Geological Survey, 2016; Maupin et al., 2014; U.S. Census Bureau, 2017).

Most private water wells use groundwater for their water source, so water quality can vary significantly. Many contaminants affect private well water quality. Impacts to groundwater quality can result from agricultural pesticides, industrial chemicals, onsite wastewater systems, leaking underground storage tanks, landfills, and natural sources (e.g., arsenic) migrating into groundwater. Approximately 23% of private water wells contain one or more contaminants at or above at least one benchmark considered harmful for human health (DeSimone, Hamilton, & Gilliom, 2009). In a national sample of 219 domestic water wells, more than one in five wells had contaminants that exceeded public drinking water standards or other human health benchmarks (DeSimone et al., 2009).

Despite the large number of potential contaminants and the millions of people in the U.S. who rely on private wells for their drinking water, private water systems are largely unregulated at federal and state levels (i.e., not regulated by the federal Safe Drinking Water Act or parallel state safe drinking water acts). No federal policy requires sampling or analysis of these private water wells. Accordingly, the regulation of private water supplies predominantly remains under the purview of local authorities (Wallender, Ailes, Yoder, Roberts, & Brunkard, 2014). Private water well owners are largely left on their own to assess and protect the quality of their well water.

The U.S. Environmental Protection Agency recommends that private water well owners sample their wells annually and contact local health and environmental agencies for assistance with sampling (U.S. EPA, 2002, 2017, 2018). Despite these recommendations, insufficient resources are available at local health and environmental agencies to support private water well owners (Chappells et al., 2014). With this study, we sought to identify the practices of local environmental health agencies in Kansas regarding private water well sampling and analysis.

TABLE 1

Respondent Demographics (*N* = 52)

Demographic	#	%
Jurisdiction served (*n* = 51)		
County	22	43
City	9	18
Multiple counties	7	14
Statewide	7	14
City/county	6	12
Educational attainment (*n* = 42)		
Graduate degree or more	5	12
Bachelor's degree	29	69
Some college	3	7
High school or less	5	12
Education and training (*n* = 44)		
Microbiology	26	59
Geology	13	30
Hydrology	12	27
On-the-job training	5	11
No formal education or on-the-job training	3	7
Water well-specific training (*n* = 42)		
Seminars or conferences	19	45
On-the-job training	13	31
College/academic	6	14
Outside resources	5	12
No training	7	17

Note. Percent totals might not equal 100% because respondents were able to give multiple responses.

Methods

In 2016, current members of the Kansas Environmental Health Association (KEHA), the professional organization for environmental health professionals in Kansas, were identified as potential participants. KEHA membership is open to anyone who wishes to join and consists primarily of environmental health professionals from Kansas cities, counties, and the Kansas Department of Health and Environment. Responses were solicited from those attending either of the two semiannual meetings or via an electronic survey invitation. We requested one survey per respondent.

The survey instrument comprised 18 items that addressed the respondents' organizational practices regarding private well inspection, sampling, analysis, and data sharing. The survey also assessed the type of organization represented by the respondents (e.g., city, county), as well as their education and professional training. Responses to the in-person surveys and the electronic surveys were compiled and analyzed using SPSS version 23.0. Univariate analyses were conducted, and frequencies and percentages are reported.

Results

Respondent Demographics

Of the 61 KEHA members, 55 completed the survey, for a response rate of 90%. Of these 55 respondents, 2 indicated they were retired and 1 submitted an incomplete survey; these 3 respondents were omitted from the analysis for a final sample of 52.

Respondents were most likely to indicate they represented a single county (22, 43%) or city agency (9, 18%), followed by those who worked for multiple county regions (7, 14%) or statewide agencies (7, 14%) (Table 1). Most respondents (34, 81%) reported that they had earned at least a 4-year college degree and some (5, 12%) indicated they had earned a graduate-level degree. Respondents were most likely to report having been educated in microbiology (26, 59%), geology (13, 30%), or hydrology (12, 27%). Respondents were most likely to report that their water well-specific training consisted of seminars or conferences (19, 45%) or on-the-job training (13, 31%). Lastly, approximately one in five (7, 17%) reported no water well-specific training.

Well Inspection Practices

Respondents reported they inspected wells most often at the time of a real estate transaction (29, 56%), after the construction of a new well (24, 46%), or at the request of the well owner (22, 42%) (Table 2). Of the respondents, approximately one in four (14, 27%) indicated that they did not inspect private wells.

Well Sampling Practices

Respondents indicated they sampled well water most often at the time of a real estate transaction (30, 58%) or at the request of the well owner (28, 54%) (Table 3). Respondents also reported sampling after a new well was constructed (19, 37%). Additionally, nearly one out of three (15, 29%) indicated they did not sample water wells. Some (8, 15%) indicated there were other circumstances in which sampling would occur, such as the need to sample wells at day care centers, foster care homes, or new homes.

Sampling Capabilities and Data Sharing

Half of all respondents indicated their agency was able to sample wells upon request from the public and nearly one third (6, 31%) of respondents indicated they referred residents to private labs when called for samples (Table 4). Again, nearly one third of respondents (16, 32%) indicated they did not record the results of well sampling conducted by them or other entities such as private labs or state agencies. Among the 34 respondents who reported documenting the results of well water sample analysis, more than half (18, 53%) reported maintaining a hard copy of the results and more than one third (13, 38%) reported using an electronic database.

Of the 34 respondents who reported documenting analysis results, 35% reported that water sample data could be accessed by the public and 24% indicated limited access to analysis results by their internal agency. Among the 37 respondents who reported sampling wells, 78% reported that results were shared by letter and 54% indicated that they shared results by phone. Furthermore, of the 37 respondents who reported sharing results, 49% indicated sharing results within 1–2 days and 27% indicated sharing results within 3–5 days.

TABLE **2**

When Respondents Reported Inspecting Wells (*N* = 52)

	#	%
At time of real estate transaction	29	56
After new well construction	24	46
At owner's request	22	42
Do not inspect private wells	14	27
Prior to construction	12	23
Other inspection arrangements	8	15
At time of construction	6	12
Don't know if well inspection occurs	1	2

Note. Percent totals might not equal 100% because respondents were able to give multiple responses.

TABLE **3**

When Respondents Reported Collecting Samples (*N* = 52)

	#	%
At time of real estate transaction	30	58
At owner's request	28	54
After new well is constructed	19	37
Do not sample private wells	15	29
Other sampling arrangement	8	15
Annually as part of regulations	1	2
Don't know if sampling occurs	1	2

Note. Percent totals might not equal 100% because respondents were able to give multiple responses.

Discussion

The Kansas Department of Health and Environment and the Kansas State University Research and Extension recommend at least annual testing for bacteria and nitrates and testing every 3–5 years for other nuisance contaminants that impact water quality but not health, such as chloride, iron, or total dissolved solids—yet there is no consistent set of local or county-level practices or policies to support private water well owners performing these testing recommendations (Kansas State University Agricultural Experiment Station and Cooperative Extension Service, 1999). Respondents who reported inspecting wells or sampling private well water did so as a one-time event or at the request of the well owner. One respondent reported sampling on an annual basis; the other respondents reported sampling well water at events such as real estate transactions, new well construction, or at owner request.

A lack of uniformity in private water well inspection and sampling practices was observed among the environmental health professionals surveyed. These findings are consistent with studies suggesting a lack of uniformity in the support available to private water well owners from government entities (Chappells et al., 2014; Fox, Nachman, Anderson, Lam, & Resnick, 2016). Nearly one third of respondents reported that their jurisdictions neither inspect wells nor sample private well water. Although a private laboratory might be available to sample and analyze water, it is often left to owners (at their own expense) to coordinate the water well testing with a private lab. Moreover, while one half of all responding agencies reported having the capacity to sample wells themselves, the remainder relied on referrals or testing kits that place the responsibility of sampling on the well owner.

Additionally, there is a lack of uniformity in educational attainment and water well training for environmental health professionals. Local environmental health workers need to be skilled in groundwater science to be better equipped to protect private water wells (Fox et al., 2016). Based on the results of this study, this training appears to be needed among the environmental health workforce in Kansas. Currently, little training on sampling procedures or analysis is provided (Kansas Department of Health and Environment, 2012).

Results of water well analyses in Kansas are not made widely available and there is not any consistency in who is allowed to access results from water well samples. Data from private water well samples can be instrumental for well owners and environmental health professionals in evaluating water quality of private water wells and identifying potential contamination that could impact those using the water (Brown, Van Dyke, Kuhn, Mitchell, & Dalton, 2015; Fox et al., 2016). With the complexity of data-sharing permissions, formats, and timeliness reported in this survey, data-sharing standardization could be an

TABLE **4**

Sampling and Analysis Capabilities (*N* = 52)

Capability	#	%
Well sampling (*N* = 52)		
Able to sample when called	26	50
Refer residents to a private lab when called	16	31
Refer to other government agency (e.g., KDHE, county)	8	15
Provide information or sampling kits	6	12
Other referral when called	6	12
Well sampling documentation (*n* = 50)		
Do not document	16	32
Maintain hard copy of files	18	53
Use electronic database	13	38
Use inspection form document	13	38
Other documentation	3	9
Data access (*n* = 34)		
Public	12	35
Internal agency	8	24
Homeowner	5	15
State	3	9
Agents of homeowners	1	3
No data access indication provided	11	32
Results sharing (*n* = 37)		
Letter	29	78
Phone	20	54
E-mail	15	41
Another way	4	11
Results timing (*n* = 37)		
Shared in 1–2 days	18	49
Shared in 3–5 days	10	27
Shared in 6–10 days	3	8
Shared after >10 days	2	5
Shared in some other time frame	4	11

KDHE = Kansas Department of Health and Environment.
Note. Percent totals might not equal 100% because respondents were able to give multiple responses.

important opportunity for consistency across organizations in Kansas.

When the responsibility for private water well testing is placed entirely on owners, barriers such as cost, inconvenience, and lack of knowledge can inhibit individual compliance with testing recommendations (Imgrund, Kreutzwiser, & de Loë, 2011; Jones et al., 2006; Knobeloch, 2011; Knobeloch, Gorski, Christenson, & Anderson, 2013). These inhibitors, however, are also factors that government support can overcome through environmental and public health action (Fox et al., 2016). Public health action models suggest that context-changing interventions such as updating or adding policies and regulations to support private water well testing could be more effective than individual-level interventions (Frieden, 2010). Moreover, local/county codes and state regulations can provide protections to private water well owners or those acquiring property who obtain drinking water from a nonpublic water source.

Local/county codes can:

- require periodic inspection and water testing of nonpublic water wells,
- establish requirements for inspection and testing of nonpublic water wells,
- establish water quality standards for nonpublic water wells or adopt state or national primary drinking water standards,
- mandate testing of nonpublic water sources at the time of a real estate transaction,
- require notice to the public and potentially affected users if a nonpublic water well is found to be contaminated, and
- mandate disclosure of abandoned and inactive nonpublic water wells and nonpublic wastewater treatment systems to prospective buyers.

Limitations

Although this study had a 90% response rate, it did not include all environmental health professionals in Kansas. Given the wide range of responses, however, it is unlikely that the remaining 10% would have significantly altered the inconsistency of responses. Though the survey was sent to individuals in the Kansas Environmental Health Association, the questions focused on the practices of respondents' agencies, which might not have captured the practices of all environmental and public health agencies in Kansas. Nonetheless, the approach of sampling the state environmental health association likely yielded representatives for most of the state of Kansas.

These survey data are based on self-report and do not verify what policies and practices are actually in place across locales in Kansas. The survey also did not examine how practices are enforced or executed on a daily basis in contrast to what could be required legally or procedurally.

Finally, this survey used the term "private" water well, when a more precise term is "nonpublic." Nonpublic water supplies include all water sources that are not classified as a "public water supply" under the federal Safe Drinking Water Act or parallel state public water supply laws. Different states and local (city and county) jurisdictions use different terminology when referring to different nonpublic water sources, including private, nonpublic, domestic, and semipublic water wells.

There is no common understanding or legal definition of the term private, whereas nonpublic is a designation that involves a relationship to the legal category of public water sources. The designation of nonpublic generally includes all categories of water sources that do not fall under federal and state public water source designation (i.e., semipublic and private). In general, the regulation of these nonpublic water supplies is minimal and falls short of the federal Safe Drinking Water Act or state public water source regulations.

Conclusion

Kansas environmental health professional practices and policies to protect private well water lack uniformity and might be inadequate to protect private water well quality. This study identifies gaps that can be used by local public and environmental health agencies to develop more consistent procedures and support the development of policies to better protect residents who rely on private wells for their drinking water.

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References

Belitz, K., Jurgens, B.C., & Johnson, T.D. (2016). *Potential corrosivity of untreated groundwater in the United States* (Scientific Investigations Report 2016–5092). Reston, VA: U.S. Geological Survey. Retrieved from http://dx.doi.org/10.3133/sir20165092

Brown, E.M., Van Dyke, M., Kuhn, S., Mitchell, J., & Dalton, H. (2015). Private well water in Colorado: Collaboration, data use, and public health outreach. *Journal of Public Health Management and Practice*, *21*(Suppl. 2), S85–S92.

Chappells, H., Parker, L., Fernandez, C.V., Conrad, C., Drage, J., O'Toole, G., . . . Dummer, T.J. (2014). Arsenic in private drinking water wells: An assessment of jurisdictional regulations and guidelines for risk remediation in North America. *Journal of Water and Health*, *12*(3), 372–392.

DeSimone, L.A., Hamilton, P.A., & Gilliom, R.J. (2009). *The quality of our nation's waters—Quality of water from domestic wells in principal aquifers of the United States, 1991–2004: Overview of major findings* (Circular 1332). Reston, VA: U.S. Geological Survey. Retrieved from https://pubs.usgs.gov/circ/circ1332/includes/circ1332.pdf

Fox, M.A., Nachman, K.E., Anderson, B., Lam, J., & Resnick, B. (2016). Meeting the public health challenge of protecting private wells: Proceedings and recommendations from an expert panel workshop. *The Science of the Total Environment*, *554–555*, 113–118.

Frieden, T.R. (2010). A framework for public health action: The health impact pyramid. *American Journal of Public Health*, *100*(4), 590–595.

Imgrund, K., Kreutzwiser, R., & de Loë, R. (2011). Influences on the water testing behaviors of private well owners. *Journal of Water and Health*, *9*(2), 241–252.

Jones, A.Q., Dewey, C.E., Doré, K., Majowicz, S.E., McEwen, S.A., Waltner-Toews, D., . . . Henson, S.J. (2006). Public perceptions of drinking water: A postal survey of residents with private water supplies. *BMC Public Health*, *6*, 94.

Kansas Department of Health and Environment. (2012). *Water well inspection manual.* Retrieved from http://www.kdheks.gov/waterwell/download/Well_Inspection_Training_for_Water_Wells_4-5-12_Final.pdf

Kansas Geological Survey. (2016). *WWC5—Water use code statistics.* Retrieved from http://chasm.kgs.ku.edu/ords/wwc5.wwc5d2.FindUsageCounts

Kansas State University Agricultural Experiment Station and Cooperative Extension Service. (1999). *Water quality: Recommended water tests for private wells.* Retrieved from http://www.kdheks.gov/waterwell/download/MF871-Recommended_Water_Tests_for_Private_Wells.pdf

Knobeloch, L. (2011). *2008–9 survey of private well owners.* Retrieved from http://dnr.wi.gov/topic/Groundwater/documents/GCC/minutes/2011NovPrivateWellOwnerSurvey.pdf

Knobeloch, L., Gorski, P., Christenson, M., & Anderson, H. (2013). Private drinking water quality in rural Wisconsin. *Journal of Environmental Health*, *75*(7), 16–20.

Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., & Linsey, K.S. (2014). *Estimated use of water in the United States in 2010* (Circular 1405). Reston, VA: U.S. Geological Survey. Retrieved from https://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf

U.S. Census Bureau. (2017). *Quick facts—Kansas.* Retrieved from https://www.census.gov/quickfacts/table/PST045216/20

U.S. Environmental Protection Agency. (2002). *Drinking water from household wells* (EPA 816-K-02-003). Washington, DC: Author. Retrieved from https://19january2017snapshot.epa.gov/sites/production/files/2015-05/documents/epa816k02003.pdf

U.S. Environmental Protection Agency. (2017). *Testing wells to safeguard your water.* Retrieved from https://www.epa.gov/privatewells/additional-information-private-wells#how

U.S. Environmental Protection Agency. (2018). *Learn about private water wells.* Retrieved from https://www.epa.gov/privatewells/about-private-water-wells

Wallender, E.K., Ailes, E.C., Yoder, J.S., Roberts, V.A., & Brunkard, J.M. (2014). Contributing factors to disease outbreaks associated with untreated groundwater. *Ground Water*, *52*(6), 886–897.

DIRECT FROM ATSDR

Choose Safe Places for Early Care and Education: Building State Programs

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Editor's Note: **As part of our continued effort to highlight innovative approaches to improve the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the Agency for Toxic Substances and Disease Registry (ATSDR) at the Centers for Disease Control and Prevention (CDC). ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. The purpose of this column is to inform readers of ATSDR's activities and initiatives to better understand the relationship between exposure to hazardous substances in the environment, its impact on human health, and how to protect public health.**

The conclusions of this column are those of the author(s) and do not necessarily represent the official position of ATSDR or CDC.

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Introduction

What would you want to know before your children attend a day care opening in a former industrial building or adjacent to a nail salon? Are children at risk if their new preschool is located on former farmland where lead arsenate pesticide might have been used? What site-related environmental risks are most concerning for children attending early care and education (ECE) facilities?

States involved with the Agency for Toxic Substances and Disease Registry's (ATSDR) Choose Safe Places for Early Care and Education (CSPECE) effort are addressing site-related questions like these to help protect children from harmful environmental exposures.

Background

Young children are more susceptible to harmful effects from exposure to environmental contamination. In 2011, preschoolers spent an average of 33 hours per week in child care (Laughlin, 2013). The extended periods of time that children spend in ECE facilities make it important to reduce harmful exposures.

Newly licensed ECE programs might inadvertently open in places where children and staff could be exposed to environmental contamination, such as contaminated former industrial buildings. Screening proposed locations for indicators of site-related contamination could help prevent harmful exposures to children.

In 2016, ATSDR launched the CSPECE effort to help prevent harmful exposures (ATSDR, 2019a). Several states, including Connecticut, New Jersey, New York, and Pennsylvania, have already developed programs to address these concerns and their experience has helped inform ATSDR's CSPECE effort. ATSDR has already shared information on the early efforts of CSPECE, including the development of a Choose Safe Places manual (ATSDR, 2017; Somers & Ulirsch, 2018). ATSDR's website houses the manual and other resources for protecting children from environmental contaminants (ATSDR, 2019a).

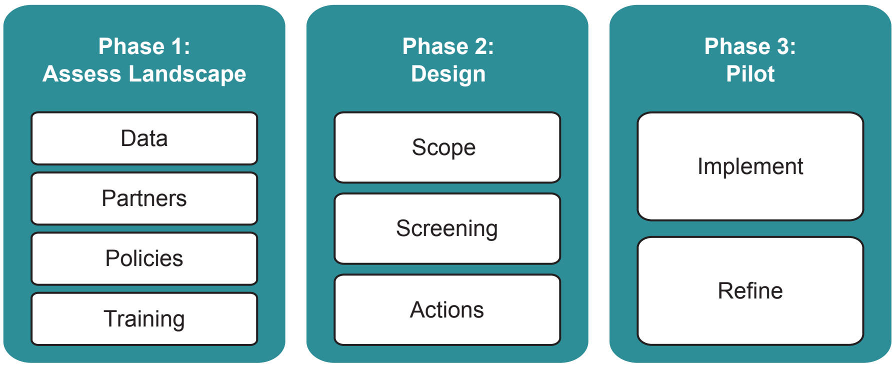
In spring 2017, ATSDR began a 3-year cooperative agreement with 25 states that supported the development of pilot programs for screening proposed ECE locations for site-related environmental contamination. The pilot programs could also provide recommendations for further assessment or mitigation to help prevent harmful exposures.

The state CSPECE work has three phases (Figure 1). The first phase involves a landscape assessment of the stakeholders and policies that could influence site-related contamination risk at ECEs. State staff also identified data for screening sites and trainings where CSPECE might be included. In the second phase, for those states without existing programs, state CSPECE staff and stakeholders develop a pilot plan that describes the scope, process for screening, and actions that could be taken. In the third phase, CSPECE staff implement, evaluate, and refine the pilot plan.

CSPECE complements other efforts to improve children's health. Caring for Our Children Basics, supported by the Administration for Children and Families, rep-

FIGURE **1**

Choose Safe Places for Early Care and Education Phases of State Pilot Development



resents the minimum health and safety standards that experts believe should be in place at ECE facilities (Administration for Children and Families, 2015). Caring for Our Children Basics includes the standard to conduct an environmental audit of a proposed site location. Caring for Our Children Basics is founded on *Caring for Our Children: National Health and Safety Performance Standards; Guidelines for Early Care and Education Programs*, a collection of over 600 national standards that represent the best practices for health and safety policies and practices for ECE settings (American Academy of Pediatrics, American Public Health Association, & National Resource Center for Health and Safety in Child Care and Early Education, 2019).

Results

In the first year of the 3-year CSPECE pilot effort, states identified partners and data needed to build a program (ATSDR, 2019b). Almost all 25 states engaged in the program had child care and licensing partners; most states also had environmental partners. In total, 146 partnerships were formed. To help assess contamination risk, almost all 25 states had locations of contaminated sites and most states found additional data such as water, property history, or soil contamination information. About 6,400 new ECE facilities open yearly in the 25 cooperative agreement states. While the pilot CSPECE effort will only address a portion of new ECE facilities, an expanded program could protect a large number of children.

Opportunities for linking CSPECE with zoning and training exist. Among the 25 states, 79 existing city or county zoning rules were identified that could help reduce environmental risks at ECEs. State CSPECE staff identified trainings for inspectors or ECE staff that could be leveraged to help inform them about CSPECE.

By the end of the second year, states had conducted outreach, developed pilot program plans, and some states had begun implementation. State CSPECE staff provided technical assistance to address ECE environmental concerns on 58 occasions. State CSPECE staff created 66 screening or educational tools and they educated over 1,100 people, including licensing staff and ECE providers. Approximately half of all state CSPECE programs proposed or were already implementing a policy, systems, or environmental change (e.g., providing recommendations to regulatory organizations).

Next Steps

By spring 2020, all CSPECE states will implement pilot programs to assess proposed ECE facility locations. States will determine the scope of the pilot effort, including whether the pilot effort is limited to a geographic area or types of contaminants. States can elect to conduct partner outreach and training. States can also determine what constitutes a potential risk and what action to take if a potential risk is identified.

States draw upon published literature, environmental data, and experience with environmental assessment to conduct screening. Epidemiologic studies have linked proximity to gas stations, major roads, and contaminated sites to adverse health outcomes (Brender, Maantay, & Chakraborty, 2011; Fazzo et al., 2017). Occupational epidemiologic studies identifying links between exposures and health outcomes could also help. State CSPECE staff are using inventories of hazardous sites or emissions data for screening proposed locations. Environmental specialists skilled in environmental site assessments (Wisconsin Department of Natural Resources, 2014) might have experience that could help with refining CSPECE screening methodologies in states. If property owners have access to completed environmental site assessments, the information could expedite a CSPECE screening.

States determine how to communicate findings and appropriate actions if a potential problem is identified. As with screening for other health-related issues, screening implies that acceptable diagnostic and treatment strategies exist. If screening is done for a specific concern, some state CSPECE programs can help identify viable strategies for confirmatory testing and mitigation. The ECE operator might also decide that selecting a different site is preferable. CSPECE state staff are working with stakeholders to design pilot plans that can rapidly identify risks and communicate the potential risks at a proposed ECE location.

Conclusion

The introduction posed questions about how to identify and address site-related environmental concerns for children. These questions are challenging; individuals can have different perspectives. The professionals involved with the CSPECE effort are working to build the programs, partnerships, resources, and knowledge to prevent ECE facilities from being located in areas that could lead to harmful exposures in children.

State and local environmental health professionals can get involved with CSPECE by learning more on ATSDR's CSPECE website (ATSDR, 2019a). They might consider taking CSPECE trainings that their states offer. Some state CSPECE programs might also seek assistance in designing and implementing the program; environmental health professionals could consider getting involved.

CSPECE strives to help prevent site-related contamination from harming children. The CSPECE work conducted in 25 states might take varied approaches but all are finding ways to identify environmental risks and prevent exposures at potential ECE locations. ATSDR's CSPECE work seeks to help build the systems and resources to facilitate strategies to prevent site-related exposures.

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References

Administration for Children and Families. (2015). *Caring for our children basics: Health and safety foundations for early care and education*. Washington, DC: Author. Retrieved from https://www.acf.hhs.gov/sites/default/files/ecd/caring_for_our_children_basics.pdf

Agency for Toxic Substances and Disease Registry. (2017). *Choose Safe Places for Early Care and Education (CSPECE) guidance manual*. Atlanta, GA: Author. Retrieved from https://www.atsdr.cdc.gov/safeplacesforece/docs/Choose_Safe_Places_508_final.pdf

Agency for Toxic Substances and Disease Registry. (2019a). *Choose Safe Places for Early Care and Education*. Retrieved from https://www.atsdr.cdc.gov/safeplacesforECE/index.html

Agency for Toxic Substances and Disease Registry. (2019b). *State cooperative agreement program*. Retrieved from https://www.atsdr.cdc.gov/states/index.html

American Academy of Pediatrics, American Public Health Association, & National Resource Center for Health and Safety in Child Care and Early Education. (2019). *Caring for our children: National health and safety performance standards; Guidelines for early care and education programs* (4th ed.). Itasca, IL: American Academy of Pediatrics. Retrieved from http://nrckids.org/files/CFOC4 pdf- FINAL.pdf

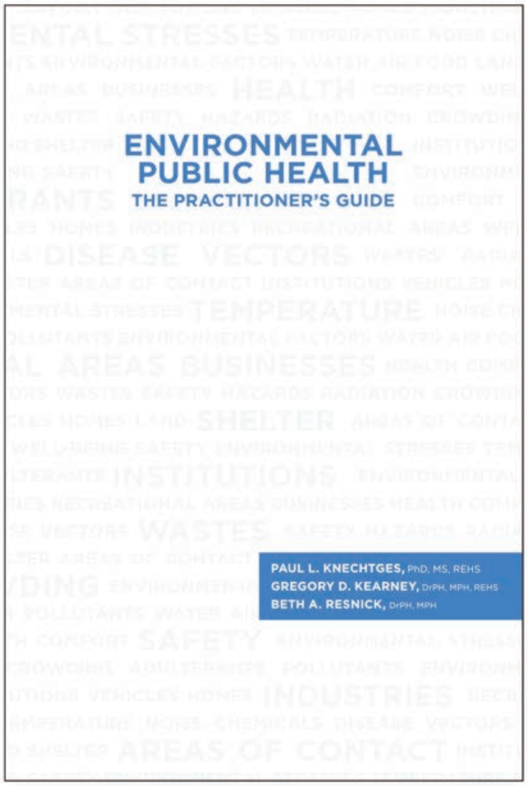
Brender, J.D., Maantay, J.A., & Chakraborty, J. (2011). Residential proximity to environmental hazards and adverse health outcomes. *American Journal of Public Health*, *101*(Suppl. 1), S37–S52.

Fazzo, L., Minichilli, F., Santoro, M., Ceccarini, A., Della Seta, M., Bianchi, F., . . . Martuzzi, M. (2017). Hazardous waste and health impact: A systematic review of the scientific literature. *Environmental Health*, *16*(107), 1–11.

Laughlin, L. (2013). *Who's minding the kids? Child care arrangements: Spring 2011*. Washington, DC: U.S. Census Bureau. Retrieved from https://www2.census.gov/library/publications/2013/demo/p70-135.pdf

Somers, T.S., & Ulirsch, G.V. (2018). Agency for Toxic Substances and Disease Registry child care safe siting initiative. *Journal of Environmental Health*, *78*(10), 40–42.

Wisconsin Department of Natural Resources. (2014). *Basic elements of phase I and II environmental site assessments*. Retrieved from https://dnr.wi.gov/files/pdf/pubs/am/am465.pdf



Environmental Public Health: *The Practitioner's Guide*

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DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES

Preventing Legionnaires' Disease Through a New Learning Opportunity: A Training on *Legionella* Water Management Programs

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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 this column on environmental health services from the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.**

In these columns, authors from CDC's Water, Food, and Environmental Health Services Branch, as well as guest authors, will share insights and information about environmental health programs, trends, issues, and resources. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of CDC.

The Need for Water Management Program Training

The number of reported Legionnaires' disease (LD) cases increased by more than 250% over the past decade, with at least 8,400 cases reported in 2018 (Centers for Disease Control and Prevention, 2018). A recent review of Centers for Disease Control and Prevention (CDC) field investigations indicates that 85% of LD outbreaks were caused by problems that could have been prevented with more effective water management (Garrison et al., 2016). Water management programs (WMPs) can help prevent cases of LD by identifying and addressing conditions that might lead to the growth and spread of *Legionella* bacteria within premise plumbing systems. WMPs can mitigate risk factors such as stagnation of water, inadequate residual disinfection levels, and improper maintenance of aerosolization devices (e.g., decorative fountains). The Centers for Medicare & Medicaid Services now requires healthcare facilities to have WMPs to minimize the risk of *Legionella* and other pathogens in hospitals, skilled nursing facilities, and critical access hospitals.

A proactive approach to water management requires a diverse team with skill sets in engineering and environmental health. In healthcare settings, the team should also include the skill set of infection control. This WMP team must have adequate knowledge of the building's water system, the capacity to identify proper control locations and limits, and the authority to implement appropriate corrective actions when necessary. Additionally, this team should have the ability to reconcile environmental data with clinical surveillance for LD. Effective educational resources and templates can help facility management and operations staff design and carry out a WMP (Lucas, Cooley, Kunz, & Garrison, 2016). In response to CDC's Federal Register Notice (Docket No. CDC–2017–0069) to assess WMP implementation methods, respondents indicated that inadequate awareness, knowledge, or expertise were major barriers to implementation. To address these needs, CDC developed a WMP toolkit (www.cdc.gov/legionella/wmp/toolkit/index.html), a suite of tools and materials for LD response and prevention (Table 1), and online training.

In December 2018, CDC and partners launched Preventing Legionnaires' Disease: A Training on *Legionella* Water Management Programs (PreventLD Training). The online training was designed for public health professionals, building managers, maintenance and engineering staff, safety officers, equipment and water treatment suppliers, infection control specialists, and other professionals involved in WMP design and implementation. CDC worked in partnership with the National Network of Public Health Institutes, the University of Arizona Mel and Enid Zuckerman College of Public Health, and the Western Region Training Center at the University of Arizona to create the PreventLD Training. A team of LD subject matter experts from federal agencies, industry, and health departments reviewed and provided consultation at every stage of the training development. The training meets CDC quality training standards, including a training needs assessment, accurate and relevant content, and learner engagement opportunities.

TABLE **1**

Centers for Disease Control and Prevention Legionnaires' Disease Resources

Resource and Description	Website
Fact sheets for distribution to employees, guests, or the public	www.cdc.gov/legionella/resources/materials.html
Steps involved in a full outbreak investigation • Considerations for travel-associated and community outbreaks • Patient interview and hypothesis generation tools • Line list templates	www.cdc.gov/legionella/health-depts/epi-resources/outbreak-investigations.html
Environmental investigation and sampling resources • Environmental assessment form • Sampling procedures and potential sampling sites protocol • Environmental investigation videos • Procedures for identifying cooling towers • Things to consider when hiring consultants	www.cdc.gov/legionella/health-depts/environmental-inv-resources.html
Laboratory resources • Environmental *Legionella* Isolation Techniques Evaluation (ELITE) program • Laboratory response plan toolkit • Processing environmental samples guidance • Specimen submission form	www.cdc.gov/legionella/labs/index.html
Healthcare investigation resources • Defining healthcare-associated disease • Unique healthcare investigation factors and guidance	www.cdc.gov/legionella/health-depts/healthcare-resources/index.html
Communication resources • Example notification letters for hotel guests, healthcare patients, and staff • Sample press releases and health advisories • Other communication considerations	www.cdc.gov/legionella/health-depts/communications-resources.html
Water management program guidance • Key elements of water management programs • Guidance for monitoring building water systems • Water management program data collection template • Special considerations for healthcare facilities • Public hot tub operator guidance	www.cdc.gov/legionella/wmp/index.html

TABLE **2**

Preventing Legionnaires' Disease: A Training on *Legionella* Water Management Programs (PreventLD Training) Sections and Corresponding ASHRAE 188 Standard Steps

Section	ASHRAE 188 Standard Step
Module A: Getting Started–Introduction to *Legionella*	Step 1: Create a water management program team
Module B: Hazard Analysis	Step 2: Describe the building water systems using text and flow diagrams Step 3: Identify areas where *Legionella* could grow and spread
Module C: Hazard Control	Step 4: Decide where control measures should be applied and how to monitor them Step 5: Establish ways to intervene when control limits are not met
Module D: Confirmation	Step 6: Make sure the program is running as designed and is effective (verification and validation) Step 7: Document and communicate all the activities of your water management program
Additional resources	Healthcare facility case study Manufacturing facility case study Templates

PreventLD Training Highlights

PreventLD Training is a free, dynamic, online training made up of modules that follow the seven steps of creating a *Legionella* WMP consistent with the industry standard (i.e., ASHRAE Standard 188) for minimizing the risk of LD (Table 2). Pilot testers took an average of a half hour to complete each module and an average of 3 hours to complete the entire training. The training provides tools to manage water systems in hospitals, retirement homes and long-term care facilities, hotels, high-rise apartment complexes, and other buildings. This training also addresses other devices that might need a WMP such as cooling towers, decorative fountains, hot tubs, and water misters. Through interactive course content and templates (Figures 1 and 2), users create an action plan for developing a practical WMP and team. Course participants also have the opportunity to apply the learning concepts in two case study scenarios: a skilled nursing facility and a manufacturing facility. These case studies provide concrete examples of potential challenges and solutions faced when creating and implementing a WMP.

Diverse organizations working with hospitals, hotels, and state and local organizations have promoted the PreventLD Training. As of July 2019, over 1,600 participants have registered for the training. Most training participants have been environmental health staff, followed by professionals from infection control and prevention, engineering and maintenance, and nursing homes. Wide use of this training should lead to more effective WMPs and a reduced risk of patient, visitor, guest, and staff exposure to *Legionella* bacteria. Take advantage of PreventLD Training by enrolling today or sharing with colleagues. Learn more at www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html.

FIGURE **1**

Key Skills of a Water Management Program Team

FIGURE **2**

Preventing Legionnaires' Disease: A Training on *Legionella* Water Management Programs (PreventLD Training) Hazard Control Table Template

Water Processing Step	Potential Hazards (Microbial, Chemical, Physical)	Risk Characterization (Significant Y/N)	Basis for Risk Characterization	Hazard Control Options (at This Location)	Is Control at This Location Essential? (Y/N)
1. Receiving					
2. Cold Water Distribution					
3. Heating					
4. Hot Water Distribution					
5. Wastewater					

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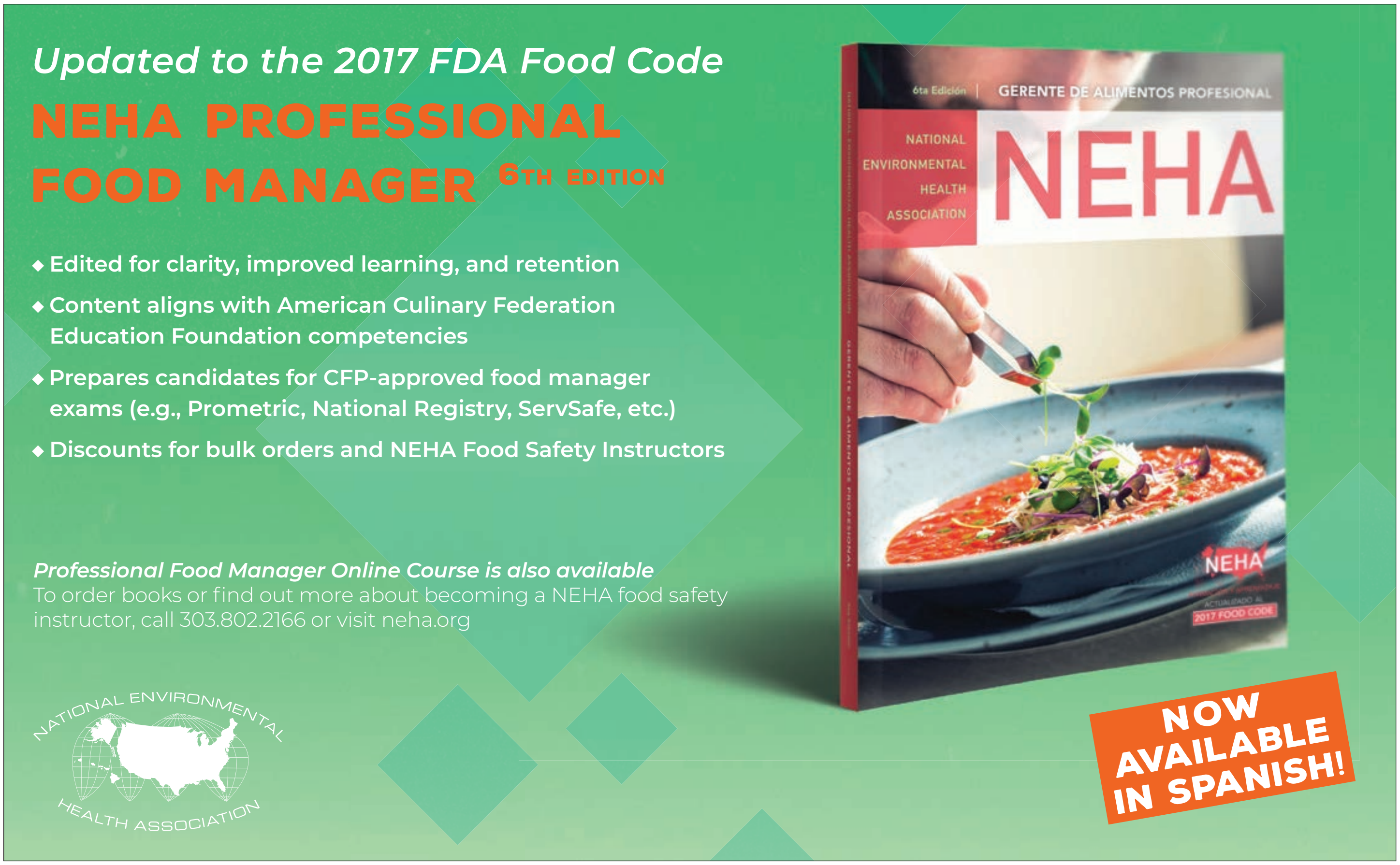
References

Centers for Disease Control and Prevention. (2018). *National Notifiable Diseases Surveillance System: Notifiable infectious diseases and conditions data tables*. Retrieved from https://wwwn.cdc.gov/nndss/infectious-tables.html

Garrison, L.E., Kunz, J.M., Cooley, L.A., Moore, M.R., Lucas, C., Schrag, S., . . . Whitney, C.G. (2016). Vital Signs: Deficiencies in environmental control identified in outbreaks of Legionnaires' disease—North America, 2000–2014. *Morbidity and Mortality Weekly Report*, *65*(22), 576–584.

Lucas, C., Cooley, L.A., Kunz, J.M., & Garrison, L.E. (2016). Legionnaires' outbreaks preventable with water management programs. *ASHRAE Journal*, *58*(11), 84–86.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EH CALENDAR

UPCOMING NEHA CONFERENCES

July 13–16, 2020: NEHA 2020 Annual Educational Conference & Exhibition, New York City, NY. For more information, visit www.neha.org/aec.

July 12–15, 2021: NEHA 2021 Annual Educational Conference & Exhibition, Spokane, WA.

NEHA AFFILIATE AND REGIONAL LISTINGS

Alabama
October 16–18, 2019: Annual Conference, hosted by the Alabama Environmental Health Association, Lake Eufaula, AL. For more information, visit www.aeha-online.com.

Alaska
October 9–11, 2019: Annual Education Conference, hosted by the Alaska Environmental Health Association, Anchorage, AK. For more information, visit https://aehablog.wordpress.com.

California
October 24, 2019: CEHA Update, hosted by the Redwood Chapter of the California Environmental Health Association, Santa Rosa, CA. For more information, visit www.ceha.org/2019-update.html.

Illinois
November 4–5, 2019: Annual Educational Conference, hosted by the Illinois Environmental Health Association, Utica, IL. For more information, visit www.iehaonline.org.

Michigan
March 18–20, 2020: Annual Education Conference, hosted by the Michigan Environmental Health Association, Traverse City, MI. For more information, visit www.meha.net/AEC.

New Mexico
October 22–23, 2019: Annual Conference, hosted by the New Mexico Environmental Health Association, Albuquerque, NM. For more information, visit www.nmeha.org.

Texas
October 14–18, 2019: 64th Annual Educational Conference, hosted by the Texas Environmental Health Association, Austin, TX. For more information, visit www.myteha.org.

Virginia
October 29, 2019: Fall Educational Conference, hosted by the Virginia Environmental Health Association, Richmond, VA. For more information, visit https://veha32.wildapricot.org/events.

Wisconsin
October 16–18, 2019: Annual Educational Conference, hosted by the Wisconsin Environmental Health Association, Elkhart Lake, WI. For more information, visit www.weha.net.

TOPICAL LISTINGS

Emergency Response
November 10–15, 2019: Environmental Health Training in Emergency Response Operations, held by the Federal Emergency Management Agency's Center for Domestic Preparedness, Anniston, AL. For more information, visit https://cdp.dhs.gov/find-training/course/PER-309.

Food Safety
March 9–12, 2020: Integrated Foodborne Outbreak Response and Management (InFORM) 2020 Conference, Atlanta, GA. For more information, visit www.aphl.org/conferences/InformConf/Pages/default.aspx.

Recreational Water
October 16–18, 2019: 16th Annual World Aquatic Health Conference, hosted by the National Swimming Pool Foundation, Williamsburg, VA. For more information, visit www.nspf.org/wahc.

Did You Know?

Septic systems can be damaged and might fail to operate correctly after a disaster. Ensuring that these systems function properly is essential to providing safe waste disposal for millions of U.S. residents, yet there can be a lack of standard safety protocols for using septic systems after disasters occur. NEHA has worked with subject matter experts and national partners to develop a toolkit with guidance documents for different types of disasters such as hurricanes and flooding, wildfires, earthquakes, freezing temperatures, and power outages. Access the toolkit at www.neha.org/eh-topic/preparedness-response-septic-systems.

CAREER **OPPORTUNITIES**

Food Safety Inspector

UL Everclean is a leader in retail inspections. We offer opportunities across the country. We currently have openings for trained professionals to conduct audits in restaurants and grocery stores. Past or current food safety inspection experience is required.

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In addition to food safety inspectors, we are also looking for GMP auditors for OTC, dietary supplement, and medical device applications. If interested, contact Diane Elliott at Diane.Elliott@ul.com to apply or receive further information.

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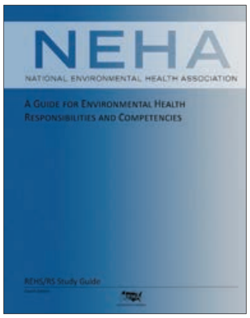
RESOURCE CORNER

Resource Corner highlights different resources the National Environmental Health Association (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

REHS/RS Study Guide (4th Edition)

National Environmental Health Association (2014)



The Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential is National Environmental Health Association's (NEHA) premier credential. This study guide provides a tool for individuals to prepare for the REHS/RS exam and has been revised and updated to reflect changes and advancements in technologies and theories in the environmental health and protection field. The study guide covers the following topic areas: general environmental health; statutes and regulations; food protection; potable water; wastewater; solid and hazardous waste; zoonoses, vectors, pests, and poisonous plants; radiation protection; occupational safety and health; air quality; environmental noise; housing sanitation; institutions and licensed establishments; swimming pools and recreational facilities; and disaster sanitation.

308 pages / Paperback
Member: $149 / Nonmember: $179

Certified Professional–Food Safety Manual (3rd Edition)

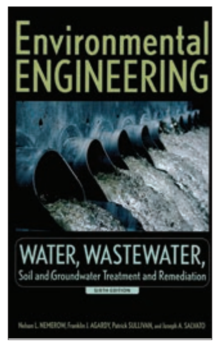
National Environmental Health Association (2014)

The Certified Professional–Food Safety (CP-FS) credential is well respected throughout the environmental health and food safety field. This manual has been developed by experts from across the various food safety disciplines to help candidates prepare for NEHA's CP-FS exam. This book contains science-based, in-depth information about causes and prevention of foodborne illness, HACCP plans and active managerial control, cleaning and sanitizing, conducting facility plan reviews, pest control, risk-based inspections, sampling food for laboratory analysis, food defense, responding to food emergencies and foodborne illness outbreaks, and legal aspects of food safety.

358 pages / Spiral-bound paperback
Member: $179 / Nonmember: $209

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)

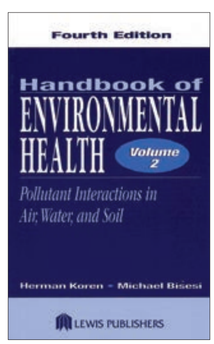


First published in 1958, Salvato's *Environmental Engineering* has long been the definitive reference for generations of sanitation and environmental engineers. The most recent edition was completely rewritten by leading experts in the field and offers succinct new case studies, new process and plant 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 Registered Environmental Health Specialist/Registered Sanitarian exam.

384 pages / Hardback
Member: $140 / Nonmember: $155

Handbook of Environmental Health, Volume 2: Pollutant Interactions With Air, Water, and Soil (4th Edition)

Herman Koren and Michael Bisesi (2003)



A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the outdoor environment. It was written by experts in the field and copublished with NEHA. A variety of environmental issues are covered such as toxic air pollutants and air quality control; risk assessment; solid and hazardous waste problems and controls; safe drinking water problems and standards; onsite and public sewage problems and control; plumbing hazards; air, water, and solid waste programs; technology transfer; GIS and mapping; bioterrorism and security; disaster emergency health programs; ocean dumping; and much more. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

876 pages / Hardback
Volume 2: Member: $215 / Nonmember: $245

JEH QUIZ

FEATURED ARTICLE QUIZ #2

Public Awareness and Perceptions Surrounding Radon Testing in a State With High Radon Emission Potential and Low Smoking Rates

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) hours 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 found at www.neha.org/publications/journal-environmental-health,

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

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   720 S. Colorado Blvd., Ste. 1000-N
   Denver, CO 80246.

   Be sure to include your name and member number!
4. One CE hour will be applied to your account with an effective date of October 1, 2019 (first day of issue).
5. Check your continuing education account online at www.neha.org.
6. You're on your way to earning CE hours!

Quiz Registration

Name

NEHA Member Number

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JEH Quiz #6 Answers

May 2019

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

➔ Quiz deadline: January 1, 2020

1. Radon is the leading cause of lung cancer mortality among nonsmokers.
   a. True.
   b. False.

2. A radon level of __ in indoor air is recognized by the Centers for Disease Control and Protection, U.S. Environmental Protection Agency, and World Health Organization as harmful.
   a. 1 pCi/L
   b. 2 pCi/L
   c. 3 pCi/L
   d. 4 pCi/L

3. In this study, __ of Utah residents never tested their homes for radon and __ could not identify radon as a risk factor for lung cancer.
   a. 50%; 75%
   b. 50%; 80%
   c. 75%; 80%
   d. 80%; 75%

4. Utah has the lowest smoking rate in the U.S., with less than __ of the Utah population estimated to be smokers.
   a. 6%
   b. 9%
   c. 10%
   d. 15%

5. At a national level, the following tend to be the most uninformed about radon:
   a. women.
   b. racial/ethnic minorities.
   c. less educated populations.
   d. lower-income households.
   e. all of the above.

6. Only __ of study participants reported ever testing their homes for radon.
   a. 15%
   b. 17%
   c. 19%
   d. 21%

7. Of the participants who were unaware of testing, __ did not know what radon was and __ had never thought about testing.
   a. 25%; 65%
   b. 25%; 45%
   c. 65%; 45%
   d. 65%; 25%

8. Lung cancer was identified as an outcome of radon exposure by __ of respondents from all counties.
   a. 17.2%
   b. 20.5%
   c. 21.9%
   d. 22.2%

9. Of respondents from all counties, __ identified cost as a reason for not testing their homes for radon.
   a. 4%
   b. 5%
   c. 6%
   d. 7%

10. Of respondents from high radon counties, __ were unaware of radon testing.
    a. 24.6%
    b. 39.1%
    c. 39.9%
    d. 40.0%

11. Compared with urban residents, rural residents were __ to test for radon and to identify radon as a risk factor for lung cancer.
    a. less likely
    b. more likely

12. Utah landlords are required to test for radon, disclose radon levels to tenants, or mitigate the rental property for radon.
    a. True.
    b. False.

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The board of directors includes NEHA's nationally elected officers and regional vice-presidents. Affiliate presidents (or appointed representatives) comprise the Affiliate Presidents Council. Technical advisors, the executive director, and all past presidents of the association are ex-officio council members. This list is current as of press time.

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NEHA 2019 AEC WRAP-UP

83rd ANNUAL EDUCATIONAL CONFERENCE & EXHIBITION
Nashville, Tennessee • July 9 - July 12

Local Voices. Universal Language.

Jonna Ashley
Kristie Denbrock
Soni Fink
Angelica Ledezma
Robert Stefanski
National Environmental Health Association

The 83rd Annual Educational Conference (AEC) & Exhibition continued the National Environmental Health Association's (NEHA) excellent track record of hosting a highly successful and innovative event. The 2019 AEC took place July 9–12 in the beautiful city of Nashville, Tennessee, affectionately referred to as the Music City because of its robust live music scene. Nearly 1,200 environmental health practitioners from all corners of the globe gathered together to meet, interact, and build their professional networks. Attendees learned how the perspectives of local agencies, industries, and levels of government fit into the universal language of environmental health and how their unique voices advance the profession to ensure the safety of the public and environment.

NEHA 2019 AEC photos courtesy of Jason Mallory, Event Coverage Nashville, www.eventcoveragenashville.com.

A highly informative and inspirational keynote address was delivered by Dr. Robert Kadlec, Assistant Secretary for Preparedness and Response at the U.S. Department of Health and Human Services. Speaking to a capacity crowd, Dr. Kadlec discussed the urgency to protect our nation and its people during increasingly complex and dangerous environments. Dr. Kadlec highlighted opportunities for environmental health professionals to provide their expertise and engage in a shared disaster preparedness mission. He presented key initiatives and priorities of his office, stressing the importance of innovation, recovery after a disaster, and how to restore communities so that every person feels safe and secure upon returning home.

Following Dr. Kadlec's address was Anne Godfrey, chief executive of the Chartered Institute of Environmental Health. Godfrey led a thought-provoking discussion about the history of the environmental health profession, its workforce, and how both have evolved over time. She shared many interesting facts, one being that environmental health practitioners in the United Kingdom were referred to as "Inspectors of Nuisance" back in the 1840s. Food safety, healthy homes, and other topics were covered, with Godfrey providing one of the great quotes of the day: "Size matters when it comes to advocacy but small organizations still have a voice with the expertise of professionals."

The 2019 AEC hosted 205 educational sessions, workshops, and learning labs covering a wide range of prominent and emerging environmental health issues such as emergency response and preparedness, disaster relief and recovery, infectious and vectorborne diseases, climate and health, food safety, and retail food standards, as well as other environmental health topics. Over 250 speakers from around the world shared the latest information, trends, research, tools, and resources to packed rooms. The exhibit hall was filled with over 70 exhibitors from various industries showcasing innovative products and services that improve the job functions and performance of environmental health professionals.

Social events are a fun-filled and popular component of the AEC and this year provided attendees with some of the most exciting events to date! Nearly 800 people relaxed and socialized with their fellow peers aboard the General Jackson Showboat, enjoying scenic views as they cruised down the beautiful Cumberland River. Underwriters Laboratories (UL) hosted another successful UL Event at the historic Grand Ole Opry House. The event included an onstage dinner reception and tours were given backstage where many famous musical icons prepared before appearing on the world-renowned main stage.

NEHA wishes to thank its attendees, members, board, staff, technical advisors, presenters, exhibitors, and sponsors who participated and contributed to the success of the 2019 AEC. The conference could not be possible without you! We look forward to seeing everyone next year in New York City for the 2020 AEC. Check out the promo for next year's conference on page 67.

Featured Speakers

Keynote Address: July 9

Robert Kadlec, MS, MTM&H, MD, Assistant Secretary for Preparedness and Response, U.S. Department of Health and Human Services

Bringing federal medical and public health support to local and state authorities was the major theme of the 2019 AEC Keynote Address presented by Dr. Kadlec. He explained the structure of the Office of the Assistant Secretary for Preparedness and Response within the U.S. Department of Health and Human Services, as well as the programs and roles it plays during a variety of disasters. These programs include 1) the National Disaster Medical System that supports patient care and movement, definitive care, and fatality management during emergencies; 2) the Hospital Preparedness Program that promotes a sustained national focus to improve patient outcomes, minimize the need for supplemental state and federal resources during emergencies, and enable rapid recovery; and 3) the Regional Disaster Health Response System that emphasizes collaboration among local healthcare coalitions, trauma centers, public and private healthcare facilities, and emergency medical services to expand access to specialty clinical care expertise and increase medical surge capacity. Dr. Kadlec concluded his presentation to the packed room by discussing the understanding of response and recovery and the anticipated challenges to environmental health.

Grand Session Kickoff: July 10

Anne Godfrey, CCMI FCIM, Chief Executive, Chartered Institute of Environmental Health

The first full day of educational sessions commenced with the Grand Session Kickoff presented by Anne Godfrey. Utilizing the Chartered Institute of Environmental Health's history of over 130 years and keeping with the 2019 AEC theme (Local Voices. Universal Language.), Godfrey's presentation was titled, "A Profession United? The Evolution of Environmental Health Practice." She spoke of the key issues facing environmental health professionals as the profession has evolved, including austerity, changing food controls and delivery, and Brexit and its possible impact on public health and protection. She also addressed the declining UK environmental health workforce and having to "do more with less." A recent Chartered Institute of Environmental Health workforce survey identified a 12% reduction in environmental health staff. Creativity and innovation, along with growth in the private and third-sector environmental health workforces, multidisciplinary professional teams, variation by region, and devolved nations, were areas she addressed to combat the declining workforce. Godfrey concluded with examples of a "caring profession" that consists of passion, partnership, professionals, and unity of purpose. Emphasizing the importance of every environmental health professional, she closed by saying that major impacts happen because "one environmental health officer cared."

Closing Session: July 12

Grayson Brown, PhD, Executive Director, Puerto Rico Vector Control Unit

The 2019 AEC came to a close with a presentation from Dr. Brown on the rapid changes taking place in the field of vector management and control in Puerto Rico. The Puerto Rico Vector Control Unit is an initiative of the Puerto Rico Science, Technology, and Research Trust, a private nonprofit organization. The unit focuses on strengthening the capacity for vector control in Puerto Rico, as well as implementing vector surveillance, creating innovative information systems, carry out vector control operations, and boosting community engagement. Its overall vision is, "Striving together for a Puerto Rico free from mosquito-borne disease." Dr. Brown began the Closing Session with a review of the current status of vector management programs and the current challenges with insecticide resistance, invasive species, and regulatory and legal issues. He went on to discuss new and emerging vectorborne disease threats, as well as new technology to address these threats with an emphasis on how they can be adapted into ongoing programs. Dr. Brown closed his presentation with insights on the progress being made toward a national strategy for integrated vector management and funding prospects of such an initiative.

Education & Training

More than 200 educational, informative, and inspiring sessions along with nearly 1,200 attentive attendees demonstrated at the 2019 AEC that the environmental health profession does speak in local voices that make up a universal language. The sessions encompassed the wide scope of environmental health (see sidebar on page 57 for a list of session tracks) and spanned over three days of the conference.

There was standing-room only for many of the emerging issue topics such as new data and technology developments, cannabis, and the latest food safety regulations and practices. "I was able to collaborate with other environmental professionals and gather ideas to bring back to my organization," one attendee commented on the conference evaluation. Overall, 94% of attendees rated the conference as meeting or exceeding their expectations. In terms of why they attended, 88% of conference attendees wanted to learn more about the most current trends in environmental health, 74% wanted to connect with other environmental health professionals, and 51% wanted to earn continuing education credits.

Sessions with universal appeal garnered the highest attendance. These sessions included the interactive Learning Labs, "Water Emergencies and Outbreaks: Tools and Guidance for Preparedness and Response" presented by Jonathan Yoder from the National Center for Emerging Zoonotic and Infectious Diseases at the Centers for Disease Control and Prevention (CDC); and "A NEHA LeaderHERship Sessions: EH Workplace Matters and Sorry, Not Sorry; How to Speak With Authority and Confidence" presented by Michéle Samarya-Timm from the Somerset County Department of Health. As one attendee stated, "Several talks were directly relevant to my job and role. I was able to learn new skills that will help me develop as a professional."

CDC's National Center for Environmental Health, cosponsors of the 2019 AEC, hosted water and food safety sessions that were popular with the attendees. Presentation included "Improving Restaurant Food Safety: CDC's Practice-Based Research;" "Critical Contributions: Cases Studies on Environmental Health and Foodborne Illness Outbreak Investigations;" and "Environmental Health Data That Inform Foodborne Illness Outbreak Prevention: CDC's National Environmental Assessment Reporting System."

Food safety, water quality, special populations, and data and technology sessions drew large crowds of attendees.

NEHA Executive Director Dr. David Dyjack moderated a panel on rebuilding post-hurricane environmental health systems.

The Learning Lab sessions gave attendees the opportunity to interact in small groups and learn about a variety of relevant topics.

Attendees were engaged during the educational sessions and had many thoughtful and inquisitive questions for the speakers.

As in past years, several presentations were recorded at the conference and were made available to 2019 AEC attendees in September to view on NEHA's learning management system. In March 2020, NEHA members will be given access to these presentations. The recorded presentations cover a variety of topics including food safety, cannabis, per- and polyfluoroalkyl substances (PFAS), vector control and vectorborne diseases, climate change, and water quality. The Keynote Address, Grand Session Kickoff, and Closing Session were also recorded.

Networking opportunities at the AEC are instrumental in bringing together those who work in the next office, city, county, state, and country. "Networking at NEHA is always among the best, so many opportunities to engage with colleagues from around the world! Saw so many valuable presentations and a wide variety of topics and speakers," commented one attendee. Another attendee went on to say that the 2019 AEC was a "well balanced slate of opportunities for learning and networking."

While the 2019 AEC was just a few months back, work is already under way for the 2020 AEC. The 2020 AEC, NEHA's 84th annual conference, will take place July 13–16 at the Sheraton New York Times Square Hotel in New York City. Preconference workshops will take place prior to that on July 11–12. The Call for Abstracts is open until October 7. NEHA seeks abstracts that address the latest advances in environmental health, as well as practical applications in both public and private sectors. Visit www.neha.org/aec/abstracts for more information. And stay tuned to www.neha.org/aec over the coming months as we start to post information about registration, lodging, special events, and the educational program.

2019 AEC SESSION TRACKS

This year's educational program featured over 200 sessions within 10 tracks and 32 disciplines.

1. **Climate & Health**
   - Climate Change
2. **Data & Technology**
   - Environmental Health Tracking & Informatics
   - Technology & Environmental Health
3. **Emergency Preparedness**
   - Emergency Preparedness & Response
4. **Food**
   - Food Safety & Defense
   - Home Restaurants
5. **General Environmental Health**
   - Air Quality
   - Emerging Environmental Health Issues
   - Food Waste
   - General Environmental Health
   - Global Environmental Health
   - Hazardous & Toxic Materials
   - Solid Waste
   - Sustainability
6. **Healthy Communities**
   - EH Health Impact Assessment
   - Healthy Homes & Communities
   - Land Use Planning & Design
   - Lead
   - School & Institutions
7. **Infectious and Vectorborne Diseases**
   - Pathogens & Outbreaks
   - Vector Control & Zoonotic Diseases
8. **Special Populations**
   - Children's Environmental Health
   - Environmental Justice
   - Uniformed Services
9. **Water**
   - Onsite Wastewater
   - Premise Plumbing
   - Recreational Water (including shorelines)
   - Unregulated Drinking Water
   - Water Quality
   - Water Reuse
10. **Workforce & Leadership**
    - Leadership/Management/ Enumeration
    - Student & Young Professional Career Development

Education & Training

Preconference Courses & Workshops

More than 200 attendees enhanced their knowledge and AEC experience with one of the seven preconference offerings at the 2019 AEC.

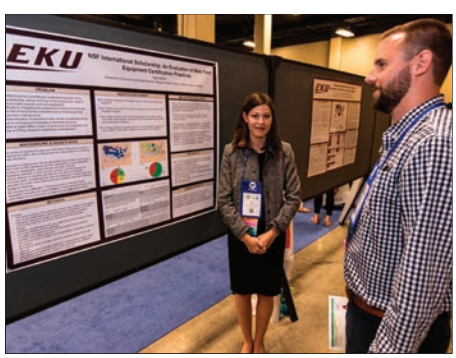
As in previous years, attendees had the opportunity to take a review course and exam at the AEC for two of NEHA's most popular credentials—the Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) and Certified Professional–Food Safety (CP-FS) credentials. The CP-FS Review Course prepared 16 attendees and the REHS/RS Review Course prepared 25 attendees for each credential's respective exam. A total of 41 attendees kicked off the AEC by taking a NEHA credential exam with 85% receiving a passing score.

NEHA continued offering some of the most successful preconference workshops from previous years. Nearly 40 affiliate leaders attended the Affiliate Leadership Workshop to learn about government advocacy and what role they can play for their environmental health associations surrounding advocacy at the local level. The Survival Skills for Environmental Health Leaders Workshop was once again a success in teaching leadership and management skills in an engaging environment to emerging professionals.

A handful of new preconference workshops were offered in Nashville on a variety of topics. NEHA partnered with ecoAmerica, Climate for Health to combat the growing concern of climate change with a half-day Ambassador Training. Over 50 participants were equipped with knowledge, hands-on experience, and resources to speak and act confidently on climate change and solutions. In the NEHA/Food and Drug Administration's National Retail Food Regulatory Program Standards Self-Assessment and Verification Audit Workshop, attendees were given an overview of the program standards criteria and hands-on experience in conducting a self-assessment or verification audit. In the Instructional Skills Training, attendees learned how to make presentations and teaching more exciting in a full-day workshop that taught participants how to deliver effective and engaging training geared specifically toward adults.

Student Poster Session

A wide spectrum of environmental health research topics were displayed and presented during the Student Poster Session. In total, 29 posters were displayed in the exhibit hall. Topics ranged from establishing an air monitoring network for wildfire smoke, mosquito surveillance, and food allergy awareness training to assessing e-cigarette use in educational institutions through an ecological framework. One attendee commented, "The student presentations were excellent and a great way to meet other academics."



Student Activities

Students are an important part of the NEHA community. To recognize this key group of members, NEHA held a Student Welcome Reception before the Keynote Address on July 9. During this networking event, students had the opportunity to connect with leadership and get acquainted with programming NEHA offers for the next generation of environmental health professionals at the conference and throughout the year.

This year marked the 50th anniversary of NEHA's longtime partner, the National Environmental Health Science & Protection Accreditation Council (EHAC). To celebrate its anniversary, EHAC created a large poster representing their history supporting environmental health academic programs and their students. The poster was displayed prominently through the duration of the conference. EHAC schools also encouraged their students to present research posters in the exhibit hall, which contributed to the large number of students in attendance at the 2019 AEC.

Social Events

General Jackson Showboat Event: July 10

Nearly 800 attendees enjoyed a warm summer evening in Nashville cruising down the Cumberland River toward the downtown Nashville skyline. Attendees enjoyed a variety of Tennessee-inspired cuisines and ice-cold beverages during the 3.5 hour cruise. Those onboard networked, relaxed, and danced the night away while up-and-coming country singer and songwriter Jay Bragg kept the entertainment going into the evening. Thank you to Hedgerow Software US, Inc. for sponsoring the onboard photo booth where guests snapped a photo to commemorate the evening. And thank you to the attendees for making the General Jackson Showboat Event a night to remember.

Grand Ole Opry House UL Event: July 11

Attendees of this year's sold out UL Event got to explore what many refer to as "the heart of country music." The evening at the Grand Ole Opry House included an onstage dinner reception, backstage tours, and the once in a lifetime experience of standing where country music legends like Johnny Cash, Willie Nelson, and Dolly Parton have performed. The historic venue set the stage for attendees to connect with old friends, meet new colleagues, and expand their network. Thank you to Underwriters Laboratories for continuing to sponsor this exciting event!

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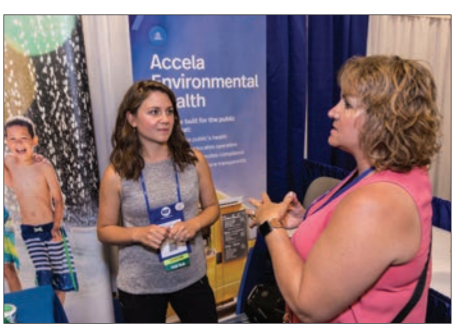
Exhibition

The Exhibition Grand Opening took place on July 9 after the Keynote Address. The exhibit hall was packed with 73 booths this year, with representatives from federal agencies, non-profit organizations, academic institutions, and private companies representing the broad spectrum of environmental health topics. It was great to see past exhibitors offering information on products and services to make the lives and work of conference attendees easier and more efficient, as well as see a whole array of new exhibitors present at the 2019 AEC. The Student Poster Session consisting of 29 posters was held in the exhibit hall and offered attendees further learning opportunities while perusing all the booths.

A variety of food and beverages were enjoyed during the Exhibition Grand Opening. The exhibit hall was described by attendees and exhibitors as exciting, engaging, and alive. Exhibit hall hours were extended by an hour this year, which helped to accommodate longer conversations and additional networking among previous friends and new contacts.

Located in the center of the exhibit hall was NEHA's booth—a popular place for people to interact with NEHA staff and board members. Attendees could pick up a free copy of the June 2019 *Journal of Environmental Health* that included an article about the groundbreaking UNCOVER EH initiative conducted by NEHA, the Centers for Disease Control and Prevention, and Baylor University. Attendees could also learn more about NEHA's programs and educational offerings. A drawing for a full registration to the 2020 AEC in New York City was held in the NEHA booth. The drawing winner was Alan Whyman of the Palm Beach County Health Department.

The second day of the Exhibition brought more interaction among conference attendees. The morning coffee break in the exhibit hall was sponsored by GOJO Industries and NYC & Company provided black and white cookies for the afternoon break to promote the 2020 AEC. Both breaks contributed to more traffic in the exhibit hall. Overall, the Exhibition was a great success for networking, learning, and finding new treasures. Thank you to the exhibitors who helped make the event a success.



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5,000
NEHA INFORMATION









Check out more photo booth shots at www.neha.org/aec!





Awards, Honors, & Scholarship Recipients

Numerous notable individuals and organizations were recognized at the 2019 AEC. For more information about NEHA's awards, please visit www.neha.org/about-neha/awards.

Accela/NEHA 2019 AEC Scholarships

Accela Environmental Health and NEHA partnered to award scholarships to 12 professionals to attend the 2019 AEC.

Vincentiu Anghel
Meredith Garman
Adam Hahn
Maia Hanson
Nicholas Iszler
Shannon Jaworski
Matthew Simonovic
Twila Singh
Mark Sproat
Amber Sturdivant
Kelsi Sullivan
Audrey Tran Lam

AEHAP Student Research Competition Winners

Presented by the Association of Environmental Health Academic Programs (AEHAP), this award recognizes students who have conducted outstanding research benefiting the field of environmental health.

Summer Corsolini
Nicholas D'Antonio
Thomas Gerding
Justine Marecaux
Darcy Van Deventer

Davis Calvin Wagner Sanitarian Award

This award represents the highest honor that the American Academy of Sanitarians bestows upon one of its diplomates.

CAPT Michael M. Welch

Dr. R. Neil Lowry Grant

Given by the Association of Pool & Spa Professionals, this award honors and recognizes public health officials who have made outstanding contributions to advance the public's healthy and safe use of recreational water.

Pueblo Department of Public Health and Environment

HUD Secretary's Award for Healthy Homes

The U.S. Department of Housing and Urban Development (HUD), in partnership with NEHA, gives this award to recognize excellence in making indoor environments healthier through healthy homes research, education, and program delivery, especially in diverse, low-to-moderate income communities.

City of Rochester, New York, Certificate of Occupancy and Lead Inspection Program

Partnership Between the American Association of Radon Scientists and Technologists in North Carolina and HUD Multifamily Program

NEHA Affiliate Certificates of Merit

Awarded to affiliate members and teams who made exemplary contributions to the profession. Each affiliate selects winners based upon its own criteria for recognition. The nominating affiliate is indicated in parentheses.

Individuals

Tesann Achilles (AZ)
LCDR Katie Bante (Uniformed Services)
Sandy Bubke (IA)
Tom Butts (CO)
Alice Cadotte (NJ)
Chuck DeJockheere (OH)
Mark DiMenna (NM)
Diane Eastman (CA)
John Galbraith (VA)
Kristen Geary (MO)
Tony Georgeson (MN)
Alysa Gustafson (AK)
Hunter Hubrig (ND)
Ed Norris (IN)
Carol Pharr (AL)
Stacy Thompson (IL)
Natalie Vandeveld (WI)
Lynette Wheatley (NJ)
Stacy Williamson (AL)
Vivian Zang (MA)

Teams

Fairfax County Health Department: NACCHO Mentorship Program Leadership Team (VA)

Florida Environmental Health Association 2018 Annual Education Meeting Planning Committee (FL)

Iowa Environmental Health Association 2018 Fall Conference Planning Committee (IA)

Accela/NEHA 2019 AEC Scholarship recipients with Accela's Darryl Booth (far right).

AEHAP Student Research Competition winners and NSF International Scholarship Program winner with NSF's Derek DeLand (top left) and AEHAP's Dr. Clint Pinion (top right).

HUD Secretary's Award for Healthy Homes winners with HUD's Michelle Miller (middle).

NEHA Past Presidents Award winner Dr. Bryan Brooks (right) with NEHA Past President Bob Custard (left).

NEHA Past Presidents Award

Each year, NEHA's Past Presidents affiliate identifies a hero or group of heroes from the profession of environmental health.

Bryan W. Brooks

NEHA Presidential Citations

This award is given to individuals who have made exemplary contributions to NEHA during the president's term of office. President Vince Radke presented the following citations.

James Balsamo
Robert Blake
Eric Bradley
Laura Brown
Brian Collins
Robert Custard
Michele DiMaggio
Tambra Dunams
Justin Gerding
Ernest Julian
Jasen Kunz
Glenda Lewis
Adam London
John Marcello
Monterey County Health Department, Environmental Health Bureau
Marilyn Radke
Michele Samarya-Timm

Minneapolis Health Department staff proudly display the 2019 Samuel J. Crumbine Consumer Protection Award plaque.

NSF International Scholarship Program

AEHAP, in partnership with NSF International, offers a paid internship project to students from National Environmental Health Science & Protection Accreditation Council–accredited programs.

Kate Walters

Samuel J. Crumbine Consumer Protection Award

This award is given annually to local environmental health jurisdictions that demonstrate unsurpassed achievement in providing outstanding food protection services to their communities.

Minneapolis Health Department

On behalf of the organization, NEHA President Vince Radke accepts USEHA's 50th Anniversary Award. From left to right: Vince Radke, Dr. Welford Roberts, and MAJ Sean Beeman.

50th Anniversary Celebration of EHAC

To mark its 50th anniversary, the National Environmental Health Science & Protection Accreditation Council (EHAC) honored the first environmental health undergraduate degree program to be accredited in 1969.

East Tennessee State University

50th Anniversary Celebration of USEHA

To mark its 50th anniversary, the Uniformed Services Environmental Health Association (USEHA) honored an organization for its support throughout the years.

National Environmental Health Association

Walter F. Snyder Environmental Health Award

LCDR Katie L. Bante, MPH, REHS/RS

NEHA and NSF International were honored to present LCDR Katie L. Bante, MPH, REHS/RS, with the distinguished Walter F. Snyder Environmental Health Award. The Snyder Award pays homage to NSF International's cofounder and first executive director who provided outstanding contributions to the advancement of environmental and public health.

Working as an environmental health professional since 2008, LCDR Bante has taken leadership roles in multiple initiatives to recognize and improve environmental health disparities. She has provided direct expertise to diverse populations on a wide range of environmental health issues including drinking water, solid waste management, indoor air quality, pest management and vector control, infection control, and occupational health and safety.

Serving as an environmental health officer with the U.S. Coast Guard, LCDR Bante was selected in 2017 to serve as project officer for a multiyear industrial hygiene project assessing hazards and exposure risks associated with aviation corrosion control operations. She collaborated with teams of senior U.S. Public Health Service and U.S. Coast Guard officers to evaluate corrosion control work at air stations. LCDR Bante's efforts contributed to identifying and correcting 300 hazardous conditions, implementing safe work practices, mitigating exposure risks, and improving workplace safety for over 800 U.S. Coast Guard members.

Snyder Award Winner LCDR Katie Bante with NEHA's Dr. David Dyjack (left) and NSF International's Kevan Lawlor (right).

LCDR Bante is a current member of NEHA and the Virginia Environmental Health Association, and was a previous member of the Alaska Environmental Health Association. Representatives from each of LCDR Bante's professional associations, as well as her colleagues in the Uniformed Services, attended the 2019 AEC Awards Ceremony to celebrate her accomplishment. To read more about LCDR Bante's career, visit www.neha.org/about-neha/awards/walter-f-snyder-award.

Tuned In With Social Media

Social media was a great way for attendees to share their conference experiences, insights, and thoughts with a wide network of environmental health professionals. Attendees shared comments and photos of the 2019 AEC via Twitter, Facebook, LinkedIn, Instagram, and the conference app. Attendees were encouraged to post using the hashtags #NEHAAEC and #EHMatters. Below is just a sample of the many posts from the 2019 AEC.

Accela @AccelaSoftware
@AccelaSoftware General Manager for Environmental Health, Darryl Booth (@EnvHealthData), awards twelve scholarships to EH professionals at @nehaorg's annual conference. These young professionals represent the future of EH in our profession. Congratulations! #NEHAAEC #EHMatters

APHA Environmental Health @EH_4_All
Insightful session on "social media strategies for environmental health professionals" at #NEHAAEC. P.S. Fully packed room!

CDC Tracking Network @CDC_EPHTracking
Howdy, partner! Tracking's headed to Nashville, where we'll meet up with our friends at @nehaorg #NEHAAEC! Thanks for your work in advancing environmental health & workforce development! #TAW2019 #BeyondData

Climate for Health @Climate4Health
@nehaorg Another standing room only session in the Climate & Health track at the #NEHAAEC, where we are hearing about climate change efforts across the nation, including Salt Lake City where @path2positive is active! #EHMatters #ClimateChangesHealth

Natasha DeJarnett @DrDeJarnett
@CDCEnvironment's Dr. Justin Gerding shares an overview of the unprecedented UNCOVER EH Initiative at #NEHAAEC. #EHmatters #UNCOVEREH #NEHAinAction

Anne Godfrey @weegieexpat
Looking forward to this year's #NEHAAEC here are the @GaylordOpryland convention centre #EHmatters

Anna Goodman Hoover @AnyaFanya
Excited to hear about water-related perceptions research @EKUPublicHealth faculty are doing in some of the same communities served by @ukcares1 & @UK_SRC. Opportunities for #collaboration abound! #NEHAAEC

Institute for Childhood Preparedness @ChildPrepared
Wonderful night of networking with environmental health professionals at #NEHAAEC. Thank you @nehaorg for such a fantastic experience and venue!

Naser Jouhari @NaserJouhari
Great start to the morning with the @nehaorg opening session! Anne Godfrey is bringing the #facts on why #EHMatters and the importance of the Environmental Health profession. #NEHAAEC

Heather MacDavid, MPH, REHS, CHES (via LinkedIn)
I'm looking forward to all of these presentations today. It's the only time I can live in my two passions at once! #passions #maternalchildhealth #environmentalhealth #NEHAAEC

Connie Mendel @EnviroHealthKy
Great workshop on messaging! #NEHAAEC #EHMATTERS #WeTrackThat #KYData #TAW2019 @CDC_EPHTracking

Mimi @haarihyke
I'm excited to be attending my first #NEHAAEC. Looking forward to so many activities, including my presentation.

Private Well Class @help4wellowners
Our "Effective Online and Offline Strategies to Engage Private Well Owners" presentation went great today at #NEHAAEC!

Prometric Global @PrometricGlobal
The Prometric Food Safety team has enjoyed connecting with the regulator community at the @nehaorg Annual Educational Conference. See you next year in the Big Apple!

Andrew Roszak @AndyRoszak
Looking forward to another wonderful day at #NEHAAEC! Great time last night on @General_Jackson. #YeHaForNEHA

Laura Runnels (via LinkedIn)
Over 15 million U.S. households receive their drinking water from private sources like wells, cisterns, water storage tanks, and trucked water. #NEHAAEC

WEHA @WEHA_EnvHlth
NEHA's Executive Director Dr. Dyjack photo bombs WEHA's pic! #NEHAAEC #EHMatters

2019 AEC Scavenger Hunt

The Connect4App Game was reimagined this year and evolved into the AEC Scavenger Hunt. Attendees logged into the conference app, powered by Zerista, and earned points by scanning QR codes scattered throughout the AEC at events, sessions, and in the exhibit hall, as well as by participating in other various activities. Bonus points were awarded to those who posted pictures of their conference experience on social media. The AEC Scavenger Hunt proved to be wildly popular with well over 300 active participants. Winners were selected in a random drawing. Attendees who scored the highest point totals earned multiple entries into the drawing. Congratulations to the 2019 AEC Scavenger Hunt winner Amy Zagar, senior environmentalist with the Minnesota Environmental Health Association, who won a $50 Amazon gift card. Thank you to everyone who participated—we hope you enjoyed your experience with the reimagined app game! We look forward to hosting it again at the 2020 AEC in New York City.

NEHA NEWS

NEHA Staff Profile

As part of tradition, NEHA features new staff members in the *Journal* around the time of their 1-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. This month we are pleased to introduce you to one NEHA staff member. Contact information for all NEHA staff can be found on page 53.

Lexi Nally

Originally from Columbus, Ohio, I earned a bachelor's degree in fine arts and a minor in business administration from Ohio University. After growing up in the Midwest, in August 2018 I was ready to take on a new adventure and move to Colorado. Soon after moving, I realized my current job in the health insurance field was no longer serving me and I needed to find a career that would better suit my dreams and ambitions. I was craving a career that needed to do three main things: 1) nurture my passions, 2) foster my professional growth, and 3) positively impact others. Working at NEHA checks off all those boxes for me as I've learned about our association's mission.

My passion for environmental concerns began with my involvement in multiple collaborative and personal environmental artwork projects. Those experiences opened my eyes to the need for a better future by creating better environments. As NEHA's member services representative, I appreciate interacting with our members and learning from them, as well as providing them with the care and information they need from NEHA so they can continue to create healthier environments. I am endlessly learning how NEHA impacts the environmental health field, how we support environmental health professionals in their success, and how we are habitually working for solutions.

By nature, I am a passionate, caring, and adventurous person who strives for growth in every aspect of my life. Outside of work I devote time to hiking and being active outside. I am an avid runner and enjoy challenging myself with half marathons every year. I love healthy cooking and am always experimenting with new unique recipes. As time allows, I work on a variety of projects—from paintings and drawings to coaster designs. As a lover of the arts, you can find me exploring Colorado's art scene all year around!

NEHA ORGANIZATIONAL MEMBERS

Sustaining Members

HealthSpace USA Inc
www.healthspace.com

LaMotte Company
www.lamotte.com

North Bay Parry Sound District Health Unit
www.myhealthunit.ca/en/index.asp

NSF International
www.nsf.org

Sweeps Software, Inc.
www.sweepssoftware.com

Texas Roadhouse
www.texasroadhouse.com

Note. As of October 1, 2018, NEHA no longer offers organizational memberships. We will continue to print this section in the Journal *to honor the membership benefits due to these listed organizations until their memberships expire. For more information about NEHA membership, visit www.neha.org/membership-communities/join.*

Did You Know?

NEHA's latest policy statement addresses the adoption and implementation of the current Food and Drug Administration's *Food Code*. NEHA believes that complete adoption of the current *Food Code* in retail food establishments can likely reduce the incidence of foodborne illnesses and promote the most up-to-date knowledge of food safety. Other recent policy statements from NEHA cover topics such as cottage foods, clean energy, ear piercing guns and microblading, comprehensive mosquito control, and cannabis-infused food products. All current policy statements can be found at www.neha.org/publications/position-papers.

DirecTalk
continued from page 70

mental health professors are solo players is widely embraced, exacerbated by narrow tenure requirements. I've observed it myself. Our laboratories, our curriculum, and our nomenclature are foreign to many in the public health enterprise and administrations. I believe CEPH correctly perceived us as self-absorbed and the drive toward an integrated curriculum was seen as a solution to nudging us back to the table. You can disagree with me if you want. I believe, however, that we are partially responsible for the 2016 CEPH accreditation modifications.

What has been the net effect? Has environmental health been deemphasized in CEPH-accredited institutions? Let's review the data. Of the 67 CEPH-accredited schools, four have dropped an environmental health major primarily due to low enrollments. Painfully, one of the first to do so was my prior employer, Loma Linda University School of Public Health. A total of 24 new environmental health degrees have been added and two degrees have been modified to reflect a more global health orientation.

Is the glass half empty or half full? As we see, there are opportunities to embed environmental health throughout the life trajectory of a public health student that were largely absent prior to 2016. Many public health academic institutions have in the meantime expanded their environmental health offerings.

Mollie Mulvanity, deputy director of the Council on Education for Public Health, addresses the audience at our 2019 Annual Educational Conference & Exhibition in July in Nashville, Tennessee. Photo courtesy of David Dyjack.

I encourage our friends and partners at the Association of Environmental Health Academic Programs and EHAC to seize the moment. If CEPH has taken its eye off the prize and we perceive a strategic opening, let's dive in and provide educational leadership. I believe there are abundant career opportunities in environmental health writ large and while I lack the empirical data to support this notion, I see career opportunities across the U.S. and its territories.

Before I close, I'd like to give the Association of Schools and Programs of Public Health (ASPPH) a shout-out. ASPPH's Chief Executive Officer Dr. Laura Magaña, Chief Academic Officer Rita Kelliher, and Chief Finance and Operations Officer Allison Foster have been generous with us. They have inserted us in national educational conversations, provided us visible leadership opportunities, and been generous with their office space in Washington, DC. We are grateful and look to build upon that relationship with them and their network in the years ahead.

The 2016 CEPH criteria is a bête noire for many of us. I encourage you to explore and reflect on the changes and familiarize yourself with your local school or program's curriculum. Better yet, secure a seat on your SPH's community advisory board. If you care about this matter then it is time to dress up, show up, and speak up.

ddyjack@neha.org
Twitter: @DTDyjack

DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Canards and Accreditation

Young academics are impressionable and I was no different. As I conversed with senior professors from the University of Michigan and University of Utah, I was puzzled by their collective animus toward accrediting bodies. The acronyms flew fast and furious as these leading researchers bristled with contempt for the considerable effort required to achieve and maintain accreditation status. Their enemy lists were extensive as they disparaged accrediting bodies that included the Accreditation Board for Engineering and Technology (ABET), Council on Education for Public Health (CEPH), Liaison Committee on Medical Education (LCME), National Environmental Health Science & Protection Accreditation Council (EHAC), and Western Association of Schools and Colleges (WASC).

I experience goose flesh upon reflection on my 18 years in academia as I rose from assistant professor to dean of a nationally-accredited school of public health (SPH). The journey was rewarding and I'm overwhelmed each time I encounter my students working in environmental and public health. They seem to be doing well because of, or more likely despite, my classroom prowess. I digress, however.

The ecological dominant in this accreditation conversation is CEPH, arguably the most important accrediting body for public health education in the world. Established in 1974 and located in Silver Spring, Maryland, CEPH is formally recognized by the U.S. Department of Education, governed by a 10-member board, and supported by 10 staff. They dispatch their stable of 100 trained academic and practitioner site visitors to public health educational institutions to assess conformance to established standards.

Let's be steely eyed—academia is a business.

A dramatic increase in the number of CEPH-accredited schools and programs has occurred over the last 20 years. When I joined Loma Linda University as an assistant professor in 1992, there were 28 CEPH-accredited SPHs, fewer than 60 CEPH-accredited programs, and no CEPH-accredited baccalaureate programs. Today, over 200 schools and programs are accredited: 67 schools, 122 programs, and 15 stand-alone baccalaureate programs. Of the accredited institutions, six are outside the U.S.: Canada, Grenada, Israel, Lebanon, Mexico, and Taiwan. In full disclosure, I am a CEPH site visitor and have participated in or chaired site assessments throughout the U.S. and at two universities abroad.

Why is CEPH relevant to us? In 2016, CEPH published revised accreditation criteria that sent ripples across the education landscape. First, among other things, CEPH explicitly reminded SPHs that master of public health (MPH) students, regardless of major, were not necessarily required to complete a stand-alone course in environmental health, though most SPHs historically had offered one. Second, SPHs would no longer be required to offer students a major in environmental health. Third, accredited institutions would no longer be required to have full-time environmental health faculty and maintain an environmental health department. Environmental health professionals in my sphere went ballistic when they discovered the changes. While the expressed aim of these amendments was to provide the individual academic institutions an opportunity to meet the educational needs of their local constituency, our network viewed the changes as a frontal assault on the profession. Now then, let's unpack the changes.

The 2016 CEPH criteria require MPH students to demonstrate mastery in foundational knowledge in public health. There are 12 learning objectives—six of those are related to environmental health such as "explain effects of environmental factors on a population's health." Additionally, there are 22 foundational competencies that MPH students must master. Examples include leadership, negotiation, and communication, among others. Finally, concentration specific competencies relevant to the student's declared major must also be attained and demonstrated.

What issues drove these changes? The answer is complex. First, small environmental health enrollments, reduced tuition waivers sponsored by the federal government, and fewer research dollars are likely major contributing factors. Let's be steely eyed—academia is a business. Secondly, we did not help ourselves. The perception that environ-

continued on page 69

hands are like
your best pair
of blue jeans.

the more
you wash them,
the better you feel.

Ozark River
PORTABLE SINKS

NSF

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Greater Nashville Area