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Volume 84, No. 3 October 2021

Climate Change, Dust Storms, Vulnerable Populations, and Health in the Middle East

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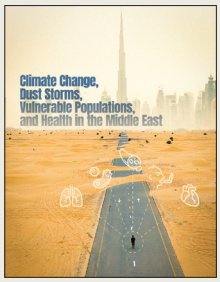

The impact of dust storms on human health has been well described in Asian and European countries. Despite an increasing number of dust storm events plaguing the Middle East attributable to climate change, little is presently understood about the effects of dust storms on the health of human populations residing in this region. This month's cover article, "Climate Change, Dust Storms, Vulnerable Populations, and Health in the Middle East: A Review," sought to identify and assess what is currently understood about the health impacts of dust storms in the Middle East. The review identified a number of health consequences associated with dust events in the region of interest, existing gaps in available literature, vulnerable populations, and directions for future research.

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PRESIDENT'S MESSAGE

Roy Kroeger, REHS

Environmental Health Marketing

I am days from my 28th anniversary working in environmental public health. Throughout my career I have heard that environmental health is unknown, underappreciated, and underfunded. I will not argue with any of these perceptions because I am right there with you in these discussions. Most professionals in this field understand that environmental health is where public health began nearly 200 years ago.

It has been shown repeatedly that core environmental health programs like air quality, water quality, food safety, and sanitation have nearly doubled life expectancy. Yet, most individuals in the U.S. do not know what environmental health is or the role it plays everyone's lives.

When talking to others about environmental health, I like to explain that it is working to ensure that the water we drink is safe, the food we eat is safe, and the air we breathe will not make us sick. Environmental health also provides protection against communicable diseases, vector issues, natural and manmade disasters, and mass gatherings. Though these programs have always been the core of environmental health, we are doing so much more.

So why is it when I say I work in environmental health, people think I clean the schools and hospitals or hug trees for a living? Where did we lose control of the messaging? How can people not know what we do or who we are when we play such a large part in their daily lives? We want to be recognized like firefighters and police officers. We want the public to love us like doctors and teachers.

Our world is hectic and almost everyone is trying to achieve the same recognition we are. I have heard so many people say we are unsung heroes or label environmental health as the silent or invisible profession. Can we improve recognition of our profession through marketing? I believe that we can, but at what cost? How do we achieve this goal? Should we run ads on television explaining who we are? Do we have to have connections in Hollywood to make movies about environmental health or have an environmental health specialist save the planet? Actually, some of that has been done, but the hero was not called an environmental health professional.

Can we improve recognition of our profession through marketing?

The National Environmental Health Association (NEHA) has started several marketing initiatives to market both the association and the profession. Over the past several years, NEHA has been working to improve the exposure of environmental health to our policy makers. Most of us believe that a person who is appreciated will always do more than expected. Many of us want to feel appreciated for what we do.

NEHA Hill Day is one example of what the association is doing to gain recognition for the profession. The NEHA Board of Directors uses the Hill Day opportunity to discuss how environmental health protects the public and the importance of federal funding for state, local, tribal, and territorial programs, as well as support for our federal partners. NEHA has also hired staff in Washington, DC, to have staff available to attend meetings with members of Congress, congressional staff, and agency leaders at a moment's notice.

In June, NEHA penned a letter to the White House encouraging the inclusion of environmental health in the American Rescue Plan Act of 2021. Last month the White House announced that it would be redistributing $7.4 billion from the American Rescue Plan to hire and train public health workers in response to the COVID-19 pandemic.

Also in June, NEHA hired a marketing firm to work on a rebranding effort for the association. The rebranding will involve more than a new look; the change will include improvements to the website, including how members access their accounts to reduce frustrations in accessing continuing education information, online training, and more.

NEHA has also created an animated video to expose the overlooked and undervalued work of environmental health professionals. The video shows some of the many ways an "invisible" environmental health professional impacts and protects many aspects of our daily lives. I encourage everyone to take a look at the video and then share it. NEHA is sharing the video in as many places as possible, but without members doing their part, it will sit on the website and not reach a larger audience. You can find the video at www.neha.org/eh-animated-video.

An additional item that has been discussed is the creation of a toolkit to help state and

local environmental health programs get on the curriculum at junior high and high schools. A toolkit could help make students more aware of environmental health and be used as a recruitment tool to get students interested in pursuing a career in environmental health.

With everything NEHA has done or is doing, I still understand that environmental health professionals want to hear their elected officials reach out and say thank you. Unfortunately, this type of recognition and appreciation will not come from actions at NEHA. Individuals who are proud of their profession, along with departments and state affiliates, must carry a large part of this responsibility. An idea could be as simple as a state affiliate hosting a legislative breakfast, not to lobby but to educate attendees on the benefits of a strong environmental health program. Professionals could also work with their governors to proclaim an environmental health day or week in conjunction with World Environmental Health Day, which is observed on September 26.

As a gardener, one of my favorite quotes is: "The best time to plant a tree was 20 years ago. The second best time is now." We are at that crossroads now. We should have marketed our profession 20 years ago, but since we didn't, we need to do it now!

President@neha.org

Did You Know?

You can stay in the loop every day with NEHA's social media. Find NEHA on

- Facebook: www.facebook.com/NEHA.org
- Twitter: https://twitter.com/nehaorg
- LinkedIn: www.linkedin.com/company/national-environmental-health-association

SUPPORT THE NEHA ENDOWMENT FOUNDATION

The NEHA Endowment Foundation was established to enable NEHA to do more for the environmental health profession than its annual budget might allow. Special projects and programs supported by the foundation will be carried out for the sole purpose of advancing the profession and its practitioners.

Individuals who have contributed to the foundation are listed below by club category. These listings are based on what people have actually donated to the foundation—not what they have pledged. Names will be published under the appropriate category for 1 year; additional contributions will move individuals to a different category in the following year(s). For each of the categories, there are a number of ways NEHA recognizes and thanks contributors to the foundation. If you are interested in contributing to the Endowment Foundation, please call NEHA at (303) 756-9090. You can also donate online at www.neha.org/donate.

Thank you.

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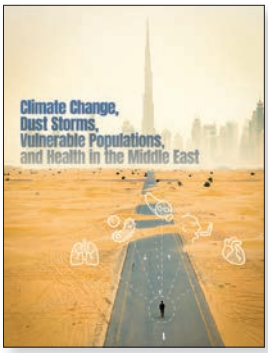


Climate Change, Dust Storms, Vulnerable Populations, and Health in the Middle East: A Review

Muge Akpinar-Elci, MPH, MD
Brenda Berumen-Flucker, MPH
Hasan Bayram, MD, PhD
Abdullah Al-Taiar, MD, PhD
Old Dominion University

Abstract **The impact of dust storms on human health has been well described in Asian and European countries. Several research studies have examined adverse health outcomes attributable to dust and dust storm events, including respiratory and cardiovascular diseases, across these and other developed countries. Despite an increasing number of dust storm events plaguing the Middle East attributable to climate change, little is presently understood about the effects of dust storms on the health of human populations residing in this region. This review sought to identify and assess what is currently understood about the health impacts of dust storms in the Middle East. A systematic review was designed and conducted using MEDLINE/PubMed and Google Scholar. Out of 534 articles identified, 16 met predetermined eligibility criteria and were included in our analysis. Our review identified a number of health consequences associated with dust events in the region of interest, existing gaps in available literature, vulnerable populations, and directions for future research.**

Introduction

In recent decades, growing bodies of literature have acknowledged climate change and variability as threats to human health and safety. Existing research has focused on increasing temperatures, rising sea levels, increased frequency and intensity of extreme weather events, and air pollution, among other events associated with climate change. Less frequently studied are the impacts of dust storms on human health, despite increases in the frequency and intensity of such events (Schweitzer et al., 2018). Climate variability and drought—two key climate change factors associated with the increased occurrence and severity of dust storms—are caused by the draining of wetlands, decreased levels of vegetation, unsustainable development, and increased land degradation (Akpinar-Elci et al., 2015; Bell et al., 2018).

While the majority of dust storms are concentrated in drylands, the threats posed by dust storms transcend regional and continental boundaries. Existing research has determined that dust particles have the capability to travel long distances. Saharan dust, for example, can travel across the Atlantic Ocean into the Americas and the Amazon, and has been recognized as the principal source of dust in the Mediterranean Sea (Schweitzer et al., 2018). Dust particles, along with air pollution, have been recognized as some of the most significant predisposing factors to noncommunicable diseases in the world (Geravandi et al., 2017).

Although dust transcends political boundaries and poses risks to the health and human safety of populations worldwide, specific regions are at increased vulnerability to suffer from the consequences associated with these climate events. The Middle East has been recognized as one of the largest dust-producing regions in the world, with different locations within this region frequently exposed to local and regional dust systems, including dust originating in the Sahara (Najafi et al., 2017; Schweitzer et al., 2018). Dust storms are most prominent in the Middle East during the summer months, an event pattern attributable to the presence of shamal winds (i.e., fierce winds from the northwest) and an increasing number of cyclones in the region (Choobari et al., 2014; Parolari et al., 2016; Schweitzer et al., 2018). The highest density of dust sources in the Middle East include the northern region of Iraq and along the Syria–Iraq border (Parolari et al., 2016).

Dust particles, particularly particulate matter <10 µm in diameter (PM_{10}) and coarse particulate matter ($PM_{2.5–10}$), have been recognized to adversely impact air quality (De Sario et al., 2013; Kabatas et al., 2014). Dust events in the Middle East are associated with a considerable amount of airborne PM_{10}. It has been estimated that approximately 85% of dust generated in the Middle East is smaller than PM_{10} in size (Schweitzer et al., 2018). Other studies have reported high concentrations of suspended particles and PM_{10} during dust storms in the Middle East, and

strong associations between high levels of PM_{10} concentrations and Saharan dust events (Kabatas et al., 2014; Shahsavani et al., 2017). Hosseini et al. (2015) found that concentrations of PM_{10} were considerably higher during dusty days compared with non-dusty days, highlighting the relationship between these climate events and resulting air quality in increasingly susceptible regions. The effects of dust storms are not limited solely to increased concentrations of PM_{10}. Studies have also established associations between levels of water-soluble ions, metals, and dust events. Pirsaheb et al. (2014) reported increased concentrations of heavy metals (lead, cadmium, arsenic, mercury, and chromium) in dust samples collected for the study; most heavy metal levels were beyond the acceptable concentration levels established by the World Health Organization. Similarly, Öztürk and Keleş (2016) found increased concentrations of magnesium, silicon, and aluminum attributable to dust events.

Overall, existing literature has established strong associations between dust events and hazardous air quality, further framing the critical need to develop an improved understanding on the effects of dust storms on human health. Recent research has focused on exploring the health effects of dust storms primarily across the European region and other developed countries. Despite the increased vulnerability of the Middle East to dust storm events, the health impacts of dust storms on populations across this region have not yet been thoroughly explored. The goal of our study was to assess what is presently understood about the impact of dust storms on the health of populations in the Middle East.

Methods

A systematic review was designed to answer the research question: "In what ways do dust storms impact the health of populations in the Middle East region?" We conducted the literature search using MEDLINE/PubMed and Google Scholar. We considered articles for inclusion if they were published in English during 2008–2019.

We used keywords Middle East, dust storm, and health. After initial review, we also included keywords for each Middle East country's name, dust storm, and health (e.g., "Iran, dust storm, health"). We defined and identified countries in the Middle East using the U.S. Central Intelligence Agency's World Factbook (www.cia.gov/library/publications/the-world-factbook/wfbExt/region_mde.html). The definition of "Middle East region" has changed over time with the number of countries in the region presently unsettled. Different resources have differing definitions on which countries and territories are included when using the terminology "Middle East region." As a result of these discrepancies, we made the decision to include Egypt as a territory belonging to the Middle Eastern region.

This review included only studies that examine diseases, health outcomes, or health conditions afflicting human populations that have been strongly associated with local dust storms in the Middle Eastern countries predetermined by the study team. Literature was limited to include only full-text articles published in scientific journals. Studies on dust from volcanic activity or those originating or resulting from human activities were excluded, as these topics are outside of the scope of this review and do not align with the overall goal of our study. Those studies on dust exposure or dust levels that failed to consider or discuss the impacts of such events on human health were also excluded, as they did not provide the detail required to meet eligibility criteria. Because the present study aimed to review health outcomes among human populations associated with dust storms, we excluded any articles focused on animal populations.

All articles extracted for review were assessed by the study team to confirm compliance with eligibility criteria and appropriateness. The extraction process consisted of two stages: 1) title and abstract review and 2) full-text review for adherence to eligibility criteria guidelines.

Results

A total of 534 articles matched the initial screening criteria based on their title or abstract. Of these articles, 31 were deemed eligible for full-text review, which resulted in the exclusion of 15 articles. The main reasons for excluding these 15 studies were a) lack of clarity surrounding the human health impacts of exposure to dusts and b) the use of animal subjects. A total of 16 articles adequately met the criteria outlined for our review (Table 1, Figure 1).

While study locations varied, the majority of the articles eligible for inclusion focused on populations within Iran (n = 11). Two studies focused on populations within Kuwait, one within both Kuwait and Iraq, one within Turkey, and one within Israel. Studies varied in both purpose and methodology, with some focused on threats to human health resulting from dust composition and others focused more heavily on measurable health impacts attributable to dust storm events.

Infectious Agents and Diseases

Two studies examined dust composition as a hazard to human health. Leski et al. (2011) studied airborne particles within dust samples collected in Iraq and Kuwait; their study detected a number of pathogens in dust samples collected that had the potential to adversely impact human health through inhalation. *Coxiella burnetii*, recognized to cause the respiratory illness Q fever, was found in a number of samples collected over the time their study took place.

Nourmoradi et al. (2015) conducted a similar study in Iran investigating the relationship between dusty days and airborne particles containing potentially hazardous microorganisms. Similar to the findings of Leski et al. (2011), Nourmoradi et al. detected the presence of several potentially hazardous airborne bacteria and fungi in air samples assessed. The pathogens detected included *Bacillus* spp. and *Mycosporium* spp., which have the potential to adversely impact respiratory health through the onset or development of conditions such as asthma, pneumonia, or respiratory infections. This study was able to establish a relationship between increased dust (dusty day occurrence) and increased airborne microorganism concentrations.

A study by Alavi et al. (2014) investigating the relationship between dust and pulmonary tuberculosis (TB) found that while dust did not increase the overall prevalence of TB in the population, it did have the potential to impact TB relapse and treatment outcomes, as well as increased the risk for the incidence of multidrug-resistant TB (MDR-TB). Study authors observed an increase in the prevalence of TB cases among women, children, and urban residents over the study period, which suggests increased vulnerability for disease occurrence among individuals in any of these groups. Interestingly, the authors

TABLE **1**

Summary of Articles Included for Analysis

Author (Year)	Country	Study Purpose	Main Findings	Health Impact
Alavi et al. (2014)	Iran	To investigate the relationship between dust and pulmonary tuberculosis (TB)	Soil dust had no obvious effect on TB prevalence. Study authors found, however, that soil dust had the potential to influence TB relapse, TB emergence, and adversely impact treatment outcomes.	TB relapse and emergence
Al-Hemoud et al. (2018)	Kuwait	To assess the environmental burden of dust storms on morbidity and mortality	Dust particulates were strongly correlated with acute lower and upper respiratory disorders and infections, as well as asthma. Additionally, there were strong associations between dust storms and morbidity rates of asthma.	Respiratory diseases and morbidity
Amarloei et al. (2015)	Iran	To evaluate respiratory tract function of a population exposed to dust storms	There was a statistically significant negative relationship between the time a resident had inhabited the region of interest and respiratory capacity, which suggests possible reductions in pulmonary function as a result of long-term exposures to dust storms.	Reductions in pulmonary function
Ebrahimi et al. (2014)	Iran	To evaluate the possible effects of dust storms on cardiovascular and respiratory disease incidence	There was a statistically significant correlation between PM_{10} levels and the number of cardiovascular patients admitted during dust storm events. There was a correlation between concentration of PM_{10} and hospitalizations for respiratory disease on dust event days; however, the correlation was not statistically significant.	Increased hospital admissions for cardiovascular diseases
Geravandi et al. (2017)	Iran	To determine the number of hospital admissions for respiratory diseases attributed to PM_{10} during normal and dust storm days	There was a positive correlation between dust events and hospital admissions for respiratory diseases. Cases of respiratory disease during dust events increased over the study period. Hospital admissions were higher during dust event days compared with normal days.	Increased hospital admissions for respiratory diseases
Gheybi et al. (2014)	Iran	To determine the effects of dust air pollution on the immune system, specifically on immune system lymphocytes	Individuals exposed to dust air pollution secrete higher levels of cytokines recognized to be involved in the development of allergic responses. Ambient exposure to dust air pollution affects the immune system.	Allergic inflammation
Goudarzi et al. (2017)	Iran	To assess the impact of dust events in the Middle East on hospital admissions for COPD, cardiovascular and respiratory diseases, and respiratory mortality	Pollution peaks associated with dust storms adversely affect health. Increases in PM_{10} were associated with increases in respiratory mortality as well as hospital admissions for respiratory and cardiovascular diseases.	Increased respiratory mortality as well as hospital admissions for cardiovascular and respiratory diseases
Khaniabadi et al. (2017)	Iran	To estimate the effects of dust storms on hospital admissions related to cardiovascular and respiratory diseases	Excess cardiovascular and respiratory morbidity were recorded on normal, dusty, and dust event days in the Middle East. Hospital admissions for both cardiovascular and respiratory diseases were highest on dusty days.	Increased hospital admissions for respiratory and cardiovascular diseases

continued ▸

found an increase in secondary cases of TB attributable to close contacts in dusty conditions likely resulting from diminished treatment impacts. Prognostic indicators used to measure the success of TB control programs decreased over the study period, increasing treatment failure rates from 2.5% to 5.0%.

Increased Hospitalization Risk

Several studies showed increased risk for respiratory and cardiovascular hospitalizations attributable to dusty days and dust storm events. A study in Kuwait assessing the potential relationship between dust storms, asthma, and respiratory-related hospital admissions found a statistically significant relationship between dust events and the outcomes of interest (Thalib & Al-Taiar, 2012). Dust storm events were associated with increases of 4–8% in respiratory admissions. The study also found that children with asthma were particularly vulnerable to the impacts of dust storm events. Geravandi et al. (2017) found similar results in Iran and established a positive correlation between dust events and hospital admissions for respiratory diseases. Analyses in that study found that hospital admissions for respiratory diseases and conditions were higher on dusty days when compared with non-dusty days.

Three studies eligible for inclusion in our review examined the effects of dust and dust storm events on cardiovascular hospital admissions. Goudarzi et al. (2017) found that rates of respiratory mortality and hospital admissions for respiratory and cardiovascular diseases increased with dust events that elevated PM_{10} levels. Similar studies found statistically significant relationships between

TABLE **1** *continued*

Summary of Articles Included for Analysis

Author (Year)	Country	Study Purpose	Main Findings	Health Impact
Leski et al. (2011)	Iraq and Kuwait	To investigate the potential for airborne dust to contain human pathogens	Analysis of collected samples resulted in the detection of a number of pathogens that might cause disease in humans. The two most prevalent bacteria found with the potential to act as human pathogens were *Mycobacterium* and *Brucella. Coxiella burnetii*, known to cause Q fever, was also detected in a number of samples collected.	Potential for infectious diseases contracted through inhalation
Neisi et al. (2017)	Iran	To compare children's fractional exhaled nitric oxide values and lung function as parameters of adverse health effects of air pollution in dusty and normal days	Short-term exposure to high particulate matter concentrations adversely affected lung function among children. Significant decreases in lung function were observed on dusty days when compared with normal days.	Decreased lung function
Nourmoradi et al. (2015)	Iran	To investigate the relationship between airborne particles containing microorganisms on normal versus dusty days	*Bacillus* spp., *Cladosporium* spp., and *Mycosporium* spp. were the most common microorganisms detected during both normal and dusty days. Airborne bacteria and fungi microorganism concentrations increased on dusty compared with normal days.	Increases in the prevalence of potential disease-causing organisms
Saeb et al. (2013)	Iran	To assess the effect of dust and sand on coagulation state	Dust has the potential to reduce prothrombin time and increase platelet levels, fibrinogen degradation, and factor VII levels. These changes in coagulant factors have the potential to increase the risk for cardiovascular diseases.	Irregularities in coagulation factors and risk for cardiovascular diseases
Soleimani et al. (2019)	Iran	To assess the effects of particulate matter on heart disease	There was a significant relationship between particulate matter and hospital referrals for cardiovascular patients. PM_{10} increased the risk of cardiovascular events.	Cardiovascular disease
Soy et al. (2016)	Turkey	To investigate the effects of dust storms on the quality of life of patients with allergic rhinitis, with or without asthma	Dust storms adversely impact the quality of life and lung capacity of patients with asthma and allergic rhinitis. Patients with both asthma and allergic rhinitis reported poorer quality of life after dust storms when compared with those without asthma.	Reduced quality of life and increased respiratory symptom presence
Thalib and Al-Taiar (2012)	Kuwait	To assess the potential relationship between dust events and asthma and respiratory-related hospital admissions	Authors found a statistically significant association between the occurrence of dust storm events and asthma and respiratory-related hospital admissions. Children with asthma were particularly vulnerable to dust storms events.	Increased hospital admissions for respiratory conditions
Vodonos et al. (2015)	Israel	To determine if high levels of particulate matter from dust storms pose risks to cardiovascular health and identify individual characteristics that modify potential health effects	Exposure to nonanthropogenic particulate matter was associated with an increased risk of acute coronary syndrome. Age, gender, and ethnicity were found to be significant risk factors for adverse cardiovascular outcomes.	Increased hospital admissions for acute coronary syndrome; cardiovascular diseases and outcomes

elevated PM_{10} levels attributable to dust storm events and cardiovascular and respiratory hospital admissions (Ebrahimi et al., 2014; Khaniabadi et al., 2017; Soleimani et al., 2019). Vodonos et al. (2015) explored the relationship between increased PM resulting from dust storms and hospital admissions for acute coronary syndrome in Israel. The authors found that women were at increased risk for adverse health outcomes, which was similar to findings by Alavi et al. (2014). Women, particularly those over the age of 65, and individuals who identified as Bedouin Arabs were at increased risk for hospitalization for acute coronary syndrome following dust storms (Vodonos et al., 2015).

Elevated Risk for Adverse Health Outcomes

Several studies were able to establish relationships between adverse health outcomes and dust storms. Two such studies identified through our analysis worked to establish links between lung function and dust storm events. Amarloei et al. (2015) identified a statistically significant negative relationship between respiratory function tests and duration of inhabitance in an area heavily impacted by dust events. These findings suggest pulmonary function can be adversely impacted by long-term exposure to dust storms. Neisi et al. (2017) found decreases in the values on pulmonary function tests among school-aged children on dusty days. Study authors concluded that short-term exposure to high PM concentrations can adversely impact lung function. In addition to reductions in lung capacity, other studies established strong associations between dust

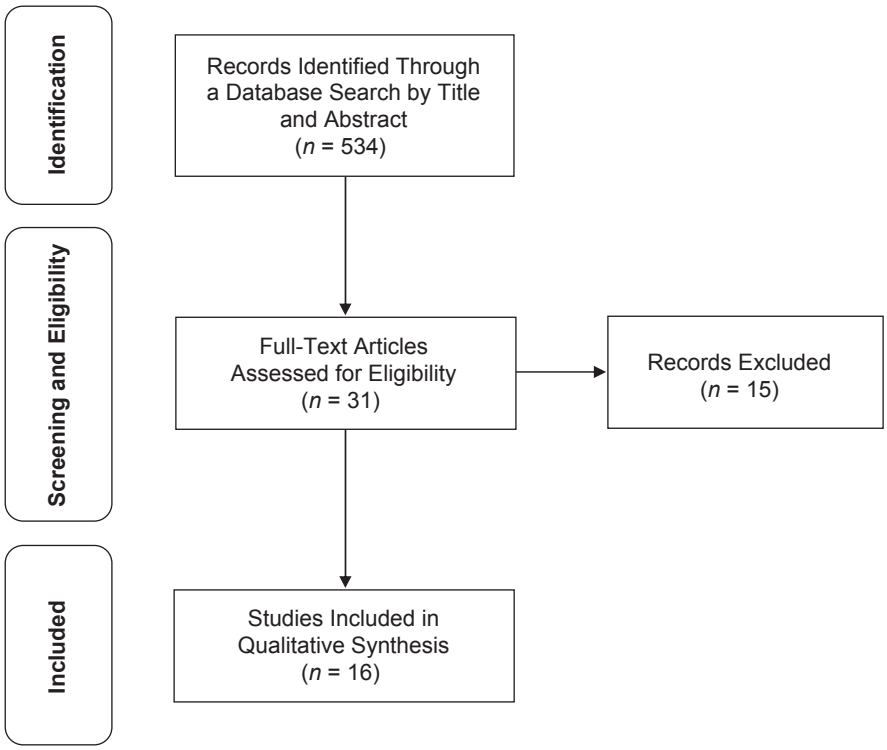
storm events, asthma-associated morbidity, and acute upper and lower respiratory tract infections (Al-Hemoud et al., 2018).

A study conducted by Gheybi et al. (2014) established a relationship between dust events and allergies. The authors concluded that frequent exposures to dust air pollution increased allergic inflammation and suggested a potential relationship between ambient air pollution and the rising prevalence of allergic diseases among a population at increased risk for exposure to dust. Having recognized the relationship between air pollutants and allergic rhinitis, Soy et al. (2016) sought to investigate the effects of dust storms on the quality of life of individuals with allergic rhinitis both with and without asthma. The authors found that dust storms were associated with impaired quality of life and reduced lung capacity, especially among individuals with asthma.

The final study we included focused on the effects of dust on coagulation and found associations between exposures to dust storm events and changes in coagulation factors including prothrombin time, platelet levels, fibrin degradation products, and factor VII levels (Saeb et al., 2013). These changes in coagulation factors impact coagulation time, and as such have the potential to threaten the cardiovascular health of individuals.

FIGURE **1**

Summary of Systemic Review Process on Health Impacts of Dust Storms in the Middle East



Discussion and Conclusion

Current research has suggested that environmental changes, including climate variability, changes in global and regional climate patterns, desertification, and human factors such as agricultural practices and resource management are responsible for the increasing frequency and intensity of dust events (Krasnov et al., 2014; Middleton, 2019; Najafi et al., 2017; Parolari et al., 2016). Human interference and climate change likely will continue to effect dust sources and contribute to the expansion of susceptible arid lands that are a source of dust emissions, increasing the likelihood for dust events in the future (Lababpour, 2020). Increasing dust storm events pose threats to the health of populations across the globe; however, populations across the Middle East where dust sources are abundant are at increased likelihood to suffer negative health consequences. Although the overall occurrence and intensity of dust storm events in the Middle East have increased significantly in recent decades and relationships have been established between dust and adverse health outcomes, epidemiological research exploring the relationships between dust events and health among populations in the Middle East continues to be limited (Goudie, 2014; Najafi et al., 2017).

Dust storms are one of the most prominent natural sources of air pollution in the Middle East and have been recognized to affect population health through a number of physical and physiological hazards. Our review found that dust storm events and dust were associated with increased risk for hospital admissions for both respiratory and cardiovascular events, reductions in lung function and capacity, irregularities in blood coagulation, and increases in allergic inflammation, as well as increased risk for diseases associated with exposures to airborne human pathogens. While the mechanisms by which dust directly impacts the development or onset of adverse health outcomes have yet to be thoroughly studied, research has been able to establish significant relationships between dust storm events and unfavorable health consequences among populations in the Middle East.

Researchers focused on the effects of dust among populations in European and Asian countries as well as the U.S. have identified subgroups at increased vulnerability for adverse health consequences associated with dust. Children, pregnant individuals, older adults, those reporting lower levels of income, and those with preexisting cardiovascular and respiratory diseases have been identified to be the most susceptible to the effects of dust storm events in these nations (Chien et al., 2014; De Sario et al., 2013; Goudie, 2014; Li et al., 2018; Yu et al., 2013). Studies conducted in the Middle East identified similar patterns of vulnerability in children, women, and individuals with asthma who are at increased risk for hospitalization and adverse health outcomes associated with exposures to dust storm events. Additionally, studies conducted in the Middle East also presented evidence that dust

has the potential to exacerbate serious conditions and diseases, such as TB (Alavi et al., 2014). Dust adversely affected symptoms, prognosis, and recovery time for those with TB, suggesting increased vulnerability among TB patient subgroups. Despite the identification of vulnerable subgroups across existing literature, there has been little exploration on the effects of dust storms on these specific groups across nations in the Middle East. Given the expanding body of knowledge that suggests increasingly serious health outcomes attributable to dust storm events, the current lack of research surrounding the impacts of dust storms on vulnerable groups presents a critical gap in literature. For example, a study conducted in West Africa established strong associations between neonatal mortality and exposure to dust events, while a study in Kuwait identified women and older adults to be at increased risk for mortality attributable to dust storm exposure (Achilleos et al., 2019; Karimi et al., 2020).

In addition to the vulnerability of specific subgroups to succumb to the effects and hazards associated with dust storms, refugees comprise another potentially susceptible population not currently studied. It is estimated that more than 7 million people have fled from conflict zones to neighboring countries including Jordan, Iraq, and Turkey, among others (Silbermann et al., 2016). Refugees have unique health, cultural, and social challenges. Syrian refugees, in particular, are more frequently afflicted by chronic and noncommunicable diseases than other refugee populations, often requiring expensive treatment and care. They also face various social and physiological issues in adapting to host environments, along with language barriers, difficulties in accessing healthcare, and financial hardships. Existing research has suggested that nationality has the potential to impact susceptibility to dust storm events (Achilleos et al., 2019). As such, Syrian refugees potentially represent a population at increased vulnerability for adverse health consequences attributable to dust storm events and should be considered as a population of interest for future studies.

To our knowledge, this article is the first systematic review to assess the health impacts of dust storms on populations across the Middle East. While we made every effort to be methodological and comprehensive, the findings presented in our review are not without limitations. The majority of articles we identified and included in our review focused on populations within Iran. Studies taking place in Iran were well justified and explained the increased risk of the population in the region to be adversely impacted by dust storm events, emphasizing both the relevance and necessity to further explore and expand knowledge on the impacts of dust storms on the health of populations in the Middle East. While the need for such studies in Iran was well justified, no exact explanation was provided in the literature we reviewed for the lack of publications or studies assessing health outcomes associated with dust events across other Middle Eastern nations that are susceptible to dust storm events.

The majority of articles that we included in our review utilized retrospectively collected health outcome data. While analyses conducted using such data allowed for the identification of statistically significant associations between dust storm events and health outcomes of interests, studies were ultimately unable to establish causality. The inability to establish causal relationships between dust storm events and specific health outcomes of interest is a major gap in the existing literature and should be explored in future research.

Dust storm data were also collected using retrospective methodologies. Different countries used different technologies to measure dust storm events and there are likely differences that exist in the categorization of dust storms, dusty days, and non-dusty days. We found that definitions of dust storm events and related terms were not well defined in the studies we analyzed.

Although the need for research capable of establishing causal relationships between dust storms and human health outcomes is of great importance, understanding the roles of social, economic, political, and contextual factors in population vulnerability and susceptibility is equally as important. There were notable differences in subgroup vulnerability to dust storm events that have not been explained in the existing literature. While the identification of vulnerable subgroups is a significant achievement, further work needs to be done to identify and expand on the factors facilitating adverse health outcomes among at-risk groups. Expanding what is currently understood about demographic, social, economic, and political factors, as well as the biological mechanisms underlying how dust impacts human health, is a crucial step in improving health at a population level.

Furthering the understanding of how these factors impact individual susceptibility and population vulnerability will aid in the 1) development of adequate public health interventions; 2) identification of specialists and personnel to involve in the development of health, safety, and prevention efforts; and 3) development of large-scale policies aimed at improving the health and well-being of populations across Middle Eastern countries.

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Corresponding Author: Muge Akpinar-Elci, Old Dominion University, 2114 Health Sciences Building, Norfolk, VA 23529.
Email: makpinar@odu.edu.

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The Effect of Ice Hockey Official Helmet Visor Length on Exposure to Whistle Noise

William J. Brazile, PhD, CIH, CSP
Karin L. Adams, PhD, CIH
Department of Environmental and Radiological Health Sciences, Colorado State University

Abstract **Research has shown that ice hockey officials can experience a decrease in auditory acuity after officiating ice hockey games. We evaluated the effect of helmet visor length on the sound pressure level of whistle noise to which ice hockey officials are exposed to determine if visors increased the sound pressure level. A Knowles Electronic Manikin for Acoustical Research with an in-ear microphone and a sound level meter were used to measure noise levels during whistle blowing. The manikin was equipped with an ice hockey helmet and three visor configurations: no visor, a short visor, and a long visor. A pea whistle was mounted adjacent to the manikin's mouth and configured to produce approximately 115 dB of whistle noise. We found that measured noise levels in the manikin ear were significantly different ($p < .001$) depending on helmet and visor configurations. Our study results suggest that longer helmet visors might increase ice hockey officials' noise exposure. These results are of importance to environmental health professionals in recognizing noise sources that can increase the risk of noise-induced hearing loss from recreational noise exposure.**

Introduction

USA Hockey is the governing body for organized amateur ice hockey in the U.S. and the National Hockey League (NHL) is the governing body for professional ice hockey in the U.S. and Canada. For this study, we will refer to the recommendations and rules set forth by USA Hockey and followed by officials of the Western States Hockey League (WSHL) unless otherwise noted. There are more than 25,000 officials registered with USA Hockey; however, registration is not required. Interestingly, ice hockey officials may begin officiating as early as 10 years of age, depending on state child labor laws (USA Hockey, 2021a).

Ice hockey has inherent hazards and risks for the players as well as the officials. It is an intensely physical sport with the probability of contact among players and contact with ice hockey sticks, pucks, boards, and skate blades (Sim et al., 1987; Tegner & Lorentzon, 1991). Personal protective equipment (PPE) has been developed to protect ice hockey participants. Beginning in 2013–2014, all players with fewer than 25 games of NHL experience are required to wear a helmet with a visor. For officials, those with more than 25 games of experience are required to wear only a league-approved helmet (National Hockey League, 2018); per USA Hockey rules, PPE for officials includes a black ice hockey helmet with a half-shield visor properly attached and a chin strap properly fastened (USA Hockey, 2021b).

Noise exposures of spectators and employees outside the game area have been studied by several researchers (Cranston et al., 2013; Engard et al., 2010; Ramma et al., 2011; Swanepoel & Hall, 2010). Noise exposure of ice hockey officials on the playing surface has been less studied (Adams & Brazile, 2017; Adams et al., 2016; Masullo et al., 2016). One of these studies found that 86% of ice hockey officials experienced a postgame auditory acuity decrease of at least 10 dB at select frequencies in both ears and that the mean personal noise exposure of officials during a game was 93 dB (Adams & Brazile, 2017).

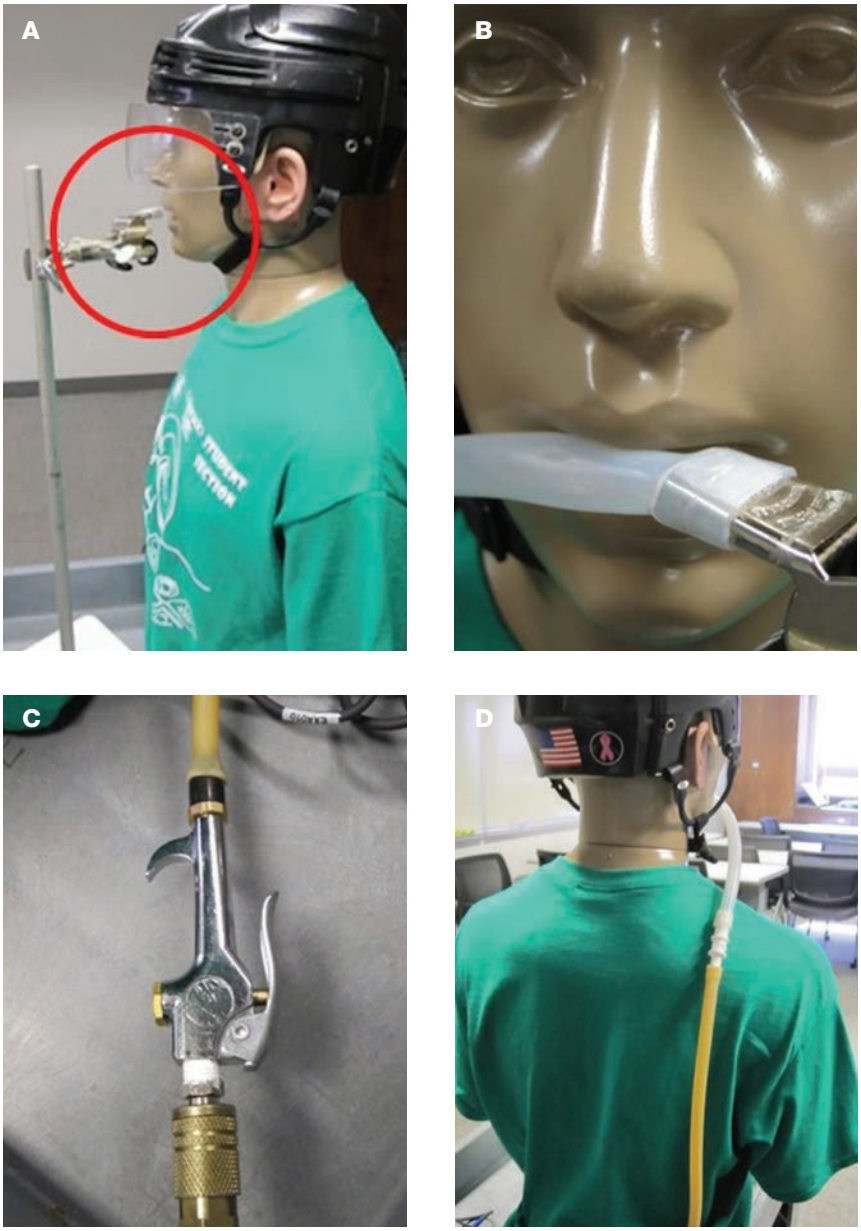
According to the American Speech-Language-Hearing Association (2021) and the National Institute on Deafness and Other Communication Disorders (2019), long repetitive exposure to sound at ≥85 dB is hazardous and can cause hearing loss. In addition, the National Institute for Occupational Safety and Health (1998) has indicated that noise exposure at a time-weighted average of 85 dBA for an 8-hr workday increases the risk of noise-induced hearing loss by 8% over a 40-year working lifetime exposure. It is important to recognize that sports officials are exposed to noise from the crowd, the public address (PA) system, and whistle noise that is in close proximity to the officials' ears as a point source of noise.

The noise point source in this study is the official's whistle. The helmet visor, when attached to the helmet, introduces a concave, reflective surface near the whistle. We studied the effect of the reflective surface of the visor on the resulting noise exposure at the ear produced by blowing a whistle. Personal noise dosimetry is the most accepted method to measure the noise exposure of officials as they are exposed to crowd noise, PA system noise, ice hockey player noise, and whistle noise.

Whistle noise can be a significant noise contributor to officials, so we sought to iso-

FIGURE **1**

Knowles Electronic Manikin for Acoustical Research (KEMAR) Whistle Noise Simulator



Note. A) whistle mounted on stand and placed near mouth of KEMAR, B) silicon tubing connecting whistle near KEMAR mouth to compressed air source, C) blow gun trigger assembly located on cart behind KEMAR, and D) silicon and rubber tubing connecting whistle to blow gun.

late it and determine if visor configuration can affect the whistle's contribution to ice hockey officials' noise exposure. We used a Knowles Electronic Manikin for Acoustical Research (KEMAR) to simulate an ice hockey official blowing the whistle on the ice. We compared the peak sound pressure levels (L_{peak}) of whistle noise measured in the left ear of the manikin wearing a helmet with no visor, with a short visor of 6.98 cm (2.75 in.), and with a long visor of 10.16 cm (4.0 in.). We sought to determine if there was a significant difference in the mean L_{peak} among the helmet and visor configurations.

Benson et al. (1999) found that facial and dental injuries were significantly reduced in ice hockey players who used full-face shields rather than half-face shields. Therefore, as ice hockey face shields are currently designed, the use of a relatively shorter visor could decrease an official's noise exposure but at the same time could increase the probability of a facial injury because more of the official's face would be exposed to physical contact.

The goal of our study was to isolate the whistle noise, as it can be a significant noise contributor for officials, to determine if ice hockey helmet visor length influenced the sound pressure level that reaches an ice hockey official's ears. The results of this investigation could inform ice hockey visor designers to better protect the hearing of officials and players.

Methods

A vacant NHL-sized ice rink in Northern Colorado was used for this study. The rink was 61 x 26 m (200 x 85 ft) with seating for 200 spectators. The noise measurements were taken at the four end zone face-off spots and the center ice face-off spot. The helmet and visors used in our study were representative of those worn by WSHL officials working in Northern Colorado and southeastern Wyoming. The operating temperature parameters of the study instrumentation encompassed the temperatures of 15–16 °C (59–61 °F) recorded during the study in the ice arena.

The KEMAR is an anthropomorphic manikin that was used to simulate in-situ noise exposure measurements of indoor ice hockey officials. A 45BA KEMAR head and torso simulator (G.R.A.S. Sound & Vibration) fitted with a 43AG Left Ear Simulator with a large left anthropometric pinna and a Type 26 AC preamplifier with an IEC 711 coupler was used in accordance with the International Organization for Standardization (2004) for the determination of sound emission from sound sources placed close to the ear. When the KEMAR is used to quantitatively determine the noise exposure levels that the human ear receives from a sound source, the head-related transfer function (HRTF) would

be applied to the data. We were collecting data only on the relative sound levels among helmet and visor configurations, therefore the HRTF was not applied.

Following manufacturer guidance, the right ear opening of the KEMAR was occluded with a foam earplug and a cotton hand towel was placed inside the head orifice to reduce or eliminate any reverberation of noise in the head of the manikin during measurements. A Class 1 Larson Davis Model 824 Precision Sound Level Meter (SLM) and Real Time Analyzer was used to measure L_{peak} of the whistle sound. The whistle noise was measured in the left ear of the manikin because researchers had previously determined that, regardless of dominant hand side, WSHL officials held the finger grip whistle in the left hand and blew it on the left side of the mouth (Adams & Brazile, 2017; Adams et al., 2016). The Type 26 AC preamplifier with an IEC 711 coupler ear microphone was removed from the manikin and directly calibrated with the Larson Davis CAL 200 primary calibrator. The Larson Davis SLM recorded the calibration of the ear microphone. Calibration was conducted before and after the sampling at 94 and 114 dB.

A Fox 40 Super Force finger grip pea whistle was used to generate the whistle noise. The whistle was secured adjacent to the manikin's mouth with a cast iron support and a three-prong clamp (Figure 1). Silicon tubing was used to attach the whistle to a Husky brass blow gun that had a 0.64 cm (0.25 in.) female national pipe thread air inlet (Figure 1B–D). The blow gun was attached to a 22.7 L, 1.5 kW Campbell Hausfeld portable air compressor with quick-connect style fittings. A Husky low-pressure regulator and gauge of 7 kPa (160 psi) maximum pressure was connected to the air compressor. The air pressure was regulated at 124–138 kPa (18–20 psi) to produce approximately 115 dB of whistle noise. Our decision to use 115 dBA whistle noise was based, in part, on previous research reporting that officials' whistles produced sound pressure levels between 104 and 116 dBA (Flamme & Williams, 2013).

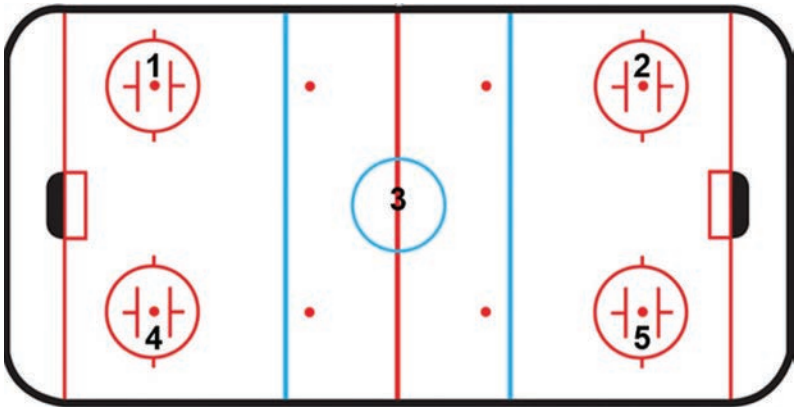
The manikin assembly was placed on a cart in the five-faceoff locations in the indoor ice hockey rink. The sampling locations are shown in Figure 2, with the KEMAR assembly facing away from the closest boards and approximately 30.5 cm (1 ft) from the face-off spots. The KEMAR assembly was placed at the center ice face-off spot facing away from the players' benches and toward the spectator stands. The face-off locations were chosen as the sampling locations because they are known areas where officials will blow the whistle.

The whistle output was confirmed at 115 dB (*SD* = 1) by measuring L_{peak} with a flat response 122 cm (4 ft) in front of the whistle and approximately 152 cm (5 ft) above the ice. The whistle output was measured with a CEL-383 integrating SLM that was calibrated before and after the sampling with a CEL-282 acoustic calibrator.

We used a Bauer 4500 ice hockey helmet with the translucent ear covers removed, as was representative of the helmet configuration WSHL officials used in previous studies (Adams & Brazile, 2017; Adams et al., 2016). We examined three helmet configurations: a helmet with no visor (Figure 3A), a helmet with an Oakley VR904 modified straight small visor with slots (Figure 3B), and a hel-

FIGURE **2**

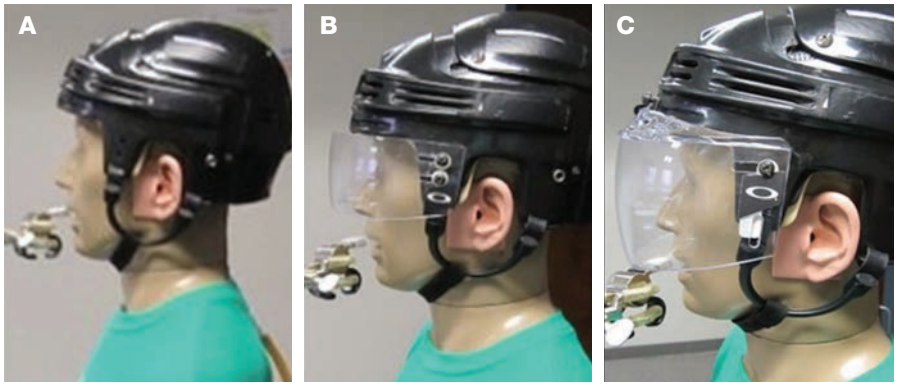
Diagram of Hockey Ice Rink Sample Locations



Note. Figure 2 was created using HockeyShare (www.hockeyshare.com).

FIGURE **3**

Hockey Helmet and Visor Configurations



Note. A) Bauer 4500 hockey helmet without a visor, B) Bauer 4500 hockey helmet with an Oakley VR904 modified straight short visor with slots, and C) Bauer 4500 hockey helmet with an Oakley VR924 CLE pro straight long visor with vents.

TABLE **1**

Summary of Analysis of Variance Results for the Differences in Mean L_{peak} for Visor Lengths

Visor Length Comparison	Difference Between Means	*p*-Value	95% Confidence Interval
Short versus none	-0.32 dB	.1558	[-0.76, 0.12]
Long versus none	3.96 dB	<.0001	[3.52, 4.40]
Long versus short	3.64 dB	<.0001	[3.20, 4.08]

Note. Short visor length = 6.98 cm (2.75 in.); Long visor length = 10.16 cm (4.0 in.); α = .05.

TABLE **2**

Mean Peak Whistle Noise Measured in the Left Ear of the Knowles Electronic Manikin for Acoustical Research

Helmet Configuration	Sample Location[a]	Peak dB Minimum–Maximum	Peak dB Mean (*SD*)	Peak dB/Helmet Configuration Mean (*SD*)
No visor	1	117–118	118 (0.4)	117 (0.3)
	2	118–118	118 (0)	
	3	116–117	117 (0.5)	
	4	118–118	118 (0)	
	5	117–117	117 (0)	
Short visor	1	117–118	118 (0.4)	118 (0.8)
	2	117–118	118 (0.4)	
	3	117–117	117 (0)	
	4	117–118	118 (0.4)	
	5	117–117	117 (0)	
Long visor	1	121–122	122 (0.4)	121 (1.1)
	2	120–121	121 (0.4)	
	3	119–120	120 (0.4)	
	4	121–121	121 (0)	
	5	122–123	123 (0.5)	

Note. Short visor length = 6.98 cm (2.75 in.); long visor length = 10.16 cm (4.0 in.).
[a]*n* = 5 for each sample location.

met with an Oakley VR924 CLE pro straight long visor with vents (Figure 3C).

We used a random number generator to determine the order of helmet configurations and face-off spot locations. One helmet configuration was sampled at each of the randomly selected five face-off spots (Figure 2) prior to changing the helmet configuration. The whistle was blown for a duration between 250 and 350 ms, a total of 5 times in each location, with a total of 25 samples for each helmet configuration. The whistle signal duration of 250 to 350 ms was chosen based on the typical whistle signal duration reported by Flamme and Williams (2013), who measured whistle noise signals blown by an experienced sports official (reported range was 200–300 ms, with a rise of a few ms and a fall of approximately 50 ms).

Statistical Analysis

Statistical analysis was performed using SAS version 9.4. Analyses of variance (ANOVA) were used to evaluate whether there were statistically significant differences in the mean L_{peak} measured in the left ear of the manikin across the different helmet and visor configurations. The ANOVA assumptions were tested and met. The independent variable represented the three different helmet and visor configurations: helmet with no visor, helmet with short visor, and helmet with long visor. The dependent variable was the L_{peak} measured at the left ear of the KEMAR. In addition, descriptive statistics expressed the mean and standard deviation of the L_{peak} measured in the left ear of the manikin with each of the helmet configurations.

Results and Discussion

The results indicated that helmet visor length contributed to whistle-blast noise level at the manikin's left ear. In both helmet configurations that included a visor, the mean L_{peak} measured at the left ear of the manikin was greater than the mean L_{peak} measured for the helmet with no visor. The difference in the mean L_{peak} was significant ($p < .001$) between the no visor versus long visor configuration and the short visor versus long visor configuration, but not between the no visor versus short visor configuration. The ANOVA analysis summary is displayed in Table 1 and the descriptive summary of the mean peak whistle noise is provided in Table 2.

The attachment of the visor to the helmet introduces a reflective plane in the proximity of the whistle noise source, causing additional noise to reflect back to the official. The longer visor provided a greater reflective surface for the whistle noise source. In addition, this surface extends further down vertically from the helmet, resulting in the bottom edge of the surface being closer to the noise source and occluding more of the space in front of an official's face. The amount of sound pressure reflected to the manikin's ear appeared to increase based on the length of the visor due to an increase in reflected noise. We found that the longer visor attached to the helmet showed an increase of sound pressure level of nearly 4 dB ($p < .001$) above the helmet configuration with no visor.

Flamme and Williams (2013) reported that sound pressure levels produced by officials'

whistles ranged between 104 and 116 dBA, corresponding to total allowable exposure times of 90 and 5 s, respectively. In their study, the authors asked 321 officials from basketball, football, volleyball, wrestling, soccer, ice hockey, and lacrosse to self-report whistle noise exposure and symptoms of tinnitus or hearing loss. They found that approximately 50% of sports officials reported symptoms of tinnitus after officiating, and the Spearman's correlation between self-reported hearing status and the frequency of reported tinnitus was significant ($p < .0005$). Our study's ANOVA results support the conclusions of Flamme and Williams that whistle noise may contribute to hearing loss among sports officials, particularly if they are wearing a long or short visor. Our results suggest that the use of a longer visor can increase the contribution of the mouth-blown whistle noise by approximately 4 dB ($p < .0001$), thereby more than doubling the intensity of the noise exposure (Berger et al., 2003).

In addition, Adams and Brazile (2017) found that ice hockey officials had an average noise exposure of 93 dB during a game, as measured with the microphone of the noise dosimeter located on the officials' shoulder. This noise exposure included crowd noise, the PA system, puck and ice hockey stick noise, and other sources in addition to the whistle. As with the reflected whistle noise increase measured in our study, it is possible that a helmet visor could also reflect and increase the noise level from these other-than-whistle noise sources, resulting in ice hockey officials having a greater personal noise exposure.

These results serve as an initiative for further research that could provide insight toward an improved design of helmet visors in the future—visors that would continue to provide protection to the eyes and face of an ice hockey official, but not at the expense of their hearing. For example, ice hockey helmet and visor manufacturers should consider a design that isolates the ear from the reflected exposure (e.g., helmet ear caps with sound-insulating material, or a visor that seals closer to the face) or a redesign of visors that reduces the reflected acoustical energy, such as a nonconcave visor or one that changes the specular focal point.

Limitations

Our study used a Fox 40 Super Force finger grip pea whistle and two Oakley visors. While multiple options for whistles and visors are available, selection for this study was based on league regulations and personal preference of the ice hockey officials studied. Therefore, the visors and whistles used are not representative of all visors and whistles available on the market. Future studies should examine a larger selection of visors and whistles.

Data were collected on L_{peak} for 5 whistle blows in each face-off spot with a total of 25 samples for each helmet configuration. As seen in Table 1, there was more variability in the whistle noise measurements at the ear of the manikin wearing the long visor ($SD = 1.1$). A larger sample set would likely decrease the standard deviation in the mean L_{peak} and increase the power and robustness of the statistical significance. In addition, it would be beneficial to investigate the octave-band spectra produced by whistles to determine the frequency bands that contain the majority of acoustic energy in relation to hearing risk, as well as the different levels of whistle noise intensities produced by ice hockey officials. Further, it is recommended that traditional noise dosimetry be used on ice hockey officials who wear different visor types to determine if the visor type influences the overall noise exposure of officials, which would also include other noise source contributions (e.g., crowd noise, PA system, ice hockey player noise).

Conclusion

The goal of our study was to isolate ice hockey officials' whistle noise to determine if ice hockey helmet visor length influenced the sound pressure level that reaches an ice hockey official's ear. Our study results indicate that when compared with a short helmet visor or no visor, a long ice hockey helmet visor could increase the risk of noise-induced hearing loss because the long visor doubled the acoustic energy reaching the ice hockey official's ear. The results of this study are important to environmental health professionals in recognizing and controlling recreational noise sources that can contribute to the risk of noise-induced hearing loss.

Declaration of Interest Statement: The authors declare no conflict of interest related to the material presented in this article. The content of the article, including any opinions and conclusions expressed, are solely those of the authors.

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Corresponding Author: William J. Brazile, Associate Professor, Department of Environmental and Radiological Health Sciences, Colorado State University, 1681 Campus Delivery, Fort Collins, CO 80523-1681.
Email: william.brazile@colostate.edu.

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Factors Influencing Radon Mitigation Behaviors Among Utah Residents

James D. Johnston, MSPH, PhD, CIH
Siena F. Davis, MPH, CPH, CHES
Gabriel S. Ghanadan
Department of Public Health, Brigham Young University

Andrea M. Jensen, CHES, AE-C
Bryce C. Larsen, MPA, LEHS
Division of Environmental Health, Utah County Health Department

John D. Beard, MPH, PhD
Department of Public Health, Brigham Young University

Abstract **For most individuals, the greatest proportion of radon exposure occurs in the home. Residential radon exposure, however, can be minimized through testing and mitigation. The purpose of our study was to explore mitigation behaviors among individuals who learned their home had high levels of radon (≥4.0 pCi/L or 148 Bq/m^3). We enrolled participants (*N* = 110) from among individuals who visited the Utah County Health Department to purchase a radon test kit. Of those participants with a residential radon level ≥4.0 pCi/L (31%), only 23% performed mitigation within approximately four months after they learned their homes had high radon levels. Traits such as older age, identifying as female, and magnitude of radon level appeared to be associated with performing radon mitigation. Inconvenience and cost appeared to be reasons for not performing radon mitigation. Our findings add to a growing number of studies that document a gap between testing, mitigation, and associated factors. These factors might be best addressed by multifaceted interventions that address policies, risk perception, cost, and other barriers.**

Introduction

Radon (^{222}Rn) is the second leading cause of lung cancer in the U.S. and worldwide (World Health Organization, 2009). For most individuals, the greatest proportion of radon exposure occurs in the home where people spend 60–80% of their time (Cohen Hubal et al., 2000; Klepeis et al., 2001; Spalt et al., 2016). Residential radon exposure can be minimized through testing and mitigation. Appropriately, there is a growing body of research directed at understanding theory-based factors that influence radon testing behaviors of individuals (Davis et al., 2018; Duckworth et al., 2002; Rinker et al., 2014; Weinstein et al., 1990). In homes that are tested and found to have high radon levels, testing must be followed by mitigation to reduce radon levels and ultimately decrease lung cancer rates. To date, however, there is little published data on the proportion of people who mitigate and factors that influence posttesting mitigation behaviors.

The U.S. Environmental Protection Agency's (U.S. EPA) recommended action level for radon is ≥4.0 pCi/L (148 Bq/m^3); for homes with actionable test results, installation of a radon reduction system is recommended as the primary mitigation strategy (U.S. EPA, 2016). The few studies that have assessed radon remediation, however, suggest a relatively low percentage of people actually mitigate after receiving actionable test results. For example, Riesenfeld et al. (2007) found only 43% of Vermont residents mitigated after receiving high test results. A mass media-based radon intervention study in the Washington, DC, area found mitigation percentages ranged from 5.5–40.4% (Doyle et al., 1991). Similarly, a clinic-based intervention study in the Minneapolis, Minnesota, area found <25% of homes with actionable radon levels were mitigated within 1 year of testing (Nissen et al., 2012). Compounding the problem of overall low mitigation percentages, Riesenfeld et al. found approximately 20% of residents who mitigated chose alternative methods to reduce radon rather than installing the recommended radon reduction system. Radon reduction strategies are known to vary in effectiveness, with active ventilation or sub-slab depressurization generally being more effective than sealing cracks or using natural ventilation (Rahman & Tracy, 2009).

Understanding factors that influence radon mitigation behaviors is a necessary first step to developing more effective interventions, as currently there is a paucity of information on this subject. Johnson and Luken (1987) found no significant relationship between high radon levels and participants mitigating their homes. In a later study, however, Doyle et al. (1991) found the magnitude of the reported radon level was positively associated with people taking mitigation steps. Riesenfeld et al. (2007) found that mitigation was associated with higher education, concerns high radon would adversely affect property values, and having a home <10 years old. Weinstein and Sandman (1992) found the home's radon level and the homeowner's global appraisal

TABLE **1**

Demographic and Housing Characteristics of Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Characteristic	#	%
Age (years)		
18–44	7	23
45–54	7	23
55–64	5	17
65–74	5	17
>74	6	20
Gender		
Male	16	59
Female	11	41
Not provided	3	
Race/ethnic background		
Caucasian	29	100
Not provided	1	
Highest grade or degree completed		
Some high school; high school or earned GED certificate; some college	10	33
Bachelor's degree	13	43
Master's degree; some graduate	7	23
Current annual family income		
$15,000–$44,999	6	22
$45,000–$64,999	8	30
$65,000–$84,999	5	19
>$84,999	8	30
Not provided	3	
Relationship status		
Currently married	25	89
Divorced; single, never been married, and not living with a partner	3	11
Not provided	2	
Number of people who live in the home		
1–2	11	39
3–4	9	32
5–9	8	29
Not provided	2	
Mean (*SD*)	3.63 (2.02)	

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of danger were the strongest predictors of the intention to mitigate. Nissen et al. (2012) reported health concerns were the primary reason people listed for mitigation, and cost was the primary reason for no mitigation.

One limitation to understanding radon mitigation percentages in the U.S. is that most of the studies that reported percentages of people who mitigated and their reasons for doing so were primarily conducted in the Eastern and Midwestern states; therefore, these study results might not be generalizable to populations in other U.S. regions. To our knowledge, there are no previous studies that evaluate radon mitigation behaviors in the Intermountain West region, which includes Utah. According to the Utah Department of Environmental Quality (2020), approximately 35% of tested homes in Utah County, Utah, have radon levels ≥4.0 pCi/L. Only 8–18% of Utah residents, however, report having tested for radon (Akerley et al., 2011; Utah Department of Health, 2019). The purpose of this study, therefore, was to explore mitigation behaviors among individuals who learned their home had high levels of radon (≥4.0 pCi/L) after conducting a test using a radon test kit purchased from the Utah County Health Department (UCHD).

Methods

Study Design

Convenience sampling was used to recruit participants (N = 110) at UCHD from May 2014 to January 2016. Participants were individuals living in Utah County who visited the UCHD Division of Environmental Health for the purpose of purchasing a radon test kit. At the time of this study, UCHD sold short-term activated charcoal radon test kits (Air Chek, Inc.) to county residents for $10. From May 2014 to February 2015, participants received $5 off the price of the test kit if they participated in our study. To increase study enrollment and provide additional compensation to participants for completing the radon mitigation survey, compensation was increased to $10 off the price of the test kit for participants who enrolled after February 2015.

Two UCHD employees were trained on study protocols and conducted all recruitment activities, which included asking individuals who visited UCHD to purchase a radon test kit if they would be interested in participating in the study and providing them with a one-page flyer about the study. Those who agreed to participate in the study were asked to complete a consent form and a 52-item survey (Davis et al., 2018; Novilla et al., 2021) while at UCHD. Participants then received a brief educational presentation about radon from a Certified Health

Education Specialist/Environmental Health Educator (i.e., one of the two trained UCHD employees). This presentation reviewed what radon is, how it enters a home, risks of exposure, how a test kit works, how to maintain closed house conditions 12 hr prior and then during the testing time period, where to place the test kit, how long to leave it exposed, how to immediately send the kit back to the lab, and what to do if the test found an elevated radon level. Participants were also provided with educational materials from U.S. EPA and the Utah Department of Environmental Quality (DEQ). Educational information compiled by DEQ included photos of a UCHD employee's mitigation system, average price of having a system installed, and a list of Utah certified radon professionals.

Approximately two weeks after participants purchased their test kits, study personnel checked participants' radon test results online using test kit serial numbers. Participants with radon levels ≥4.0 pCi/L were contacted by phone approximately four months after their test results were posted. At that time, study personnel asked participants to complete a 12-item radon mitigation survey. The institutional review board of Brigham Young University approved this study.

Radon Testing Survey

Study personnel used a 52-item paper and pencil survey to measure predictors of radon testing, sources of radon information, attitudes toward potential radon policies in Utah, and demographic and housing characteristics. This survey was completed by participants at UCHD on the day they picked up their radon test kit. Results of the radon testing survey are reported in Davis et al. (2018) and Novilla et al. (2021). For the current study, we used only the information regarding demographic and housing characteristics.

Radon Mitigation Survey

Approximately four months after participants' radon test results were posted, we used a 12-item phone survey to assess initial radon test procedures and results, radon mitigation actions (if any), postmitigation test results (if any), and factors that influenced the decision to mitigate. Some of the survey questions also included follow-up questions.

TABLE **1** *continued from page 23*

Demographic and Housing Characteristics of Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Characteristic	#	%
Number of children who live in the home		
0	14	50
1–2	6	21
3–6	8	29
Not provided	2	
Mean (*SD*))	1.39 (1.77)	
Own or rent home		
Own	29	97
Rent	1	3
Type of residence		
Single family home	30	100
How long lived in the current residence (years)		
0–10	10	34
>10–20	7	24
>20–30	6	21
>30–55	6	21
Not provided	1	
Mean (*SD*)	19.07 (15.39)	
Radon level (pCi/L) [a]		
4.0–4.5	6	20
4.6–5.9	6	20
6.0–7.0	6	20
7.1–9.5	6	20
9.6–19.4	6	20
Mean (*SD*)	7.88 (3.95)	

Note. Participants ($N = 30$) were individuals who completed a survey regarding radon mitigation behaviors after they found out their residence had radon levels greater than or equal to the U.S. Environmental Protection Agency's recommended action level of 4.0 pCi/L.

[a] Category boundaries set at quintiles of the distribution of radon level.

We used four questions to assess radon test procedures and results. Questions included:

1. When you conducted the radon test in your home, what floor did you collect the measurement on?
   a. Follow-up question: If in the basement, was the test conducted in a living area?
      - Follow-up question: Which room?
2. After you completed the radon test, did you find out what the results were?
3. Were the results of your radon test high (above 4.0 pCi/L)?
   a. Follow-up question: What was the level?
4. Did you have the level retested?
   a. Follow-up question: If yes, was the level high again?

We used four questions to assess mitigation actions. Questions included:

1. After testing your home, did you or anyone else do any work to the house to reduce the radon level?
2. What type of work was done to reduce the radon level in your home?
3. Who performed the work to reduce the radon level in your home?

TABLE **2**

Testing and Mitigation Behaviors of Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Variable	#	%
When you conducted the radon test in your home, what floor did you collect the measurement on?		
Basement	26	87
First floor [a]	4	13
If in the basement, was the test conducted in a living area?		
No	4	15
Yes	22	85
In which room was the radon test conducted?		
Bedroom	7	23
Family, great, living, play, or theater room	18	60
Middle or storage room, hallway, or walk-in closet	5	17
After you completed the radon test, did you find out what the results were?		
No	2	7
Yes	28	93
If yes, were the results of your radon test high (above 4.0 pCi/L)?		
Yes	28	100
If yes, did you have the level retested?		
No	19	68
Yes	9	32
If yes, was the level high again?		
No	3	43
Yes	4	57
Not provided	2	

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4. How much money did you spend to reduce the level of radon in your home?

We used two questions to assess radon test results following mitigation. Questions included:

1. Did you have the level retested after you made these changes to your home to reduce radon levels?
2. When your home was retested for radon, was the level high (above 4.0 pCi/L)?
   a. Follow-up question: What was the level?

We used one multiple-choice/short answer question to assess which factors influenced participants to mitigate: What factors influenced you to make changes to your home to reduce radon levels? For individuals who did not mitigate, we asked: What were your reasons for not making changes to your home to reduce radon levels?

Statistical Analyses

We used SAS version 9.4 to conduct all analyses. We calculated frequencies and percentages for all demographic and housing characteristics as well as radon testing and mitigation behaviors. We also calculated means and standard deviations for the few demographic and housing characteristics collected as continuous variables. We used simple exact unconditional logistic regression models to estimate unadjusted exact odds ratios and exact 95% confidence intervals for associations between demographic and housing characteristics and whether participants mitigated their residence for radon after learning their residence had radon levels above the U.S. EPA's recommended action level. We considered multiple versions (e.g., continuous if appropriate, two categories, three categories, etc.) of the demographic and housing characteristics and used the versions that had the lowest values of the Akaike information criterion (Akaike, 1974; Howe et al., 2011). Given our small sample size, we considered any demographic or housing characteristic that had an *OR* ≥2.00 or ≤0.50 to be associated with mitigating. We used Spearman's correlation coefficients to estimate associations between demographic and housing characteristics and individual reasons participants did not mitigate.

Results

More than 50% of participants were older than 54 years, identified as male, had completed at least a bachelor's degree, had a current annual family income of at least $45,000, were currently married, and owned their home (Table 1). All participants were Caucasian; the means for the number of people who live in the home, number of children who live in the home, how long they have lived in their current residence, and radon level were 3.63 people, 1.39 children, 19.07 years, and 7.88 pCi/L, respectively.

For the radon tests, 87% were conducted in a basement and 85% of these were conducted in a living area (Table 2). For all radon tests, 60% were conducted in a family, great, living, play, or theater room. Moreover, 93% of participants found out their radon test results and 100% of these had high radon levels. Of these participants, 32% retested their residence of whom 57% received a high result again. Only 23% of participants mitigated their residence (i.e., performed or had performed any work to the house to reduce the radon level). Of participants who mitigated, 57% installed a system for ventilation or to draw out the radon, 80% employed a professional contractor, and 80% spent more than $1,000. Of those who mitigated their residence, 80% retested their residence after mitigation and of these, 50% received high results again (i.e., mitigation did not lower the radon level below the U.S. EPA's recommended action level; results not shown).

Among participants who mitigated their residence, 75% selected "concern for your own health" and 75% selected "concern for your children's health" as factors that influenced them to make changes to their home to reduce

radon levels (Table 2). In contrast, among participants who did not mitigate their residence, reasons for not mitigating selected by at least 25% of participants included "inconvenience," "the cost is too great," and "radon levels in my home were not high enough to really concern me" (Table 3).

Demographic and housing characteristics that had *OR*s ≥2.00 for associations with mitigating residence included age >64 years versus 18–64 years, identifying as female versus male, renting versus owning a home, and a radon level ≥6.0 versus 4.0–6.0 pCi/L (Table 4). There were only two statistically significant Spearman's correlation coefficients for associations between demographic and housing characteristics and individual reasons participants did not mitigate: 1) radon level and "making changes to my home would not reduce radon levels enough to make a difference" (r = .45, p = .03) and 2) radon level and "other (please specify)" (i.e., all of the "other" responses together; r = .45, p = .03).

TABLE **2** *continued from page 25*

Testing and Mitigation Behaviors of Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Variable	#	%
After testing your home, did you or anyone else do any work to the house to reduce the radon level?		
No	23	77
Yes	7	23
If yes, what type of work was done to reduce the radon level in your home (select all that apply)?		
A system was installed for ventilation or to draw out the radon	4	57
Doors or windows were opened	2	29
Other: Put a pipe in the floor	1	14
If yes, who performed the work to reduce the radon level in your home (select all that apply)?		
A professional contractor	4	80
A member of the home or friend	1	20
Not provided	2	
If yes, how much money did you spend to reduce the radon level in your home?		
≤$100	0	0
$101–$500	1	20
$501–$1,000	0	0
$1,001–$2,000	3	60
>$2,000	1	20
Not provided	2	
If yes, what factors influenced you to make changes to your home to reduce radon levels (select all that apply)?		
Concern for your own health	3	75
Concern for your children's health	3	75
Concern about property value	1	25
Other: Saw a television program about it and I got a flyer in my mail saying that the mayor had tested his house	1	25
Not provided	3	

Note. Participants (N = 30) were individuals who completed a survey regarding radon mitigation behaviors after they found out their residence had radon levels greater than or equal to the U.S. Environmental Protection Agency's recommended action level of 4.0 pCi/L.

[a] These should be rooms above ground level.

Discussion

Our findings add to a small number of prior studies that found a gap between testing and mitigation among people who receive test results at or above the U.S. EPA's recommended action level of 4.0 pCi/L. In our study of participants with radon levels ≥4.0 pCi/L, only 23% had mitigated by the time of the follow-up phone survey approximately four months later. This finding most closely matches Nissen et al. (2012), who found fewer than 25% of participants in Minnesota mitigated after receiving high test results. The percentage of people who mitigated in our study was lower than that reported by Riesenfeld et al. (2007), who found 43% of Vermont residents mitigated after receiving high test results; our study results, however, were within the range (5.5–40.4%) reported by Doyle et al. (1991) for a mass media-based radon intervention study in the Washington, DC, area. These findings suggest intervention measures should not be limited to efforts to increase radon testing alone but must focus also on increasing the proportion of individuals who follow through with mitigation.

Although Riesenfeld et al. (2007) found mitigation was associated with higher education and concerns high radon levels would adversely affect property values, we did not find strong evidence that education was associated with mitigation and only 25% of our respondents selected "concern about property value" when asked about factors that influenced mitigation. Like Nissen et al. (2012), we found health concerns for themselves and their children were a primary reason for mitigation. We also found older individuals and female participants were more likely to mitigate.

In addition, our findings are similar to those of prior studies that found the magnitude of the radon level in the home was associated with mitigation. In our study, individuals who had radon levels >6.0 pCi/L were more likely to mitigate than individuals with lower radon levels. Doyle et al. (1991)

TABLE **3**

Reasons for Not Making Changes to the Home to Reduce Radon Levels Among Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Reason [a]	#	%
I am not concerned about radon affecting my health	1	4
Radon levels in my home were not high enough to really concern me	6	26
The benefits of reducing radon levels were not clear to me	2	9
The cost is too great	7	30
Inconvenience	8	35
Making changes to my home would not reduce radon levels enough to make a difference	4	17
The radon level in my home was not measured in a living area	1	4
Other (please specify)	16	70
Currently comparing prices of mitigating on my own versus hiring a professional	1	4
Waiting for radon test results	4	17
Haven't had time	3	13
Need to retest	3	13
I would have done something if my retest results from other areas in my house were also high, but in more open areas the test results were lower. My storage room has little air flow, so the results there were high.	1	4
Looking for the right company right now. Not enough information on radon companies. Had neighbors who spent a lot of money on radon-reducing systems, but radon levels weren't reduced enough to be worth it.	1	4
Might be other health problems to worry about at our age	2	9
Mitigation is scheduled for a couple weeks from now, but the company doing it was scheduled out	1	4

Note. Participants ($N = 30$) were individuals who completed a survey regarding radon mitigation behaviors after they found out their residence had radon levels greater than or equal to the U.S. Environmental Protection Agency's recommended action level of 4.0 pCi/L. Participants ($n = 23$, 77%) indicated that they did not do any work to the house to reduce the radon level (Table 2).

[a] Participants were asked to select all reasons that applied.

found the proportion of people who mitigated radon in their homes increased from approximately 12% for homes with radon levels between 4.0–20.0 pCi/L to >40% for homes with radon levels >20 pCi/L. Similarly, Weinstein and Sandman (1992) found that 75–80% of individuals who had homes with radon levels >20.0 pCi/L mitigated. Together, these findings suggest one's perception of risk might play an important role in the decision to mitigate. Indeed, 26% of participants in our study who did not mitigate selected "radon levels in my home were not high enough to really concern me" as a reason why. Interestingly, Weinstein and Sandman found that perceived threat was a stronger predictor of mitigation than the actual radon level. Future studies of the relationship between perceived versus actual risk and individuals' decisions to mitigate are needed to guide future interventions.

Doyle et al. (1991) suggest some of the factors that can interfere with people completing radon mitigation are it is time consuming, technical and complex, and requires coordination with other professionals. Our findings partially support this assessment, as 35% of those who did not mitigate responded it was inconvenient and another 13% responded they had not mitigated due to time constraints. We found 30% of people responded they did not mitigate due to cost, which was also reported by Nissen et al. (2012) as a barrier to mitigation.

Considering radon mitigation is a relatively complex task, we suggest that multifaceted interventions similar to those used by the Iowa AIR Coalition are needed (Bain et al., 2016). Specific intervention measures used in Iowa included increasing radon awareness and testing, sharing stories from lung cancer survivors at community events and legislative sessions, advocating for radon testing and radon-resistant new construction, and providing financial assistance or low-interest loans to help individuals or families cover the costs associated with mitigation. This intervention in Iowa led to a 108% increase in the number of homes mitigated across the state from 2009–2014. For renters, we suggest policies are needed that require property owners to test for radon and to mitigate if levels are ≥4.0 pCi/L.

Our study was limited by its relatively small sample size. Although we enrolled 110 participants, only a small percentage (31%) had homes with radon levels ≥4.0 pCi/L, and of these, only 23% mitigated their homes. Thus, even though some of the odds ratios from our study were large, they were not statistically significant. The small sample size also meant we could not adjust for potential confounders or estimate

TABLE **4**

Associations Between Demographic and Housing Characteristics and Mitigating Residences for Radon Among Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Characteristic	Mitigated		Did Not Mitigate		Exact *OR*[a]	Exact 95% CI[a]
	#	%	#	%		
Age (years)						
18–64	3	43	16	70	1.00	Reference
>64	4	57	7	30	2.93	[0.38, 25.74]
Gender						
Male	2	33	14	67	1.00	Reference
Female	4	67	7	33	3.78	[0.42, 51.67]
Not provided	1		2			
Highest grade or degree completed						
Some high school; high school or earned GED certificate; some college; bachelor's degree	5	71	18	78	1.00	Reference
Master's degree; some graduate school	2	29	5	22	1.42	[0.11, 12.77]
Current annual family income						
$15,000–$54,999	3	50	9	43	1.00	Reference
>$54,999	3	50	12	57	0.76	[0.08, 7.07]
Not provided	1		2			
Relationship status						
Currently married	5	83	20	91	1.00	Reference
Divorced; single, never been married, and not living with a partner	1	17	2	9	1.94	[0.03, 45.02]
Not provided	1		1			
Number of people who live in the home						
1–2	3	50	8	36	1.00	Reference
3–4	3	50	6	27	1.31	[0.13, 13.74]
5–9	0	0	8	36	0.31[b]	[0.00, 2.23]
Not provided	1		1			

continued ▸

unconditional logistic regression models for mitigating that simultaneously included multiple demographic or housing characteristics as independent variables. We also note that our sample of participants was taken from a relatively homogenous population. The majority of participants were Caucasian, identified as male, had at least a bachelor's degree, and owned their home. Thus, our results might not generalize to more diverse locations. We also used an approximately four month follow-up period for this study. It is possible the percentage of individuals who mitigated would have been higher had the follow-up period been longer.

Conclusion

Our findings add to a growing number of studies that have documented the gap between testing and mitigation. In this study, only 23% of individuals with radon levels ≥4.0 pCi/L mitigated their homes. Considering that this study consisted largely of college-educated homeowners who self-selected to purchase a radon test kit from UCHD, the low percentage of individuals who followed through with mitigation is concerning. Factors that could explain whether individuals mitigate include age, gender, magnitude of radon level, inconvenience, time, and cost. These factors likely would be best addressed by multifaceted interventions that address policies, risk perception, cost, and other barriers.

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Corresponding Author: James D. Johnston, Associate Professor, Department of Public Health, Brigham Young University, 2045 Life Sciences Building, Provo, UT 84602.
Email: james_johnston@byu.edu.

TABLE **4** *continued*

Associations Between Demographic and Housing Characteristics and Mitigating Residences for Radon Among Radon Mitigation Survey Participants, Utah County, Utah, May 2014–January 2016

Characteristic	Mitigated		Did Not Mitigate		Exact *OR*[a]	Exact 95% CI[a]
	#	%	#	%		
Number of children who live in the home						
0	4	67	10	45	1.00	Reference
1–2	2	33	4	18	1.24	[0.08, 13.83]
3–6	0	0	8	36	0.27[b]	[0.00, 1.81]
Not provided	1		1			
Own or rent home						
Own	7	100	22	96	1.00	Reference
Rent	0	0	1	4	3.29[b]	[0.00, 62.43]
How long lived in the current residence (10 years)					1.06	[0.58, 1.89]
Not provided	1		0			
Radon level (pCi/L)						
4.0–6.0	1	14	11	48	1.00	Reference
6.1–9.0	3	43	7	30	4.39	[0.29, 269.48]
9.1–19.4	3	43	5	22	5.95	[0.37, 377.14]

Note. Participants ($N = 30$) were individuals who completed a survey regarding radon mitigation behaviors after they found out their residence had radon levels greater than or equal to the U.S. Environmental Protection Agency's recommended action level of 4.0 pCi/L. Of these, 23 participants (77%) indicated that they did not do any work to the house to reduce the radon level and 7 participants (23%) indicated that they did do work to the house to reduce the radon level (Table 2). CI = confidence interval.

[a] Estimated via simple exact unconditional logistic regression models.

[b] Median unbiased estimate.

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JEH QUIZ

FEATURED ARTICLE QUIZ #2

Factors Influencing Radon Mitigation Behaviors Among Utah Residents

Available to those with an active National Environmental Health Association (NEHA) membership, the *JEH* Quiz is offered six times per calendar year and is an easily accessible way to earn continuing education (CE) contact hours toward maintaining a NEHA credential. Each quiz is worth 1.0 CE.

Completing quizzes is now based on the honor system and should be self-reported by the credential holder. Quizzes published only during your current credential cycle are eligible for CE credit. Please keep a copy of each completed quiz for your records. CE credit will post to your account within three business days.

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INSTRUCTIONS TO SELF-REPORT A *JEH* QUIZ FOR CE CREDIT

1. Read the featured article and select the correct answer to each *JEH* Quiz question.
2. Log in to your MyNEHA account at https://neha.users.membersuite.com/home.
3. Click on Credentials located at the top of the page.
4. Select Report CEs from the drop-down menu.
5. Enter the date you finished the quiz in the Date Attended field.
6. Enter 1.0 in the Length of Course in Hours field.
7. In the Description field, enter the activity as "*JEH* Quiz #, Month Year" (e.g., *JEH* Quiz 2, October 2021).
8. Click the Create button.

JEH Quiz #6 Answers

May 2021

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

→ Quiz effective date: October 1, 2021 | Quiz deadline: January 1, 2022

1. For most individuals, the greatest proportion of radon exposure occurs in the
   a. home.
   b. workplace.
   c. outdoors.
   d. car.
2. Radon is the __ leading cause of lung cancer in the U.S. and worldwide.
   a. first
   b. second
   c. third
   d. fourth
3. The U.S. Environmental Protection Agency's (U.S. EPA) recommended action level for radon is
   a. ≥2.0 pCi/L.
   b. ≥3.0 pCi/L.
   c. ≥4.0 pCi/L.
   d. ≥5.0 pCi/L.
4. According to the Utah Department of Environmental Quality, approximately __ of tested homes in Utah County, Utah, have radon levels at or above the U.S. EPA's recommended action level for radon.
   a. 30%
   b. 35%
   c. 40%
   d. 45%
5. Participants of this study were individuals living in Utah County who visited the Utah County Health Department's Division of Environmental Health for the purpose of purchasing a radon test kit.
   a. True.
   b. False.
6. Approximately __ months after participants' radon test results were posted, the study researchers used a 12-item phone survey to assess initial radon test procedures and results, radon mitigation actions, postmitigation test results, and factors that influenced the decision to mitigate.
   a. one
   b. two
   c. three
   d. four
7. More than __ of participants were older than 54 years, identified as male, and had completed at least a bachelor's degree.
   a. 50%
   b. 60%
   c. 70%
   d. 80%
8. For the radon tests done by study participants, __ were conducted in a basement.
   a. 81%
   b. 83%
   c. 85%
   d. 87%
9. For all radon tests, __ were conducted in a family, great, living, play, or theater room.
   a. 50%
   b. 55%
   c. 60%
   d 65%
10. Only __ of participants mitigated their residence.
    a. 13%
    b. 20%
    c. 23%
    d. 30%
11. Among participants who did not mitigate their residence, reasons for not mitigating selected by at least __ of participants included "inconvenience," "the cost is too great," and "radon levels in my home were not high enough to really concern me."
    a. 15%
    b. 20%
    c. 25%
    d. 30%
12. In this study, individuals who had radon levels >6.0 pCi/L were __ to mitigate than individuals with lower radon levels.
    a. more likely
    b. less likely

Considerations Toward Lower Toxicity Cleaning in K-12 Schools

Dawn Yeomans, PhD,
Hygiene Sciences & Partnerships
Senior Advisor
Antonio Quiñones-Rivera, PhD,
Product Safety and Sustainability
Senior Manager
GOJO Industries Inc.

Abstract **Surface cleaning and disinfection is a core mitigation strategy to control the spread of germs in K-12 educational settings. These include not only SARS-CoV-2, the virus that causes COVID-19, but also infectious agents that cause illnesses that frequently and persistently manifest in schools, such as colds, influenza, and gastroenteritis. With unprecedentedly high levels of cleaning and disinfection during the COVID-19 pandemic, concerns have started to emerge related to the exposure of school children to potentially harmful chemicals found in some disinfectants that may cause or aggravate common childhood conditions like asthma. The consideration of best practices toward healthy cleaning and disinfection in schools is critical to ensure effective infection prevention while minimizing other potential adverse health effects related to disinfectant chemical exposure. Here we highlight the need to balance disinfectant efficacy with safety, provide guidance on the selection of low toxicity disinfectants, and identify research gaps to further our understanding of secondary exposure and potential health risk to children due to widespread disinfectant usage in the K-12 educational setting.**

Background

Schools, with their high occupancy environments, represent high-risk settings for the transmission of respiratory viruses and other germs. Recent investigations have found that commonly touched objects in schools, such as desks, can carry viral particles. These objects, collectively referred to as fomites, can contribute to the spread of colds and influenza (Fong et al., 2020; Zulli et al., 2021). Thus, regular surface cleaning and disinfection is a core mitigation strategy to control the spread of germs common to K-12 facilities, not only SARS-CoV-2, the virus responsible for COVID-19, but also those that cause habitual outbreaks of cold, influenza, and gastrointestinal illnesses. Unsurprisingly, a recent national survey conducted during the COVID-19 pandemic found that 91% of educators reported more intensive cleaning protocols than the previous year, with 85% reporting the use of disinfectant wipes in classrooms (Sparks, 2021). With higher frequency cleaning and disinfection in schools as key elements of infection prevention, as well as the inappropriate disinfectant use by children in some settings, concerns are emerging related to the exposure of children to potentially harmful chemicals, particularly those that may cause or aggravate asthma and allergy. These concerns, however, should be balanced from a comparative risk perspective; the health risks associated with exposure to secondhand cleaning, sanitizing, and disinfecting agents are likely lower than the risk due to infectious outbreaks. The focus of this white paper is three-fold: 1) to highlight the need for lower toxicity cleaning and disinfection in schools, 2) to provide guidance on the selection of highly efficacious *and* low toxicity disinfectant products, and 3) to outline further research needed to inform comparative health risk assessments for children due to secondhand environmental disinfectant chemical exposure in the K-12 school setting.

Asthma Is a Common Childhood Condition

The worldwide prevalence of asthma in children (categorized as under 18 years of age) has steadily increased over the past decades. Asthma is now the most common, noncommunicable disease in children, affecting approximately 8.6%—or upwards of 6 million children—in the U.S. alone (Centers for Disease Control and Prevention, 2017; World Health Organization, 2021). Asthma is the third leading cause of hospitalization among children under 15 years of age and accounts for billions of dollars annually in healthcare costs (Hasegawa et al., 2013). Additionally, childhood asthma is a leading cause of school absenteeism, associated with more than 10 million missed school days in the U.S. each year (Hsu et al., 2016). School absenteeism affects the majority of children with asthma and is linked to lower academic performance, especially among urban minority youth (Basch, 2011; Liberty et al., 2010; Moonie et al., 2008, 2015).

Asthma often begins early in childhood and complications such as airway remodeling can begin as early as the first few years of life (Saglani et al., 2007). While the exact causes of asthma are unknown, genetics, allergies, respiratory infections, and the environment are likely to play a role (American Lung Association, 2020). Exposure to environmental allergens such as fungi or bacterial toxins, chemical irritants, or development of viral infections as an infant or in early childhood have all been linked to the development of asthma.

Cleaning Product Exposure Is Associated With Asthma

Cleaning and disinfectant products are common sources of irritants, allergens,

and asthmagens. Sustained exposure to cleaning products can cause airway irritation and chronic inflammation, triggering asthma symptoms, and worsening asthma control (Clausen et al., 2020). The use of cleaning products in professional and domestic cleaning has been associated with occupational asthma (Folletti et al., 2014; Jaakkola & Jaakkola, 2006; Siracusa et al., 2013; Zock et al., 2009, 2010). While evidence is not fully sufficient to determine a causal relationship between specific cleaning or disinfecting product exposures and the development or worsening of asthma, commonly used active disinfectant ingredients such as quaternary ammonium compounds (QACs) and sodium hypochlorite (bleach) have been associated with reduced airway function, irritation, and sensitization (Dumas et al., 2017; Gonzalez et al., 2014; Zock et al., 2009). Furthermore, recent studies suggest that QACs may be a principal cause of sensitizer-induced occupational asthma among cleaners (Vandenplas et al., 2013).

Recent cohort studies show that the health risks from exposure to cleaning products are not exclusive to occupational cleaners and adults actively participating in the cleaning process. Studies have demonstrated a relationship between frequency of cleaning product use in the home and risk of wheeze and asthma in young children (Parks et al, 2020; Sherriff et al., 2005), suggesting that even secondhand exposure may also lead to adverse health outcomes.

Children May Be Particularly Vulnerable to Environmental Asthmagens

In a typical school year, children spend a large amount of time in the indoor school environment. The indoor environment contains allergens, pollutants, and chemicals that have the potential to contribute toward new asthma development and triggering of existing cases of asthma. Compared to adults, young children have increased respiration rates, hand-to-mouth behaviors, and breath closer to the ground and hard surfaces where airborne and surface levels of these triggering materials may be higher (Moya et al., 2004). Additionally, young children are still developing their immune and respiratory systems. Taken together, these factors make children particularly vulnerable to exposures in the school setting, including chemicals that are used routinely and frequently in the cleaning and disinfection process.

Lower Toxicity Disinfectants Are Available and May Offer a Healthier Clean in Schools

In the U.S., disinfectants (or antimicrobial pesticides) are regulated by the U.S. Environmental Protection Agency (U.S. EPA). Currently, more than 4,000 antimicrobial products are registered, containing about 275 different active ingredients (U.S. EPA, 2021a). U.S. EPA recognizes the concern for people with underlying medical conditions, such as asthma, that could be exacerbated by exposure to disinfectants, and has several resources available to help identify lower toxicity products (U.S. EPA, 2021b, 2021c). The Design for the Environment (DfE) label helps identify antimicrobial products, including disinfectants, that have been reviewed by U.S. EPA and were found to meet both U.S. EPA's pesticide registration requirements and the standard for DfE-certified products. This includes only active ingredients from the least hazardous toxicity classes (e.g., Category III and IV) of U.S. EPA's acute toxicity category hierarchy. Currently, DfE-certified disinfectants include products with active ingredients of citric acid, hydrogen peroxide, ethanol, and lactic acid (U.S. EPA, 2021b). U.S. EPA also publishes a Safer Chemical Ingredients List (SCIL) of chemicals that are determined to be safer than traditional chemical ingredients (U.S. EPA, 2021c). Antimicrobial actives on the SCIL deemed "low concern" include peracetic acid, L-lactic acid, citric acid, hydrogen peroxide, sodium bisulfate, ethanol, and isopropanol (U.S. EPA, 2021c).

Nongovernment organizations (NGOs) also provide guidance on the selection of lower toxicity cleaning products in schools. For example, the American Academy of Pediatrics (AAP), an organization devoted to ensuring the health and safety of children, issued guidance recommending the selection of "safer" products on the U.S. EPA's List N (believed to be effective against the SARS-CoV-2 virus) for use in school settings during the COVID-19 pandemic (American Academy of Pediatrics, 2021). This included products labeled as safe for humans and the environment and those containing active ingredients such as hydrogen peroxide, ethanol, and citric acid because they are considered by AAP to be "less toxic, weak respiratory irritants or asthma triggers, and have no known carcinogenic, reproductive, or developmental effects." AAP furthers states that commonly used "disinfectants such as bleach and those containing quaternary ammonium compounds (or 'quats') should not be used around children." Other NGOs such as the Healthy Green Schools & Colleges (2021), Green Schools Initiative (n.d.), and SF Environment (n.d.) have also suggested to limit or avoid disinfectants containing actives such as bleach, QACs, pine oil, or ortho-phenylphenol.

Conclusion and Future Work Needed

Although current studies strongly suggest there is an association between exposure to cleaning and disinfecting products and the development or worsening of asthma, a lack of specific exposure information remains a challenge for researchers. Analyzing the effects of exposures to cleaning and disinfecting products is complex and challenging; however, children face special risks related to chemical exposures because of their unique biology and specific habits and practices that may result in exposure scenarios that are not considered for adults. Thus, including scenarios for children within comparative risk assessment frameworks is needed. In order to progress our understanding of potential health risk to children from secondhand exposure to cleaners and disinfectants, further population-based studies and quantitative chemical exposure data are also needed. Until these data are available, due to the combination of increased frequency of cleaning and disinfecting in schools and the higher vulnerability of children to chemicals of concern, it would seem prudent for K-12 schools to follow expert recommendations to use the lowest toxicity disinfectants available, such as those containing citric acid, ethanol, lactic acid, and hydrogen peroxide.

References are posted at www.neha.org/jeh/supplemental.

DIRECT FROM ATSDR

Per- and Polyfluoroalkyl Substances Multi-Site Study

Chidum Uzochukwu, MPH
Meghan Weems, MPH
Marian Pavuk, MD, PhD
Frank Bove, ScD
Chris Reh, PhD
Patrick Breysse, PhD, CIH
Agency for Toxic Substances and Disease Registry

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 regular columns 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.

Background

Per- and polyfluoroalkyl substances (PFAS) are a family of chemicals that have been manufactured and used across a variety of industries in the U.S. since the 1940s (Bulka et al., 2021). There are over 5,000 chemicals in the PFAS family. Three of the most commonly detected PFAS include perfluorooctane sulfonate (PFOS), perfluorooctanoate acid (PFOA), and perfluorohexane sulfonate (PFHxS). These chemicals are persistent in the environment and may remain in the human body for years (Rogers et al., 2021).

PFAS-contaminated drinking water is widespread in the U.S. with an estimated 18–80 million people potentially exposed to PFOA in their tap water (Andrews & Naidenko, 2020). Industrial facilities that manufacture or use PFAS have contaminated drinking water in many of the communities surrounding their facilities, including facilities in Alabama, Minnesota, New Hampshire, New Jersey, New York, Ohio, Vermont, and West Virginia (Kray & Wightman, 2018). Additionally, Hu et al. (2016) reported that 66 water supplies that serve over 6 million people across the U.S. had at least one sample at or above the U.S. Environmental Protection Agency's lifetime health advisory for PFOA and PFOS of 70 ppt. The U.S. National Health and Nutrition Examination Survey reported that PFAS were detected in the blood of >98% of U.S. general population (Calafat et al., 2019).

Since the 1960s, military and civilian facilities in the U.S. have used aqueous film-forming foam (AFFF) that contains PFAS to extinguish fires (Baduel et al., 2017). The foams and the chemicals they contain are released directly into the environment (Glüge et al., 2020). At some facilities, use of AFFF resulted in the migration of PFAS through the soil (Brusseau et al., 2020) and into drinking water sources for the surrounding communities (Stoiber et al., 2020).

Many epidemiological studies have examined the potential of PFAS to induce adverse health effects (Bell et al., 2021; Brase et al., 2021; Chohan et al., 2020; Fenton et al., 2021). Although most of the studies do not establish causality, the body of scientific evidence linking PFAS exposures with adverse health effects is rapidly growing. In 2020, the Agency for Toxic Substances and Disease Registry (ATSDR) released a health consultation at Pease International Tradeport in Portsmouth, New Hampshire. The health consultation found that drinking water from the Pease International Tradeport public water system between January 1993 through May 2014 might have led to an increased risk of harmful health effects among workers at the Tradeport and children attending on-site childcare centers (Agency for Toxic Substances and Disease Registry [ATSDR], 2020a).

Other epidemiological studies have found associations between PFAS and elevated cholesterol levels, reproductive effects (Anderko & Pennea, 2020), and decreased birth weight (Eick et al., 2020). PFAS has also been associated with increased uric acid levels, some cancer risks, and decreased immune response (ATSDR, 2020b). A study conducted by the National Toxicology Program found that PFOA and PFOS moderately suppressed antibody responses in humans and concluded that these chemicals alter immune functions in humans (National Toxicology Program, 2021).

Study Overview

On September 23, 2019, the Centers for Disease Control and Prevention (CDC) and ATSDR announced the recipients of a cooperative agreement titled the Multi-Site Study (MSS) of the Health Implications of Exposure to PFAS-Contaminated Drinking Water. (Table 1, Figure 1). ATSDR's ongoing study

TABLE **1**

Per- and Polyfluoroalkyl Substances Multi-Site Study Cooperative Agreement Partners and Locations

Partner	Site Location
Colorado School of Public Health, University of Colorado, Anschutz Medical Campus	El Paso County, Colorado
Michigan Department of Health and Human Services	Parchment/Cooper Township, Michigan Belmont/Rockford area, Michigan
Research Triangle Institute International and Pennsylvania Department of Health	Montgomery County, Pennsylvania Bucks County, Pennsylvania
Rutgers Biomedical and Health Sciences, School of Public Health	Gloucester County, New Jersey
Silent Spring Institute	Hyannis, Massachusetts Ayer, Massachusetts
University at Albany, State University of New York and New York State Department of Health	Hoosick Falls, New York Newburgh, New York
University of California, Irvine	Communities near the University of California, Irvine Medical Center, California

of PFAS exposure at the Pease International Tradeport in Portsmouth, New Hampshire, is serving as the first site in the MSS. The MSS is a cross-sectional study that aims to evaluate the potential associations between measured and historically reconstructed serum levels of PFAS, including PFOA, PFOS, PFHxS, and selected health outcomes in a community.

Specifically, the MSS will examine potential associations in children and adults between serum PFAS and lipids, renal function, kidney disease, thyroid hormones, thyroid disease, liver function, liver disease, glycemic parameters, and diabetes, as well as immune response and function. The MSS will also investigate differences in sex hormones, sexual maturation, vaccine response, and neurobehavioral outcomes in children as related to PFAS. In adults, additional outcomes of interest include cardiovascular disease, osteoarthritis, osteoporosis, endometriosis, and autoimmune diseases.

These health outcomes were selected based on epidemiological and scientific studies including: 1) endpoints that have been evaluated in previous PFAS research and need additional follow up, 2) endpoints observed to be elevated in studies of other chemicals with similar in vitro and in vivo activity, and 3) findings from other PFAS toxicological and epidemiological studies. The proposed sample sizes for the MSS have sufficient power to detect mean differences in the ranges of those observed in other well-designed epidemiologic studies and allow for the calculation of odds ratios.

The MSS sites have a wide range of PFAS exposure levels. This range will allow for the potential evaluation of exposure–response trends, including exposure effects at low levels. ATSDR also took into consideration geographic coverage when reviewing MSS applications. Participant recruitment will begin in summer/fall 2021 with a target sample size of 2,100 children and 7,000 adults across all sites.

Participant eligibility criteria includes exposure to PFAS within the last 15 years, which is due to considerations based upon the estimated half-lives in the body of PFOA, PFOS, and PFHxS, and to ensure that exposures to the contaminated drinking water are relatively recent. Adults must be at least 18 years old at the start of the study and have resided in areas with documented past or present PFAS drinking water concentrations. People who were ever employed as a firefighter, participated in fire training exercises using AFFF foam, or those employed at industrial facilities that used PFAS chemicals in the manufacturing process are not eligible to participate in the study. Children must be between 4 and 17 years old, have resided in areas with documented past or present PFAS drinking water concentrations, or were exposed in utero or through breastfeeding when the mother consumed the contaminated drinking water. Similar to adult participants, children will be excluded if their birth individuals were ever employed as a firefighter, ever participated in fire training exercises using AFFF foam, or were ever employed at industrial facilities that used PFAS chemicals in the manufacturing process. Firefighter and other occupational exposures likely involve more exposure routes than ingestion and are higher than those associated with drinking water exposures. For this reason, occupationally exposed individuals are excluded from the MSS.

Study investigators will collect blood samples from participants to measure serum PFAS levels and several biomarkers of biological effects. The study will also collect urine samples from participants to measure kidney function biomarkers and to archive for potential future analysis of PFAS. Serum samples will be archived to conduct analyses of additional PFAS and specific effect biomarkers, as feasible.

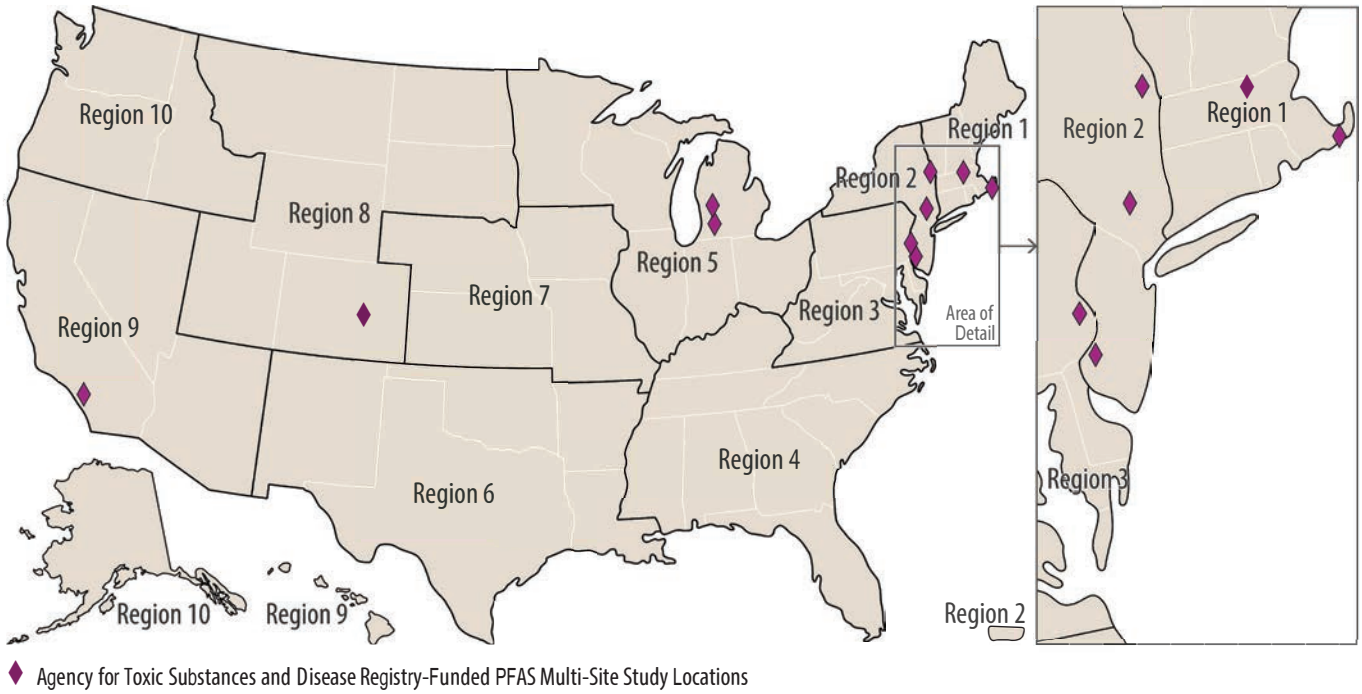
Adult participants and a parent or guardian of participating minor children will complete a questionnaire that includes their residential, medical, and occupational history, in addition to their water consumption habits. With consent from study participants, the MSS will access medical and school records as necessary to confirm adverse health outcomes reported in the questionnaire. To facilitate access to these medical and school records, study site investigators will reach out to local medical societies, the public school system, and private schools to enlist cooperation with the study. The investigators will also work closely with local and state agencies (e.g., public school systems and local and state health departments), local community organizations, and local media to conduct outreach about the study to encourage participation and community engagement with all local stakeholders.

Study Accomplishments

In preparation for individual MSS sites launching their studies, pharmacokinetic modeling and historical reconstruction work groups were established. The pharmacokinetic modeling work group will coordinate

FIGURE **1**

Per- and Polyfluoroalkyl Substances (PFAS) Multi-Site Study Regions and Locations



the technical evaluation, quality assurance, and quality control for all pharmacokinetic and physiologically-based pharmacokinetic models used for historical serum reconstruction. Similarly, the historical reconstruction work group will coordinate technical evaluation, quality assurance, and quality control for all methods and models in the historical reconstruction of groundwater and drinking water contamination.

Several study outreach efforts have been established to kick off the MSS. The study sites have developed community engagement plans, recruitment flyers, websites, and study logos. Study outreach efforts are ongoing and vary by site. For example, one site has designed strategies to connect with segments of potentially difficult-to-reach populations including veterans, older adults, and people who identify as Hispanic or Latino. To monitor public awareness of the MSS on social media, ATSDR created a standard MSS hashtag, #PFASmss, that is currently being tracked on Instagram and Twitter.

The MSS will provide serum PFAS levels and the results of the clinical tests and effect biomarker tests to each study participant. Consultation and technical assistance (e.g., workshops and training programs) to clinicians in each community will be provided by cooperative agreement partners and ATSDR. The clinician outreach is part of community engagement efforts to provide answers to questions about the potential effects of elevated PFAS levels on health, to assist with the interpretation of results, and to make recommendations for additional tests and/or treatments. ATSDR will provide summaries of the study findings to the participating communities and will assist in interpreting these results. As epidemiological research on the health effects of drinking water exposure to PFAS, other than PFOA, is at an early stage, the MSS will make an important contribution to the scientific literature by expanding knowledge in this area and helping to address concerns about past exposure.

Corresponding Author: Meghan Weems, Epidemiologist, Agency for Toxic Substances and Disease Registry, 4770 Buford Highway NE, Atlanta, GA 30341. Email: zav1@cdc.gov.

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Did You Know?

The NEHA-FDA Retail Flexible Funding Model Grant Program application portal is now open! Awarding $6 million over a 3-year period, this new grant program serves to leverage and advance the food safety efforts of retail food regulatory agencies through conformance of the Voluntary National Retail Food Regulatory Program Standards. Learn about application requirements, important deadlines, and actions to take to prepare a successful application at www.neha.org/retailgrants. The deadline to submit an application is **November 15**.

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES

Making Data-Driven Decisions for Safe Water

Raquel Sabogal, MSPH

Editor's Note: The National Environmental Health Association (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, NEHA features 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.

Raquel Sabogal is an epidemiologist, environmental health scientist, and water quality subject matter expert at CDC's National Center for Environmental Health in the Water, Food, and Environmental Health Services Branch.

From 2015–2020, the National Center for Environmental Health within the Centers for Disease Control and Prevention (CDC) funded 19 health departments to use the 10 Essential Environmental Public Health Services (www.cdc.gov/nceh/ehs/10-essential-services/index.html) to improve services for residents relying on wells and other private drinking water systems. Approximately 1 in 8 U.S. residents gets their drinking water from a private well. Furthermore, approximately 1 in 5 sampled private wells was found to be contaminated at levels that could affect health. These contaminants could be microbial, chemical, and/or radiological.

Environmental health departments have an important role in reducing harmful exposures from wells and private water systems. Having sufficient data to make decisions are key to addressing these harmful exposures, but federal guidance is limited and no uniform approach or set of standards exists for managing water quality from these types of systems. In addition, there is no central database for the collection and analysis of private well data from across the country.

State private well programs vary. CDC funding opportunities as far back as 2005 focused on identifying and accessing private well data sources. Many of the 2015–2020 Safe Water for Community Health (Safe WATCH) partners focused on monitoring well water quality and collecting and organizing environmental health data associated with private wells. Partners used data to understand and map health risks in their communities. They addressed the core public health function of assessment by monitoring environmental health status and investigating health hazards (Essential Environmental Public Health Services 1 and 2).

Safe WATCH partners created publicly available data tools to help well owners make informed decisions on managing their wells.

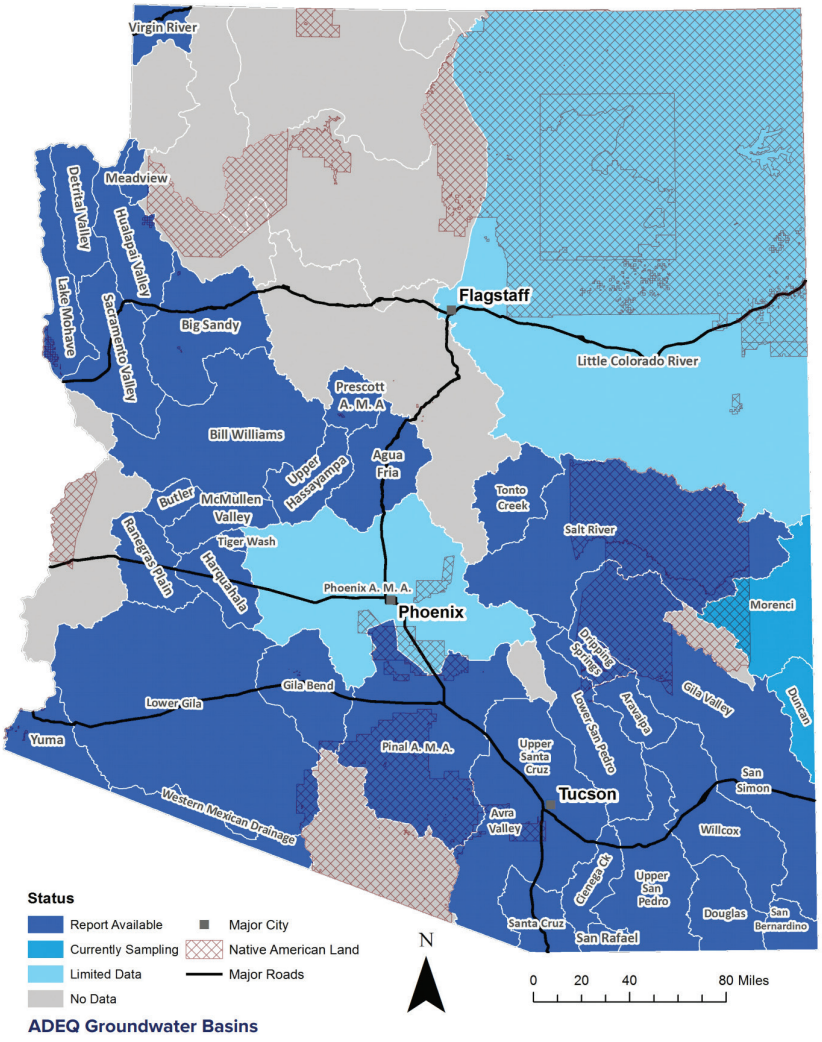
- The Arizona Department of Health Services worked with the Department of Water Resources and Department of Environmental Quality to build a private well data map for five common groundwater contaminants across the state (Figure 1). Well owners now use this web-based map to see what to test for in their local area. Well owners can also find resources about well maintenance and training, such as a well owner workshop.
- The Louisiana Department of Health used their data and data from the U.S. Geological Survey and the Department of Environmental Quality to develop a state map with private well data on 27 contaminants. They also worked with the Department of Natural Resources and other partners to create the Well Owner Network. This outreach network provides resources to educate and support Louisiana residents relying on private drinking water, including information on wells, testing, licensed well drillers, and other related topics.

Safe WATCH partners used their state environmental public health tracking portals to share private well data.

- The New Mexico Department of Health, in partnership with the Environment Department, hosts annual water fairs at community events in rural communities across the state to do private well testing. Results are posted on the New Mexico Environmental

FIGURE **1**

Arizona Private Well Data by Water Basin, 1993–2017



Note. ADEQ = Arizona Department of Environmental Quality.

Public Health Tracking Network portal with educational information for well owners, such as how to test their water, tips for well maintenance, treatment options, and how to tag or register a well.

Safe WATCH partners used data to support well testing recommendations.

- The Connecticut Department of Public Health (CT DPH) used private well data collected under Safe WATCH to complete a study on arsenic and uranium in collaboration with the U.S. Geological Survey (Flanagan & Brown, 2017). The study showed that the likelihood of having arsenic and uranium concentrations above the drinking water standard may depend on the geologic unit where a household's well is located. These results support CT DPH's recommendation that private well owners in Connecticut test their wells for naturally occurring arsenic and uranium. The CT DPH Private Wells website provides information for residents on well testing and treatment guidelines.

County-level Safe WATCH partners developed GIS databases to display data on private wells.

- In Colorado, Delta County and the West Central Public Health Partnership created a GIS map of contaminants in six rural counties. The online map shows water quality results for nine contaminants and water hardness from wells tested by homeowners in the six-county region. The map shows concentration ranges and provides recommended treatment options. Residents in the region can use the map to find out what to test for in their well and what to do if treatment is needed.
- In New York, Madison County made an interactive, online GIS map with layers including topography, flood plain areas, roadside springs, contamination sites, and arsenic and nitrate results collected across the county. Residents found this information helpful for understanding the water quality in their area and what to test for in their well water.

Quality Data Key to Public Health Decision Making

As we look to the future, health agencies will still need a skilled workforce to address pri-

Explore Resources From Safe Water for Community Health (Safe WATCH) Partners

- Arizona Department of Health Services Well Water Quality webpage: https://azdhs.gov/preparedness/epidemiology-disease-control/environmental-toxicology/well-water/index.php
- Connecticut Department of Public Health Private Wells webpage: www.ct.gov/dph/privatewells
- Delta County and the West Central Public Health Partnership Private Well Water Testing webpage: www.wcphp.org/well-water-testing
- Louisiana Department of Health Well Owner Network: https://ldh.la.gov/index.cfm/subhome/56
- Madison County Department of Health Private Individual Water Systems webpage: www.madisoncounty.ny.gov/1514/Individual-Water-Systems
- New Mexico Environmental Public Health Tracking Private Wells Water Quality webpage: https://nmtracking.org/environment/water/PrivateWells.html

vate well water issues. Access to high-quality data will be the foundation for making crucial public health decisions regarding private well water issues.

CDC continues to invest in environmental health programs, such as the new Environmental Health Capacity (EHC) program (www.cdc.gov/nceh/ehs/ehc/about.html). EHC funds environmental health programs within health departments to build core capacity to:

- Use environmental health data and information for decision making.
- Identify and address environmental health hazards in their community.
- Assess the effectiveness, effect, and value of environmental health services and interventions.

EHC expands the Safe WATCH program to include wells and private water systems, small drinking water systems, regulated recreational water, and untreated recreational water. Safe WATCH will continue to work on accessing new data sources and developing tools to meet the environmental health needs of local communities and environmental health practitioners. To learn more about Safe WATCH, visit www.cdc.gov/nceh/ehs/safe-watch.

Corresponding Author: Raquel Sabogal, Water, Food, and Environmental Health Services Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Atlanta, GA 30341. Email: rsabogal@cdc.gov.

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DIRECT FROM ecoAmerica

Robert M. Perkowitz

Rebecca C. Rehr, MPH

Local Action, National Impact

Editor's Note: The National Environmental Health Association (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 from ecoAmerica whose mission is to build public support and political resolve for climate solutions. NEHA is an official partner of ecoAmerica and works closely with their Climate for Health Program, a coalition of health leaders committed to caring for our climate to care for our health. The conclusions in this column are those of the author(s) and do not necessarily represent the official position of NEHA.

Robert Perkowitz is the founder and president of ecoAmerica. Rebecca Rehr is the director of ecoAmerica's Climate for Health program.

Environmental health professionals across the U.S. are working to provide healthier, safer conditions for their stakeholders. Hospitals, retail outlets, restaurants, and technology companies all benefit from the monitoring, enforcement, and compliance carried out by environmental health professionals on a daily basis. Environmental health professionals embedded in local health departments keep our communities safe. At the American Climate Leadership Summit 2021, Dr. David Dyjack, executive director of the National Environmental Health Association (NEHA), called environmental health specialists a small army of guardian angels (ecoAmerica, 2021a). The healthy environments they build locally lead to healthier people everywhere.

The impacts of effective environmental health initiatives are often meaningful and bring benefits to their organizations and communities. Yet, these benefits are often unrecognized by their beneficiaries and are rarely shared with broader audiences. Greater promotion of these actions and their benefits can bolster environmental health initiatives within and beyond any one organization and serve as helpful examples for other communities and organizations.

Well designed, implemented, and communicated initiatives can be like a pebble in a pond. They can ripple out to affect initiatives by other environmental health professionals, organizations, and communities, ultimately leading to national impact. All environmental health professionals can amplify their impact by broadening their perspectives and outreach.

From a recent presentation of ecoAmerica's *Let's Talk Climate* webcast series, held at the NEHA 2021 Annual Educational Conference & Exhibition, Dr. Natasha DeJarnett, assistant professor at the University of Louisville, stated:

> Let us stop being invisible. Let us engage in storytelling and share our successes more, where we avoided water contamination, where we prevented an outbreak through restaurant safety practices. Let us showcase those things that were prevented because of the great work that we have done (ecoAmerica, 2021b, 52:25).

Environmental health professionals in communities and organizations around the country steadily innovate in a myriad of ways. In just the last few issues of the *Journal of Environmental Health* there are studies covering carbon monoxide poisoning from recreational watercraft, COVID-19 outbreaks in meatpacking plants, and radium in well water. Even in broader issues, such as climate change, they are making meaningful differences. Here are a few examples:

- In San Diego, county supervisors approved the inclusion of a new environmental justice element in their general plan, which is the county's constitution for development. It includes items at the core of environmental injustice such as disproportionate siting of polluting facilities in Black and Hispanic communities. They include environmental justice in planning and zoning processes as one step to alleviating the unequal burden of pollution.
- In Ohio, Franklin County Public Health created the position of sustainability supervisor, which would have responsibility for climate and health initiatives. Creating leadership roles within health departments that directly address environmental health and specifically address climate change is critical in helping residents better understand climate and

health connections, as well as build confidence in solutions.

- The city of Boston is leading a municipal electricity aggregation program, Community Choice Electricity, using their collective purchasing power to invest in clean energy for city residents. The Boston Public Health Commission was part of the stakeholder engagement process to implement this initiative. Engaging in the stakeholder process gave the Boston Public Health Commission the opportunity to hear and help their constituency understand local climate impacts on their health and detail clean energy as a health initiative.

Each of these examples has major implications for our health and our climate, and many of the methods and solutions are replicable in communities and organizations everywhere. We just need to spread the word. Marketing and communications are not part of the core environmental health curriculum, but they should be a part of all our work. When you deliberately and officially share the projects you are leading and working on with others, it spreads the benefits. Your initiatives could be equally successful elsewhere, further increasing benefits and improving health outcomes.

The American Climate Leadership Awards program spreads the word on effective climate action through replication guides. The 10 finalists, all of which have connections to local communities, write a replication guide as the final step in choosing the winner and runner up (ecoAmerica, 2021c). Three threads typically appear in all the successful narratives:

1. Get started now. Delay impedes action and slows momentum.
2. Engage your community in solutions, including marginalized voices.
3. Amplify your work. Each initiative learns from and engages others.

We have the solutions we need now for climate change and most environmental health issues. We just need to get started. Have conversations with your leaders and colleagues. Make sure your community is invested in the solution and listen to their ideas for a healthier future. Make sure your peers in other states and localities know about your successes and obstacles. Amplifying your work is how we scale-up and accelerate success. The projects and on-the-ground work are what make a difference in people's lives and when we talk about it, we also encourage others to take action.

Corresponding Author: Rebecca C. Rehr, Director, Climate for Health, ecoAmerica, 1730 Rhode Island Avenue NW, Suite 200, Washington, DC 20036.
Email: rebecca@ecoamerica.org.

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Educating the Future Environmental Health Workforce During COVID-19: Developing a Virtual Curriculum for Navajo Student Interns Using the Environmental Health and Land Reuse Certificate Program

Laurel Berman, MS, PhD
Leann Bing
Sue Casteel, MS OEHS
Agency for Toxic Substances and Disease Registry

Sharon Unkart, PhD
National Environmental Health Association

Perry H. Charley
Neilroy Singer
Donald Robinson, PhD
Diné College

Celine Wysgalla, MPH
Yeyzy Vargas, MPH
University of Illinois Chicago

Editor's Note: Beginning in 2016, the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Environmental Health Association (NEHA) launched a partnership to create a free online course with the goal of building capacity within communities to help remediate and redevelop brownfields sites. Brownfields are land reuse sites often contaminated by harmful chemicals or redeveloped without proper environmental oversight. Due to their potentially hazardous status, brownfields sites can lead to harmful exposures in humans while accentuating and often exacerbating socioeconomic disparities within their communities.

As a result of this partnership, NEHA and ATSDR launched the Environmental Health and Land Reuse (EHLR) Certificate Program in 2020. The *Journal* is pleased to feature this column to highlight an example of how the EHLR Certificate Program was used to build understanding and increase knowledge on this important topic within environmental health students.

The findings and conclusions in this column are those of the authors and do not necessarily represent the views or official position of NEHA, ATSDR, or the Centers for Disease Control and Prevention. Furthermore, verbal permission was given by the students to use their work in this column.

Background

The Agency for Toxic Substances and Disease Registry (ATSDR) has longstanding partnerships on community revitalization and education projects with stakeholders throughout the Navajo Nation. One partner is the environmental public health program at Diné College, the first tribally controlled and accredited collegiate institution in the U.S.

Diné College hosts a yearly Summer Internship Program (SIP), which is part of the STEM 2020 program that is funded by the National Science Foundation. The STEM 2020 program offers mentored and hypothesis driven 10-week summer internships and research experiences for undergraduate students in environmental science, biology, and STEM (science, technology, engineering, and mathematics). The SIP course develops an interdisciplinary understanding of the fundamental principles of science, especially in a field research arena. Students learn how to develop basic research skills and hypotheses, use statistics to analyze data, write technical documents, and develop presentations. Students are taught to integrate native science through traditional ecological knowledge and western science methods for the collection and analysis of data, to understand the Diné relationship with their environment, and to achieve reciprocity and sustainability in both worlds.

Typically, these concepts are presented to the student interns during an intensive 3-week senior level biology course. Upon completion of the course, interns are placed in real world research projects to complete a 6-week research experience under the mentorship of research scientists. At the end of the SIP, interns return to campus to present their research findings and experiences to communities and the student body.

Since 2015, 53 students have successfully completed the SIP. Students completing the 10-week program receive 4 credit hours for each component of the SIP, totaling 8 credit hours.

Environmental Health and Land Reuse Training

In summer 2019, ATSDR's National Land Reuse Health Program hosted two undergraduate students from Diné College who were completing their SIP fieldwork experience. The students toured brownfields (potentially contaminated sites that are slated for cleanup or reuse) in the Navajo Nation and Chicago, Illinois, area. They also completed the free, online Environmental Health and Land Reuse (EHLR) Certificate Program that ATSDR developed collaboratively with the National Environmental Health Association (NEHA).

TABLE **1**

Diné College Summer Internship Program (SIP) Sample Curriculum From 2019

Timeline	Core Components
Week 1	Diné traditional ceremonial protection way blessing Welcome address
	Overview of course obligations and requirements including lectures and field labs
	Responsible conduct in research training
	Technical writing: Using your library for environmental research Riverside sampling: Freshwater ecology and environmental geology trip
Week 2	Indigenous food, energy, and water security and sovereignty
Week 3	National Science Foundation/Tribal Colleges and Universities Program and Diné Environmental Institute research projects: Cove watershed assessment project, Cove livestock study, and the Gold King Mine spill project
	Former SIP intern presentations
	Navajo Nation and U.S. government research projects National Park Service Canyon de Chelly Ecological remedies for uranium mill tailings
	University research and studies: Air quality, *Helicobacter pylori* study in the Dilkon-Leupp community in Arizona Statistics
	Student Research Experience Program: Experience and research
	Canyon de Chelly biodiversity study
	Soil bacteria for antibiotic therapy
	Water quality and riparian health
	Farms and river visual riparian assessment tool training
Weeks 4–9 (Research Internship)	Undergraduate research experience at internship sites: • Cove livestock study • Aeolian soil deposition • Fawn and water catchment project • Bat and invasive plants research • Indigenous food, energy, and water security and sovereignty • Soil antibiotics • *H. pylori* and unregulated water • NFPI preliminary assessment
Week 10	Leadership and research
	Review research draft with instruction for final paper
	Interns develop final presentation
	Internship presentations
	Final internship evaluation

The five modules of the EHLR Certificate Program are centered around ATSDR's 5-Step Land Reuse Model:

1. Engaging with your community.
2. Evaluating environmental and health risks.
3. Communicating environmental and health risks to the community.
4. Redesigning with health in mind.
5. Measuring success.

The Diné students were joined by a European Fulbright Scholar studying redevelopment in the U.S. and three students who had recently completed degrees ranging from a bachelor of science in geology to a master of public health (MPH) in environmental health. All six students earned their EHLR certificates from NEHA. In August 2019, ATSDR expanded the pilot training into a preconference training for the Tribal Lands and Environment Forum hosted by the Institute for Tribal Environmental Professionals. As a result, 17 tribal environmental professionals earned their EHLR certificates.

In spring 2020, COVID-19 throughout the Navajo Nation impacted Diné College's summer program. As a result, the college decided to conduct its first all-virtual internship. The primary challenge was how to place SIP interns in the 6-week virtual field projects, which was complicated by a lack of access to laptops and reliable internet availability throughout the vast Navajo Nation. Diné College provided laptops to students and obtained internet hotspots. They worked with Tribal College and University Program partner universities and developed the 3-week senior level biology course as a condensed, 2-week virtual course.

They simultaneously partnered with ATSDR's National Land Reuse Health Program (ATSDR Land Reuse Program) to create the 6-week virtual fieldwork project by expanding the training from the previous year. ATSDR's Land Reuse Program created an EHLR instructional team comprised of ATSDR Land Reuse experts, NEHA instructional design experts, and Diné College faculty. The result was an expansion of the existing EHLR curriculum that nine students enrolled in and eight students completed. Diné College commenced its SIP with a week of virtual sessions and a second week of the University of Arizona/University of California, Berkley on cooperative indigenous food, energy, and water sovereignty virtual sessions. Then, the students joined the ATSDR EHLR Classroom Training seminar.

Methods

The SIP has a rigorous curriculum. Table 1 describes a typical prepandemic program, such as the 2019 program. To replace the pre-COVID-19 six-week fieldwork component, ATSDR's Land Reuse Program created a 40-hr/week EHLR curriculum that integrated case examples from the Navajo Nation and surrounding areas. In addition, an integration of native and western science was a consistent method of instruction throughout the full program. An excerpt of the curriculum is shown in Figure 1.

ATSDR's EHLR instructional team, with expertise in environmental and public health assessment, health education, communication, and risk communication, was joined by NEHA staff, Diné College faculty, and guest

speakers who supplemented module topics with concepts of native science, resources, and case examples focused on Navajo and indigenous principles. Two ATSDR MPH interns from University of Illinois Chicago (UIC) served as peer mentors for the SIP interns. Students earned their EHLR certificates from NEHA upon completion of the curriculum.

We used the five EHLR modules as the basis of the 2020 SIP field curriculum. We expanded the 10-hr EHLR training into a full-time, 6-week, virtual curriculum with field and research components. Collectively, we created a draft syllabus with weekly topics. Each week the SIP interns completed additional assignments to supplement module topics. Example assignments included literature reviews on community engagement, environmental remediation, and environmental justice among tribal and nontribal communities.

The Role of Peer Mentors: Office Hours

Celine Wysgalla and Yeyzy Vargas, the MPH interns, served as peer mentors for the Diné College undergraduate students. They hosted "Office Hours With Celine and Yeyzy" during which they facilitated discussions and assignments to enhance topics learned in each weekly EHLR module. Wysgalla and Vargas created a weekly student handbook that included the lecture materials and special assignments, such as photo storytelling (i.e., photovoice), risk-based message mapping, demonstrating environmental mapping technologies, creating risk communication materials about typical brownfields contaminants, and reading case studies on environmental contamination incidents.

Guest Speakers

Guest speakers joined the SIP curriculum each week. They provided content on environmental justice in tribal and nontribal communities, risk communication, environmental remediation, and health-focused community revitalization projects, particularly in environmental justice and Navajo Nation communities. For example, ATSDR's communications expert Loretta Asbury delivered the risk communication module and a short exercise on creating key messages. Colleagues from ATSDR's stakeholder network and UIC presented environmental justice, food systems and food security, and health-focused redevelopment projects. A highlight was guest speaker Pam Maples, a Superfund division remedial project manager for the Navajo Nation's Environmental Protection Agency, who hosted a virtual tour of the former Navajo Nation forestry products industry site. Maples told the story of "how a petroleum contamination investigation led to recognizing the environmental conditions of a brownfield site" (P. Maples, personal communication, July 1, 2020). The investigation started with the petroleum contamination site assessment and resulted in finding visible asbestos-containing material along with volatile organic chemical contamination. The students virtually learned the many steps needed to evaluate how historical industrial activities and contaminant migration could lead to where the contamination is today.

FIGURE **1**

Excerpt From the 2020 Summer Internship Program Draft Syllabus

Week of July 13, 2020: Redesigning With Health in Mind

Date	Task	Activities	Assignments
7/13 9–11:30 a.m. MDT	Environmental Health and Land Reuse Module 4	Complete module activities and self-learning links Examples from the field: Navajo and elsewhere, soilSHOP (RB, MC)	Start literature review Complete posttest, due by 5 p.m. MDT, 7/15
7/13–15	Literature review on healthfields redevelopment	Conduct a literature review and summary (see below)	Literature review and summary due by 5 p.m. MDT, 7/17
7/15 9–10:30 a.m. MDT	Action Model review and exercise	Office hours with Yeyzy and Celine: Take Action! Is there a site you want to redesign near where you live? Complete the Action Model you started in Week 1 through Step 3. Or create a new Action Model and proceed through Step 3. Include at least three community issues.	Journal (2–3 paragraphs): Discuss a plan for your vision to redevelop potentially contaminated areas in Navajo Nation. Due by 5 p.m. MDT, 7/17
7/17	Prepare for Week 5	Read Section 4 Review the Action Model Indicators webpage: https://www.atsdr.cdc.gov/sites/brownfields/reusescorecard.html. Look at some of the indicators in the various categories.	

Literature review assignment: Literature review with 10–15 primary (e.g., peer-reviewed journal articles) or "grey" literature (e.g., .gov or .edu) sources, supplemented by 1–5 additional sources, such as newspaper articles. Key word searches: healthfields redevelopment; community health + brownfields; health outcomes + environmental justice; environmental justice + community health.

Challenges to Engaging Students Virtually

There were several challenges to engaging the SIP interns virtually. These included engagement and interaction in general, virtual connection, and the COVID-19 pandemic.

One-on-one engagement: Engagement of the students was different in the virtual environment. On one hand, engagement of the quieter students was easier. They could respond by writing answers in the comment section. The talkative students could unmute to answer questions or comment. Having a small class, we were able to ensure each student was able to participate by writing comments or speaking. On the other hand, with poor internet connections, most students turned their video off when not responding. Assessing the students' learning was more difficult when we were unable to see the students in real time.

Student interaction: To keep the interest of the students virtually, we had interactive lessons, community projects, and guest speakers. In the photovoice section of one project, for example, the students went out into their community to take pictures of potential brownfields and then described their vision of how redevelopment could address com-

FIGURE **2**

Example of a Student Photovoice Project

The Coal Country. This used to be a good Laundromat. The people of Crownpoint used to always come here on the weekends to do their laundry. This place brings back so much memories when me and my late auntie used to come here every Saturday morning, drinking coffee and doing our laundry. Until it closed in 2017. It is unknown to me if there are any contaminants in the building, or if it was built on top of any source of contamination. It has been closed ever since, and the building is still standing there today.

munity health disparities. Figure 2 shows an example of a photovoice project.

Internet connection challenges: At times, the instructors and students had difficulty connecting to our virtual platform, Zoom. We had alternatives to Zoom, such as a Skype link with screen sharing and conference call options. In case an internet connection was lost by one instructor, we also had other instructors to serve as backups.

COVID-19 pandemic: We had backup instructors and presentation notes to cover in case of emergencies. For example, we had instructors personally affected by COVID-19 during the semester. For the students, we planned to be flexible if any students had health issues, with extended deadlines if needed.

Career Day

Our final week of the EHLR expanded curriculum culminated in a career day panel. The SIP interns learned about careers with the U.S. Public Health Service, environmental consulting firms, universities, and NEHA. For example, Neilroy Singer emphasized his role in tribal/Navajo education and his connection to Diné culture and education through his role as an environmental specialist at Diné College.

Results and Outcomes

Diné College faculty were actively engaged with the SIP interns, which greatly benefitted the EHLR curriculum. In total, eight students and two faculty successfully passed the course and received their certificates of completion from NEHA. After the SIP ended, Diné College faculty and the peer mentors joined the ATSDR EHLR instructional team to host an EHLR Classroom Training for over 35 tribal environmental professionals attending the virtual Tribal Lands and Environment Forum hosted by the Institute for Tribal Environmental Professionals.

Through their grant mechanism, Diné College evaluated the summer program (Rogers & Laurila, 2020). Overall, nine students responded to the evaluation. In general, students were satisfied with the course and 100% strongly agreed that the course improved their ability to understand the connection between the environment and health. In addition, 88% strongly agreed and 11% agreed that the course improved their ability to visualize solutions to a cleaner, healthier environment (Figure 3).

Discussion

Despite challenges created by the COVID-19 pandemic, internet reliability, and focusing on alternate field experiences, the first-ever virtual SIP was a success. Our collaboration was enhanced by our different backgrounds and perspectives, and along with the students, we learned from each other.

Participant Reflections

Yeyzy Vargas: I gained great experience that helped me obtain a teaching assistantship in the undergraduate Public Health Program at UIC for the following fall and spring semesters. I loved the challenge of working with such a diverse group of students, learning and hearing from the Diné (Navajo) College faculty and all the guest speakers.

Celine Wysgalla: I learned to work with a variety of learning styles by offering constructive feedback, using grading rubrics, and taking time to meet with students to discuss any concerns they had. Ultimately, my experience led to a research assistantship at UIC with the Pediatric Environmental Health Specialty Unit, where I greatly enjoyed speaking Spanish with community members in community engagement and environmental justice capacities.

Neilroy Singer: The goal of this past year's SIP EHLR training was to implement more public involvement, especially with our Navajo Nation communities. This opportunity allowed our interns to conduct effective scientific studies about the environment. The interns were trained on proper procedures and phases to introduce their work to the people in the community before starting their research. So far, we are conducting good research. It was a privilege to share our collective knowledge with the students.

Perry Charley: The integration of Diné traditional ecological knowledge is truly challenging in the EHLR course. A large

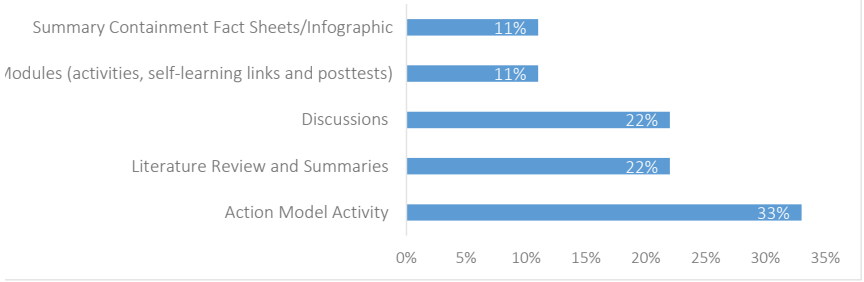
proportion of this knowledge is ingrained in and sustains the Diné and Native American communities. The integration of traditional knowledge with the course content revealed to the Diné interns the interconnectedness of the Diné environmental and cosmological belief that we live in an interrelated living world in perpetual, creative motion. For thousands of years, Native American knowledge has been used and passed down from generation to generation largely through oral traditions. The introduction of "Native Science," contained in this body of traditional environmental and cultural knowledge, is a unique approach to the ATSDR EHLR seminar. Reciprocity and sustainability to thrive in a complex native and western science environment is seldom taught and learned in this integrated context. The EHLR summer curriculum provided a great opportunity to bring together native and western science, technology, and traditional wisdom in environmental health and land reuse to STEM students. It provided a unique opportunity to learn and provided a blend of traditional and modern sustainable lifestyles in a healthy environment where Earth is respected and honored. This approach provides an intriguing alternative for implementing applied ecology and could be widely recognized as an essential component of effective ecosystem and land reuse sustainable practice, management, and education.

FIGURE **3**

Excerpt From the Summer Institute Environmental Health and Land Reuse 2020 Summer Program Evaluation

...while working through the Action Model, I began to see brownfields/abandoned buildings differently. I began to look at what it could become...a new house, a business or even a playground for children. There's a lot of possibilities that could happen.

Figure 3. Course activities that increased students' ability to apply environmental health concepts to their worldview (n = 9)



- **100% (n = 9)** of students *strongly agreed* that **this course improved their ability to understand the connection between the environment and health.**
- **88% (n = 8)** of students *strongly agreed* (11% *agreed*) that **this course improved their ability to visualize solutions to a cleaner, healthier environment.**

I have always cared for the environment and health but with the class I was able to connect them and ways to improve them in my personal life. For example, to determine and know more easily how to detect contamination, what to look at, what questions to ask, who to reach for information.

Next Steps

During the 2021 SIP, ATSDR again provided the virtual EHLR Certificate Program. This year, our Diné College partners integrated tribal ecosystem knowledge (i.e., native science) more comprehensively throughout the class and student assignments, such as preparing risk communication materials with consideration of tribal elders and Diné language. In addition, our stakeholder network volunteered to provide supplemental environmental health content for the SIP interns. This unique opportunity enabled the interns to meet and learn from a variety of community and environmental health experts.

ATSDR oversees the EHLR Classroom Training and information about this program can be found at www.atsdr.cdc.gov/sites/brownfields/classroom_training.html. NEHA maintains the online EHLR Certificate Program, which is a self-paced, self-learning course that is asynchronous (i.e., no live or virtual instructors) in their E-Learning course catalog. The program is available at no cost at www.neha.org/ehlr. ATSDR and NEHA continue their collaboration to provide both modalities of the EHLR training, such as at various environmental conferences, and are considering expanding the EHLR content in the future.

Corresponding Author: Laurel Berman, Environmental Health Scientist, Office of Capacity Development and Applied Prevention Science, Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention. Email: laberman@cdc.gov.

Reference

Rogers, L., & Laurila, K. (2020). *Summer Institute Environmental Health and Land Reuse 2020 summer program evaluation*. Diné College, Tribal Colleges and Universities Program.

Did You Know?

October 14 is Children's Environmental Health Day. The Children's Environmental Health Network established the observance to increase the visibility of children's environmental health issues while empowering individuals and organizations to take action on behalf of children nationwide. Learn more at https://cehday.org.

EH CALENDAR

UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCE

June 28–July 1, 2022: NEHA 2022 Annual Educational Conference & Exhibition, Spokane, WA, https://www.neha.org/aec

NEHA AFFILIATE AND REGIONAL LISTINGS

Florida
October 13–15, 2021: FEHA 73rd Annual Education Meeting Training (Virtual), Florida Environmental Health Association, https://feha.wildapricot.org/2021AEM

Illinois
November 8–9, 2021: IEHA Annual Educational Conference, Illinois Environmental Health Association, Oglesby, IL, https://ieha.coffeecup.com/calendar.html

Iowa
October 20, 2021: 2021 IEHA Fall Environmental Health Training, Iowa Environmental Health Association, West Des Moines, IA, https://www.ieha.net

Michigan
March 22–24, 2022: 2022 Annual Education Conference, Michigan Environmental Health Association, Traverse City, MI, https://www.meha.net/AEC

New Mexico
December 7–8, 2021: NMEHA Fall Conference (Virtual), New Mexico Environmental Health Association, http://www.nmeha.org

North Carolina
RESCHEDULED: April 27–29, 2022: NCPHA Fall Educational Conference, North Carolina Public Health Association, Asheville, NC, https://ncpha.memberclicks.net

Texas
October 6–8, 2021: 65th Annual Educational Conference, Texas Environmental Health Association, Round Rock, TX, https://www.myteha.org

Utah
September 29–October 1, 2021: UEHA Fall Conference, Utah Environmental Health Association, Tooele, UT, http://www.ueha.org/events.html

Virginia
October 28–29, 2021: VEHA Virtual Fall Conference & Interstate Environmental Health Seminar, Virginia Environmental Health Association, https://veha32.wildapricot.org/events

TOPICAL LISTINGS

Water Quality
CANCELED: Spring 2022: *Legionella* Conference: Prevention of Disease and Injury From Waterborne Pathogens in Health Care, NSF Health Sciences and NEHA, www.legionellaconference.org

Did You Know?

You can share your event with the environmental health community by posting it directly on NEHA's Community Calendar at www.neha.org/news-events/community-calendar. Posting is easy, free, and a great way to bring attention to your event. You can also find listings for upcoming conferences and webinars from NEHA and other organizations.

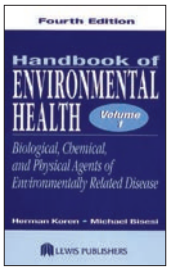
RESOURCE CORNER

Resource Corner highlights different resources the National Environmental Health Association (NEHA) has available to meet your education and training needs. These resources provide you with information and knowledge to advance your professional development. Visit the NEHA online Bookstore for additional information about these and many other pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

Handbook of Environmental Health, Volume 1: Biological, Chemical, and Physical Agents of Environmentally Related Disease (4th Edition)

Herman Koren and Michael Bisesi (2003)

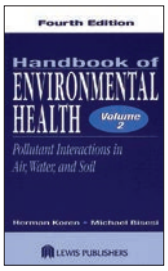


A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the internal environment. It was written by experts in the field and copublished with the National Environmental Health Association (NEHA). A variety of environmental issues are covered such as food safety, food technology, insect and rodent control, indoor air quality, hospital environment, home environment, injury control, pesticides, industrial hygiene, instrumentation, and much more. Environmental issues, energy, practical microbiology and chemistry, risk assessment, emerging infectious diseases, laws, toxicology, epidemiology, human physiology, and the effects of the environment on humans are also covered. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

790 pages / Hardback
Member: $215 / Nonmember: $245

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

Herman Koren and Michael Bisesi (2003)

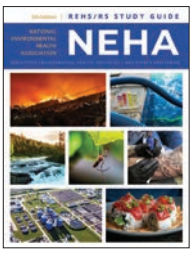


A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the outdoor environment. It was written by experts in the field and copublished with NEHA. A variety of environmental issues are covered such as toxic air 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
Member: $215 / Nonmember: $245

REHS/RS Study Guide (5th Edition)

National Environmental Health Association (2021)

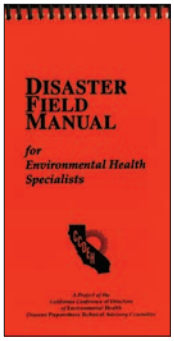


The Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential is NEHA's premier credential. This new edition reflects the most recent changes and advancements in environmental health technologies and theories. Incorporating the insights of 29 subject matter experts from across academia, industry, and the regulatory community, paired with references from over 30 scholarly resources, this essential reference is intended to help those seeking to obtain the NEHA REHS/RS credential. Chapters include general environmental health; statutes and regulations; food protection; potable water; wastewater; solid and hazardous waste; hazardous materials; zoonoses, vectors, pests, and poisonous plants; radiation protection; occupational safety and health; air quality and environmental noise; housing sanitation and safety; institutions and licensed establishments; swimming pools and recreational facilities; and emergency preparedness.

261 pages / Paperback
Member: $169 / Nonmember: $199

Disaster Field Manual for Environmental Health Specialists

California Association of Environmental Health Administrators (2012)



This manual serves as a useful field guide for environmental health professionals following a major disaster. It provides an excellent overview of key response and recovery options to be considered as prompt and informed decisions are made to protect the public's health and safety. Some of the topics covered as they relate to disasters include water, food, liquid waste/sewage, solid waste disposal, housing/mass care shelters, vector control, hazardous materials, medical waste, and responding to a radiological incident. The manual is made of water-resistant paper and is small enough to fit in your pocket, making it useful in the field. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

224 pages / Spiral-Bound Hardback
Member: $37 / Nonmember: $45

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First Vice-President

National Officers

www.neha.org/national-officers

President—Roy Kroeger, REHS
President@neha.org

President-Elect—D. Gary Brown, DrPH, CIH, RS, DAAS
PresidentElect@neha.org

First Vice-President—Tom Butts, MSc, REHS
FirstVicePresident@neha.org

Second Vice-President—CDR Anna Khan, MA, REHS/RS
SecondVicePresident@neha.org

Immediate Past-President—Sandra Long, REHS, RS
ImmediatePastPresident@neha.org

Regional Vice-Presidents

www.neha.org/RVPs

Region 1—Frank Brown, MBA, REHS/RS
Region1RVP@neha.org
Alaska, Idaho, Oregon, and Washington. Term expires 2023.

Region 2—Michele DiMaggio, REHS
Region2RVP@neha.org
Arizona, California, Hawaii, and Nevada. Term expires 2024.

Region 3—Rachelle Blackham, MPH, REHS
Region3RVP@neha.org
Colorado, Montana, Utah, Wyoming, and members residing outside of the U.S (except members of the U.S. armed services). Term expires 2024.

Region 4—Kim Carlton, MPH, REHS/RS, CFOI
Region4RVP@neha.org
Iowa, Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin. Term expires 2022.

Region 5—Traci (Slowinski) Michelson, MS, REHS, CP-FS
Region5RVP@neha.org
Arkansas, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas. Term expires 2023.

Region 6—Nichole Lemin, MS, MEP, RS/REHS
Region6RVP@neha.org
Illinois, Indiana, Kentucky, Michigan, and Ohio.
Term expires 2022.

Region 7—Tim Hatch, MPA, REHS
Region7RVP@neha.org
Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee. Term expires 2023.

Region 8—CDR James Speckhart, MS, REHS, USPHS
Region8RVP@neha.org
Delaware, Maryland, Pennsylvania, Virginia, Washington, DC, West Virginia, and members of the U.S. armed services residing outside of the U.S. Term expires 2024.

Region 9—Larry Ramdin, REHS, CP-FS, HHS
Region9RVP@neha.org
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Term expires 2022.

NEHA Staff

www.neha.org/staff

Seth Arends, Graphic Designer, NEHA EZ, sarends@neha.org

Jonna Ashley, Association Membership Manager, jashley@neha.org

Rance Baker, Director, NEHA EZ, rbaker@neha.org

Gina Bare, RN, Associate Director, PPD, gbare@neha.org

Jesse Bliss, MPH, Director, PPD, jbliss@neha.org

Nick Bohnenkamp, Program and Operations Manager, PPD, nbohnenkamp@neha.org

Trisha Bramwell, Sales and Training Support, NEHA EZ, tbramwell@neha.org

Renee Clark, Accounting Manager, rclark@neha.org

Holly Cypress, Administrative Support, PPD, hcypress@neha.org

Kristie Denbrock, MPA, Chief Learning Officer, kdenbrock@neha.org

Roseann DeVito, MPH, Project Manager, rdevito@neha.org

Steven Dourdis, MA, Human Resources Business Partner, sdourdis@neha.org

David Dyjack, DrPH, CIH, Executive Director, ddyjack@neha.org

Santiago Ezcurra Mendaro, Media Producer/LMS Administrator, sezcurra@neha.org

Doug Farquhar, JD, Director, Government Affairs, dfarquhar@neha.org

Soni Fink, Sales Manager, sfink@neha.org

Anna Floyd, PhD, Instructional Designer, EZ, afloyd@neha.org

Nathan Galanos, Contracts Administrator, ngalanos@neha.org

Madelyn Gustafson, Project Coordinator, PPD, mgustafson@neha.org

Becky Labbo, MA, Evaluation Coordinator, PPD, rlabbo@neha.org

Terryn Laird, Public Health Communications Specialist, tlaird@neha.org

Angelica Ledezma, AEC Manager, aledezma@neha.org

Stephanie Lenhart, MBA, Senior Accountant, slenhart@neha.org

Matt Lieber, Database Administrator, mlieber@neha.org

Tyler Linnebur, MAcc, CPA, Staff Accountant, tlinnebur@neha.org

Dillon Loaiza, Accounts Payable Specialist, dloaiza@neha.org

Bobby Medina, Credentialing Specialist, bmedina@neha.org

Jaclyn Miller, Marketing and Communications Specialist, NEHA-FDA RFFM, jmiller@neha.org

Avery Moyler, Administrative Support, NEHA EZ, amoyler@neha.org

Alexus Nally, Member Services Representative, atnally@neha.org

Eileen Neison, Credentialing Manager, eneison@neha.org

Michael Newman, A+, ACA, MCTS, IT Manager, mnewman@neha.org

Liz Otero, Web Developer, lotero@neha.org

Amber Potts, REHS, CP-FS, Senior Project Coordinator, PPD, apotts@neha.org

Charles Powell, Media and Workforce Development Specialist, NEHA EZ, cpowell@neha.org

Kristen Ruby-Cisneros, Managing Editor, *JEH,* kruby@neha.org

Michéle Samarya-Timm, MA, HO, REHS, MCHES, DLAAS, Senior Project Coordinator, Environmental Health, PPD, msamaryatimm@neha.org

Jordan Strahle, Marketing and Communications Manager, jstrahle@neha.org

Reem Tariq, MSEH, Senior Project Coordinator, PPD, rtariq@neha.org

Christl Tate, Training Operations and Logistics Manager, NEHA EZ, ctate@neha.org

Sharon Unkart, PhD, Associate Director, NEHA EZ, sdunkart@neha.org

Gail Vail, CPA, CGMA, Associate Executive Director, gvail@neha.org

Christopher Walker, MSEH, REHS, Senior Program Analyst, Environmental Health, PPD, cwalker@neha.org

Laura Wildey, CP-FS, Senior Program Analyst, Food Safety, PPD, lwildey@neha.org

Cole Wilson, Operations Manager, NEHA-FDA RFFM, nwilson@neha.org

Alyssa Wooden, MHS, Project Coordinator, PPD, awooden@neha.org

Brett Wyker, MS, Evaluation Coordinator, NEHA-FDA RFFM, bwyker@neha.org

2020–2021 Technical Advisors

www.neha.org/technical-advisors

CLIMATE AND HEALTH

David Gilkey, PhD
dgilkey@mtech.edu

Jennie McAdams
jenniecmcadams@franklincountyohio.gov

Richard Valentine
rvalentine@slco.org

Felix Zemel, MCP, MPH, CBO, RS, DAAS
felix@pracademicsolutions.com

DATA AND TECHNOLOGY

Darryl Booth, MBA
dbooth@accela.com

Timothy Callahan
tim.callahan@dph.ga.gov

EMERGENCY PREPAREDNESS

Martin Kalis
mkalis@cdc.gov

Christopher Sparks, MPH, MPA, RS
christopher.sparks@houstontx.gov

FOOD SAFETY

Eric Bradley, MPH, REHS, CP-FS, DAAS
eric.bradley@scottcountyiowa.com

Tracynda Davis, MPH
tracynda.davis@fda.hhs.gov

Cindy Rice, MSPH, RS, CP-FS, CEHT
cindy@easternfoodsafety.com

GENERAL ENVIRONMENTAL HEALTH

Michael Crea, RS
crea@zedgepiercing.com

Tara Gurge, MS, RS, CEHT
tgurge@needhamma.gov

Crispin Pierce, PhD
piercech@uwec.edu

Clint Pinion, Jr., DrPH, RS, CIT
clint.pinion@eku.edu

Sylvanus Thompson, PhD, CPHI(C)
sthomps@toronto.ca

HEALTHY COMMUNITIES

Stan Hazan, MPH
hazan@nsf.org

Robert Powitz, MPH, PhD, RS, CP-FS
powitz@sanitarian.com

Kari Sasportas, MSW, MPH, REHS/RS
ksasportas@lexingtonma.gov

Robert Washam, MPH, RS, DAAS
b_washam@hotmail.com

INFECTIOUS AND VECTORBORNE DISEASES

Christine Vanover, MPH, REHS
npi8@cdc.gov

Tyler Zerwekh MPH, DrPH, REHS
tyler.zerwekh@dshs.texas.gov

SPECIAL POPULATIONS

Cynthia McOliver, MPH, PhD
mcoliver.cynthia@epa.gov

Welford Roberts, MS, PhD, REHS/RS, DAAS
welford@erols.com

Jacqueline Taylor, MPA, REHS
bljacnam@aol.com

WATER

Andrew Pappas, MPH
apappas@isdh.in.gov

Maureen Pepper
maureen.pepper@deq.idaho.gov

Jason Ravenscroft, MPH, REHS, CPO
jravensc@marionhealth.org

Sara Simmonds, MPA, REHS
sara.simmonds@kentcountymi.gov

WORKFORCE AND LEADERSHIP

Robert Custard, REHS, CP-FS
bobcustard@comcast.net

Affiliate Presidents

www.neha.org/affiliates

Alabama—Beverly M. Spivey
beverly.spivey@adph.state.al.us

Alaska—Joy Britt
jdbritt@anthc.org

Arizona—David Morales
david.morales@maricopa.gov

Arkansas—Richard Taffner, RS
richard.taffner@arkansas.gov

Business and Industry—Michael Crea
nehabia@outlook.com

California—Darryl Wong
president@ceha.org

Colorado—Keith Seimsen
KeithSeimsenCEHA@gmail.com

Connecticut—Kevin Elak, RS, REHS, CP-FS
kevin.elak@middletownct.gov

Florida—Eric Maday
eric.maday@flhealth.gov

Georgia—Jessica Badour
jessica.badour@agr.georgia.gov

Idaho—Jesse Anglesey
janglesey@siph.idaho.gov

Illinois—Justin Dwyer
jadwyer84@gmail.com

Indiana—Jammie Bane
jbane@co.deleware.in.us

Iowa—Matt Even
meven@bentoncountyia.gov

Jamaica (International Partner Organization)—Karen Brown
info@japhi.org.jm

Kansas—Tanner Langer
tdlanger@cowleycounty.org

Kentucky—Clint Pinion, Jr., MA, MPH, DrPH, CIT, RS
clint.pinion@eku.edu

Louisiana—Carolyn Bombet
carolyn.bombet@la.gov

Massachusetts—Diane Chalifoux-Judge, REHS/RS, CP-FS
diane.chalifoux@boston.gov

Michigan—Drew Salisbury, MPH, REHS
dsalisbury@meha.net

Minnesota—Lisa Schreifels, REHS
president@mehaonline.org

Missouri—Deb Sees
dsees@jacksongov.org

Montana—Jeff Havens
jeffphavens@hotmail.com

National Capital Area—Julia Balsley, REHS
NCAEHA.President@gmail.com

Nebraska—Elizabeth Rhodes
elizabeth.rhodes@douglascounty-ne.gov

Nevada—Brenda Welch, REHS
welch@snhd.org

New Jersey—Lynette Medeiros
president@njeha.org

New Mexico—Samuel Frank
samuel.frank@ihs.gov

New York State Conference of Environmental Health Directors—Elizabeth Cameron
lcameron@tompkins-co.org

North Carolina—Josh Jordan
josh.jordan@dhhs.nc.gov

North Dakota—Marcie Bata
mabata@nd.gov

Northern New England Environmental Health Association—Brian Lockard
blockard@ci.salem.nh.us

Ohio—Steve Ruckman, MPH, RS
mphosu@gmail.com

Oklahoma—Jordan Cox
coxmj12@gmail.com

Oregon—Sarah Puls
sarah.puls@co.lane.or.us

Past Presidents—Vince Radke, MPH, RS, CP-FS, DLAAS, CPH
vradke@bellsouth.net

Rhode Island—Dottie LeBeau, CP-FS
deejaylebeau@verizon.net

South Carolina—M.L. Tanner, HHS
tannerml@dhec.sc.gov

Tennessee—Kimberly Davidson
kimberly.davidson@tn.gov

Texas—Stevan Walker, REHS/RS
mswalker@mail.ci.lubbock.texas.us

Uniformed Services—MAJ Nathaniel Sheehan
nathaniel.sheehan@outlook.com

Utah—Talisha Bacon
tbacon@utah.gov

Virginia—Jessica Stewart
jessica.stewart@virginiaeha.org

Washington—Tom Kunesh
tkunesh@co.whatcom.wa.us

West Virginia—Jennifer Hutson
wvaos@outlook.com

Wisconsin—Mitchell Lohr
mitchell.lohr@wisconsin.gov

Wyoming—Chelle Schwope
chelle.schwope@wyo.gov

NEHA 2021 AEC THREE-PART VIRTUAL SERIES WRAP-UP

Together a Safer and Healthier Tomorrow

Jonna Ashley
Kristie Denbrock, MPA
Soni Fink
Angelica Ledezma
Kristen Ruby-Cisneros
Jordan Strahle
National Environmental Health Association

The 84th Annual Educational Conference (AEC) & Exhibition pivoted to a new format in 2021 as a Three-Part Virtual Series, showcasing the National Environmental Health Association's (NEHA) commitment to innovation in delivering valuable, interactive, and engaging educational content. Due to the COVID-19 pandemic, NEHA made the decision in April 2020 to cancel the 2020 AEC, the first time in our history that we did not put on an AEC. For the 2021 AEC, NEHA closely monitored developments of the COVID-19 pandemic and after careful deliberation, the NEHA Board of Directors made the decision in November 2020 to transition the face-to-face 2021 AEC scheduled for July 12–15, 2021, in Spokane, Washington, to a three-part virtual series.

After making the decision, NEHA President Sandra Long stated, "As the health and safety of our members, presenters, exhibitors, attendees, partners, and staff is our highest priority, the NEHA Board of Directors has made the difficult decision to transition the 2021 AEC & Exhibition to a three-part virtual series. While I am disappointed we won't have the opportunity to see our friends and colleagues in person, I feel certain NEHA has made the right decision. I have full confidence that the NEHA leadership and staff will develop this three-part virtual series to be as valuable, educational, and interactive as past AECs. I look forward to participating in this new learning and conference format."

Along with a new virtual platform, NEHA made the decision to break up the 2021 AEC into three separate parts that were held on April 20–21, June 1–2, and July 14–15, 2021. In total, 1,100 environmental health practitioners gathered and attended the virtual conference to exchange information and discover new and practical solutions to the most pressing challenges facing the profession. Environmental health professionals have been on the front line of an unprecedented global pandemic. COVID-19 brought with it changes to roles and an increase in responsibilities. The 2021 AEC brought attendees together virtually to share experiences, research, expertise, and best practices to work together for a safer and healthier tomorrow.

During Part 1, John Wilson, founder of CBL Training and Consulting, delivered an energized and timely keynote address. Wilson provided attendees with strategies to maintain their own behavior and the tools to successfully gain compliance and create cooperation amid a world of growing stress and anxiety for the profession and the public they serve. For Part 2, a panel discussion on how policy makers view environmental health was featured. The presenters included Kim Norton, the mayor of Rochester, Minnesota, and Doug Benevento, former deputy administrator for the U.S. Environmental Protection Agency. The presenters provided an insightful discussion on key environmental health issues impacting their constituencies. We wrapped up the 2021 AEC in Part 3 with our Closing Session and Awards Recognition.

The 2021 AEC included over 100 educational sessions, workshops, and networking sessions in a wide variety of environmental health topics. Food safety, emergency preparedness, and climate and health were among the most popular topics. See pages 55–57 for more details regarding the education and training offered at the 2021 AEC.

Exhibitors showcased their products and services in a live virtual format throughout the 2021 AEC Three-Part Virtual Series. Attendees and exhibitors connected in real time during the live Exhibit Hall hours. We thank all exhibitors and sponsors for their involvement in the 2021 AEC with a special thank you to the series presenting sponsor, HealthSpace USA Inc. See pages 58–59 for more information about the exhibition and a listing of exhibitors and sponsors.

While the 2021 AEC may have looked drastically different compared with previous AECs, the 2021 AEC Three-Part Virtual series nonetheless offered a valuable experience for all those who participated. NEHA thank its attendees, members, board, staff, technical advisors, presenters, exhibitors, and sponsors who participated and contributed to the success of the 2021 AEC. The conference could not be possible without you!

We look forward to seeing everyone next year at the 2022 AEC in Spokane, Washington, on June 28–July 1, 2022, Check out the promo for next year's conference on page 67.

EDUCATION & TRAINING

While the format of the 2021 AEC shifted from in-person to virtual, the education provided was of the same caliber that environmental health professionals have come to expect from NEHA. The Call for Abstracts for the 2021 AEC ran from August 24–October 2, 2020. NEHA highly encouraged individuals that had submitted an abstract for the canceled 2020 AEC to resubmit. As in past years, we sought abstracts that discussed the latest advancements in environmental health in both the private and public sectors. NEHA reopened the Call for Abstracts after the decision was made to transition the 2021 AEC to a virtual event. The second Call for Abstracts ran from November 16–December 7, 2020. In the end, a total of 226 abstracts were submitted for the 2021 AEC.

Once the Call for Abstracts closed, all submitted abstracts were reviewed by the NEHA technical advisors (TAs) in late fall 2020. The TAs were asked to rate the abstracts in regard to quality, relevance, impact, and originality. The agenda for the conference educational sessions, taking into account that the 2021 AEC had been divided into three parts, was put together using the TA reviews of the abstracts. NEHA also identified topic areas of relevance that were not represented by the submitted abstracts and reached out to experts in those areas to fill any holes in the educational program.

We thank the TAs for their contributions to this year's educational program and their willingness to share their expertise and time in creating an educational program that was current and relevant to environmental health professionals. Please see page 53 for a full listing of the 2020–2021 NEHA TAs.

With the agenda set, the next step was to make sure that we supported all of our speakers in the transition from presenting in-person to virtually. For each part, NEHA offered a 1-hour speaker training session that was facilitated virtually by Pathable, the vendor of our virtual platform. These trainings were offered in real time and were recorded for viewing after the fact. We also conducted virtual training for session moderators, tech leads, and exhibitors. Finally, we conducted dress rehearsals for all of the featured presentations, including the Keynote Address, Opening Panel, and Closing Session. While most of their past experience in presenting has been in front of an audience, our speakers stepped up admirably in the virtual platform and tackled the unfamiliar experience of presenting to a large audience via their computers (and from their homes in many cases).

In total, the 2021 AEC offered 111 sessions in 10 different environmental health tracks over the three-part virtual series. The 2021 AEC featured 221 presenters from federal, state, local, private, nongovernmental organization, and academia sectors. The presenters came from all across the U.S., as well as from other countries across the globe. We also hosted a virtual poster hall during each part that featured a total of 32 posters. Poster presenters were able to engage and interact with attendees in real time across the virtual platform. Research topics ranged from the effect of COVID-19 on body art, water quality, special events in a postpandemic world, and lead exposure.

The Three Parts

Each part of the 2021 AEC featured different environmental health tracks and featured speakers and session.

Part 1

Part 1 took place on April 20–21, 2021, and featured the following tracks:

- Opening Keynote
- Environmental Justice & Children's Environmental Health
- Food Safety
- General Environmental Health
- Infectious & Vectorborne Diseases
- Uniformed Services
- Workforce & Leadership

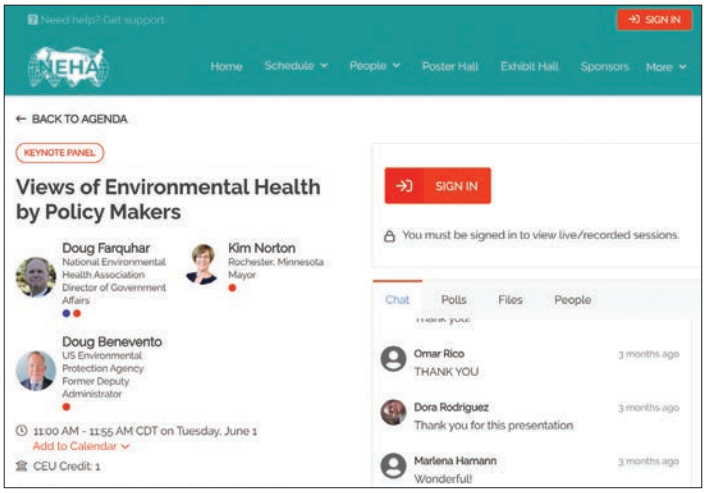
John Wilson delivered the keynote address on April 20 to over 600 attendees. Wilson is the founder of CBL Training and Consulting. He has served as a sergeant in a major California law enforcement agency where he led a crisis intervention training unit and is a U.S. Army veteran. His presentation focused on communication tools environmental health professionals can use to successfully gain compliance or create cooperation when facing difficult situations.

Food Safety was a highly attended track during Part 1. The four highest attended sessions, which had over 1,200 combined participants, included "EHS-Net Conducting Environmental Assessments: An Essential Tool for Foodborne Outbreak Investigations;" "NCEH: Improving Restaurant Food Safety Through Innovative, Practice-Base Research With the Environmental Health Specialists Network;" "Diverting Food Waste From Commercial Food Establishments: Two Success Stories From Central Oregon;" and "Automation & Technology Trends in Foodservice Equipment."

Part 2

Part 2 took place on June 1–2, 2021, and featured the following tracks:

- Opening Panel
- Climate & Health
- Emergency Preparedness & Response
- Healthy Communities
- Water Quality
- Workforce & Leadership



Part 2 opened on June 1 with a panel discussion on "Views of Environmental Health by Policy Makers." The discussion featured Kim Norton, the mayor of Rochester, Minnesota; Doug Benevento, former deputy administer of the U.S. Environmental Protection Agency; and Doug Farquhar, director of Government Affairs at NEHA.

Part 2 highlighted educational sessions that covered indoor air quality, drinking water systems contamination, the latest research on *Legionella,* and rebuilding environmental health capacity in the U.S. Virgin Islands and Puerto Rico after the 2017 hurricanes.

Part 3

Part 3 took place on July 14–15, 2021, and featured the following tracks:

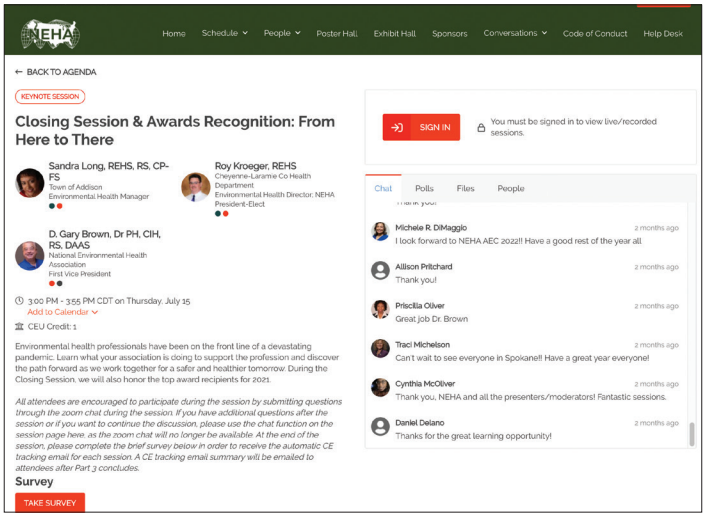
- Closing Session and Award Recognition
- Climate & Health
- Data & Technology
- Emerging Topics
- Food Safety
- General Environmental Health
- Water Quality
- Workforce & Leadership

Part 3 included the NEHA Town Hall Assembly on July 14. The Town Hall was an opportunity for attendees to hear about the state of the association and have their questions answered by NEHA staff and board members. The Town Hall has also traditionally included presentations from candidates for second vice-president of NEHA. This year two candidates, Michele DiMaggio and Larry Ramdin, submitted recorded speeches that were played during the Town Hall.

Popular sessions during Part 3 focused on workforce development and food safety. These popular sessions included "EH Workforce Needs, Now and in the Future;" "FDA Retail Food Grant Funding Improves Efficiency at the Oakland City–County Health Department;" and "The Collaborative: A Coordinated and Concentrated Approach to Reducing Foodborne Illness."

The 2021 AEC concluded on July 15 with the Closing Session and Awards Recognition. The session, "From Here to There," was hosted by NEHA First Vice-President Dr. D. Gary Brown. NEHA President Sandra Long and President-Elect Roy Kroeger discussed how environmental health professionals have been on the front line of a devastating pandemic and how together we are creating a safer tomorrow. The session also honored Long for her service as NEHA president and featured the "passing of the gavel" and start of Kroeger's 2021–2022 presidency.

Our most prestigious award recipients addressed the virtual crowd during the awards recognition part of the session. The recognitions kicked off with the first Dr. Bailus Walker, Jr. Diversity and Inclusion Awareness Award winner, Aqualia (Shauna) Nelson. In her speech, Nelson reminded us to lead the charge and strive to create a more diverse, equitable, and inclusive environment. Stan Hazan from NSF International presented the Walter F. Snyder Award to Kevin Smith of the Food and Drug Administration. This year marked the 50th anniversary of NSF International and NEHA presenting the Snyder Award.



Dr. Adam London, a NEHA past president, gave out two awards. The first was the NEHA Past Presidents Award given to NEHA Executive Director Dr. David Dyjack. Dr. London also presented NEHA's highest honor, the Walter S. Mangold Award, to Vincent J. Radke. Radke gave a speech acknowledging the history of this important award and the esteemed recipients who came before him. The closing session ended with a moment of silence lead by Dr. Brown that honored the environmental health professionals and friends we have lost over the past few years.

A Safer and Healthier Tomorrow

The NEHA 2021 AEC Three-Part Virtual Series proved that with environmental health professionals coming together, we can have a safer and healthier tomorrow.

We thank all of the presenters for sharing their knowledge and expertise with over 1,100 attendees throughout the 2021 AEC. The presentations provided attendees with a wealth of information, lessons learned, and ideas to take back to their respective workplaces. We appreciate the contributions of the Uniformed Services Environmental Health Affiliate and the National Center for Environmental Health within the Centers for Disease Control and Prevention for putting together educational tracks for the 2021 AEC. Finally, we appreciate the contributions of all of the moderators and tech leads who made the virtual sessions run smoothly.

NEHA 2022 AEC

While the 2021 AEC was wrapped up just a few months ago, work is already underway for the 2022 AEC. The 2022 AEC will take place June 28–July 1, 2022, in Spokane, Washington. Preconference workshops will be held on June 26–28. The Call for Abstracts is open from August 23–September 28, 2021. As in previous years, we seek abstracts that highlight the latest advances in environmental health from all different sectors. Visit www.neha.org/aec/abstracts for abstract submission guidelines and to submit your abstract. 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.

2021 AEC SESSION TRACKS

This year's educational program featured over 100 sessions within 10 tracks and 34 disciplines.

1. Climate & Health
   - » Climate Change
2. Data & Technology
   - » Environmental Health Tracking & Informatics
   - » Technology & Environmental Health
3. Emergency Preparedness
   - » Emergency Preparedness & Response
4. Food Safety
   - » Cannabis
   - » Food Safety & Defense
   - » Home Restaurants
5. General Environmental Health
   - » Air Quality
   - » Body Art
   - » 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
   - » Schools & Institutions
7. Infectious & Vectorborne Diseases
   - » Pathogens & Outbreaks
   - » Vector Control & Zoonotic Diseases
8. Special Populations
   - » Children's Environmental Health
   - » Environmental Justice
   - » Uniformed Services
9. Water Quality
   - » Onsite Wastewater
   - » Premise Plumbing
   - » Private Drinking Water
   - » Recreational Water (including shorelines)
   - » Water Quality
   - » Water Reuse
10. Workforce & Leadership
    - » Leadership/Management/Enumeration
    - » Student & Young Professional Career Development

Preconference Courses & Workshops

More than 100 attendees enhanced their knowledge and their 2021 AEC virtual experience with one of several preconference offerings held during Parts 1 and 3.

NEHA continued to offer one of the most successful preconference workshops from previous years, the Affiliate Leadership Workshop. Nearly 40 affiliate leaders gathered at this year's workshop to learn tips and resources for running successful associations, specifically around in-person and virtual events.

NEHA once again partnered with ecoAmerica's Climate for Health to combat the growing concern of climate change with a highly successful half-day Ambassador Training offered prior to Part 1. Over 30 participants were equipped with knowledge, hands-on experience, and resources to speak and act confidently on climate change and solutions.

Two new preconference workshops were offered during Part 3 of the 2021 AEC. The Environmental Health and Land Reuse Certificate Program Workshop explored the environmental and health risks and social disparities associated with contaminated land properties, key players in land reuse planning and policy, and redevelopment techniques to improve community health. NEHA's Private Water Network held the Effective Education and Outreach for Private Drinking Water Systems Workshop. The workshop featured a combination of presentations and interactive sessions on innovative implementation, challenges, best practices, and evaluation of effective education and outreach strategies for private wells and other small drinking water systems.

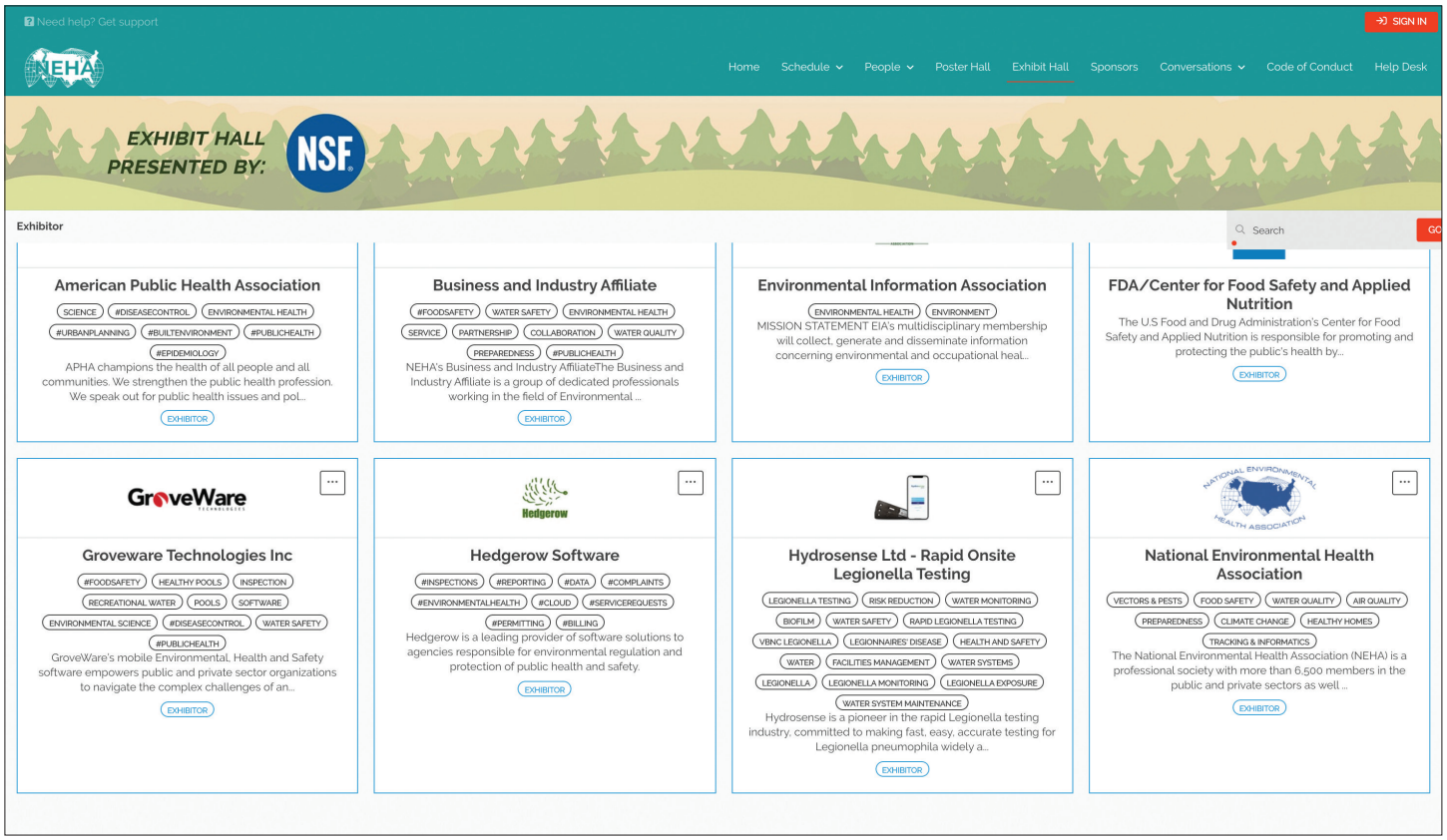
ON-DEMAND ACCESS

The 2021 AEC Three-Part Virtual Series was packed with over 100 educational sessions that are now available on-demand. Registered attendees can rewatch favorite sessions, view sessions that were missed, or catch up on any of the three parts. All registered attendees have exclusive on-demand access to the recorded sessions from Parts 1, 2, and 3.

If you did not register for the 2021 AEC, you can now purchase access to all on-demand content through the NEHA Online Store. This option is to provide early access to the sessions for those wanting it. Please note that all NEHA members will have access to the recordings beginning in early 2022 and refunds will not be issued to members that purchase the on-demand access.

To learn more about accessing the on-demand sessions for both registered attendees and those wanting to purchase access, visit www.neha.org/2021-aec.

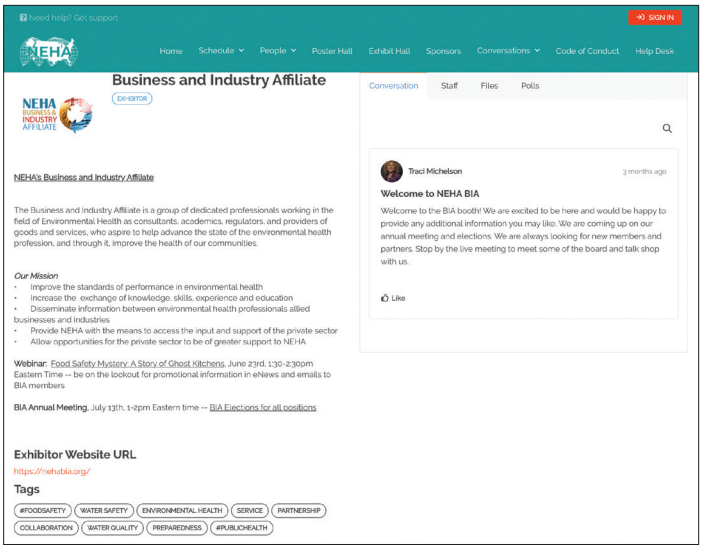
EXHIBITION



The Exhibit Hall at the 2021 AEC, sponsored by NSF International, was a virtual platform that enabled attendees to visit exhibitor booths and exhibitors during each part of the 2021 AEC. We were excited to have 23 different organizations covering a broad spectrum of environmental health—from software companies and nonprofit organizations to food safety product companies, federal agencies, and more.

The Exhibit Hall was open from 9 a.m. to 4 p.m. each day on April 20–21, June 1–2, and July 14–15. Each day also offered live Exhibit Hall times from 9–10 a.m., 12–1 p.m., and 3–4 p.m., which provided attendees with the opportunity to interact with exhibitors live via their booths. These dedicated hours gave attendees the time to learn and ask questions about products and services offered by the exhibitors to make them more effective and knowledgeable in their positions. The 23 exhibiting organizations had representatives enthusiastically waiting for attendees to interact live via their booths. It was great to see everyone!

Along with the live Exhibit Hall hours, the virtual booths offered exhibitors various different features to share their products, services, and information. The main landing page for each exhibitor booth included a section to provide background information about the organization, their website address, other relevant links, and tags to indicate the topics or areas of environmental health they focus on. The virtual booth had a chat window, a tab to list staff who were in attendance, and a tab to upload files such as brochures and flyers. The virtual booth also included a polls tab where exhibitors could post questions for attendees to provide their feedback.



The virtual component of the Exhibit Hall provided analytics that gave exhibitors a complete picture of their attendee engagement for each part of the 2021 AEC. Overall, the Exhibit Hall was well attended.

In addition to the Exhibit Hall, Hedgerow Software sponsored a Virtual Photo Booth during Part 3 of the 2021 AEC. Attendees were

encouraged to take photos utilizing props and the GIF feature that added movement to the photo. A photo montage of the 2021 AEC Virtual Photo Booth was created and can be viewed at www.neha.org/2021-aec.

We thank HealthSpace USA Inc for their support of the NEHA 2021 AEC Three-Part Virtual Series as a Presenting Sponsor. We also thank all of the exhibitors and sponsors who participated in and supported the 2021 AEC. NEHA is able to hold this premier event each year because of your generous support and dedication.

2021 AEC EXHIBITORS

- Accela
- American Public Health Association
- Business and Industry Affiliate
- Environmental Information Association
- Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Analytics and Outreach
- Groveware Technologies Inc.
- HealthSpace USA Inc
- Hedgerow Software
- Hydrosense
- Inspect2GO Environmental Health Software
- National Environmental Health Association
- National Onsite Wastewater Recycling Association
- NSF International
- Ozark River Manufacturing Co.
- Pool & Hot Tub Alliance
- Private Water Network
- Project Firstline
- Sanipur US LLC
- ServSafe/National Restaurant Association
- Sweeps Software, Inc.
- ThermoWorks
- U.S. Department of Housing and Urban Development
- U.S. Environmental Protection Agency, Office of Research and Development

2021 AEC SPONSORS, PARTNERS, AND CONTRIBUTORS

We appreciate the following sponsors, organizations, and individuals who helped make the 2021 AEC possible!

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Partners and Contributors

Association of Environmental Health Academic Programs

Centers for Disease Control and Prevention, National Center for Environmental Health

ecoAmerica, Climate for Health

Food and Drug Administration

National Environmental Health Science and Protection Accreditation Council

NEHA Endowment Fund Donators (see page 7)

NEHA Technical Advisors (see page 53)

Uniformed Services Environmental Health Association

U.S. Environmental Protection Agency, Office of Research and Development

2021 AWARDS & SCHOLARSHIPS

NEHA Award Winners Are Recognized for Exceptional Contributions

NEHA acknowledged the recipients of our 2021 awards, scholarships, and certificates during the final part of the 2021 AEC Three-Part Virtual Series. This year, NEHA was proud to bestow 10 national awards representing outstanding individuals, programs, and groups throughout the country. "Awards and recognition are important career mile markers," reflected NEHA Executive Director Dr. David Dyjack. "Let us collectively take a moment during this period of universal COVID-19 exhaustion to extend a heartfelt congratulations to each of the awardees."

The challenges that we have faced over the past year and a half make the accomplishments of our award recipients even more extraordinary. From students excelling during unparalleled times and new leaders working on diversity efforts to some of the most recognized names in our professional community, this year's recipients illustrate the dedication and selflessness of those in our field. The following people were honored with awards in 2021.

AEHAP Student Research Competition Winners

Sydney Bohall,
West Chester University of Pennsylvania
Rowan Carroll,
Illinois State University
Lexi Kyro,
Montana State University
Gabriela Ornelas,
Illinois State University
Angela Spugnardi,
Eastern Kentucky University

Each year the Association of Environmental Health Academic Programs (AEHAP) invites undergraduate and graduate students enrolled in a National Environmental Health Science and Protection Accreditation Council (EHAC)-accredited program to submit original research projects. Winning entries receive $1,000 and travel stipends to present their projects at the AEC.

Dr. Bailus Walker, Jr. Diversity and Inclusion Awareness Award

Aqualia (Shauna) Nelson, MA, REHS/RS

NEHA presented the first annual Dr. Bailus Walker, Jr. Diversity and Inclusion Awareness Award to Aqualia (Shauna) Nelson. The Walker Diversity Award was introduced in 2020 to recognize an individual or group who has made significant achievements in the development or enhancement of a more culturally diverse, inclusive, and competent environment.

Nelson serves as a consumer safety officer for the Food and Drug Administration where she conducts activities to regulate the manufacture, distribution, and marketing of tobacco products. As an REHS/RS, she works to cultivate healthier relationships between humans and the environment by providing direction on issues impacting air quality and pollution, healthy homes, water and food safety, hazardous waste management, and environmental justice.

Throughout her career, Nelson has been an avid champion for the promotion of environmental stewardship to create healthy platforms inclusive to all. From conducting investigations into environmental and public health hazards and natural disasters in diverse communities to serving on environmental and public health task forces addressing ways of lessening health disparities in under resourced or racial–ethnic minority communities, she continuously advocates for positive change.

Nelson's commitment to diversity extends beyond her work life and stretches into the community she serves. She lends her time being an ally for underrepresented groups, advocating to amplify marginalized voices on issues impacting their livelihood. Furthering her commitment to serve, Nelson has completed the Diversity, Equity, and Inclusion in the Workplace Certificate Program from the University of South Florida.

Her dedication to public service is embodied through a level of care and genuine empathy for others, which is showcased in all she does. Nelson believes the best work relationships are reflective of people from diverse backgrounds who value differences, support mutual respect, embrace inclusivity, and provide opportunities for all to thrive to reach their maximum potential.

Dr. R. Neil Lowry Grant

North Richland Hills, Texas

Sponsored by the Pool & Hot Tub Alliance (PHTA), this $5,000 grant honors a public health official or department who has made outstanding contributions to advance the public health and safe use of recreational water in pools, spas, and water parks. The grant is given in honor of Dr. R. Neil Lowry, a long-time member of PHTA. The city of North Richland Hills (NRH) provides education and community outreach on water safety, promotes protective engineering, and delivers effective enforcement of local ordinances through the NRH 365 Water Safety 365 Drowning Prevention Program. To learn more, visit www.nrhws365.com.

NEHA/AAS Scholarship

Graham Siegel,
Western Carolina University
Samson Strickland,
East Carolina University
Saba Wube,
University of Nevada, Las Vegas

Each year NEHA and our partner organization, the American Academy of Sanitarians (AAS), provide scholarships for three deserving

students. NEHA and AAS began the scholarship program 25 years ago out of a shared desire to support well-educated and well-prepared environmental health students committed to working as sanitarians/environmental health professionals and contributing to the public health of their communities. In 2020, the boards of both organizations voted to name one of the undergraduate scholarships to honor Dr. Sheila Davidson Pressley. In 2021, the second undergraduate scholarship was named in honor of Dr. Carolyn Hester Harvey. Both of these esteemed individuals served as champions for students and environmental health academics throughout their impressive careers.

NEHA Affiliate Certificates of Merit

Certificates of Merit are awarded to members of NEHA-affiliated organizations. Each affiliate selects individual and team winners based upon its criteria for recognition. The certificates are an opportunity for local affiliates to be recognized on national level. The 2021 recipients are:

Individuals

Karen Contador,
Massachusetts Environmental Health Association

Brian Gutierrez and Derreck Webb,
New Jersey Environmental Health Association

Patrick Lindsey,
Alabama Environmental Health Association

Mark Peloquin,
Minnesota Environmental Health Association

Michael Sukup,
Iowa Environmental Health Association

Teams

Fall Conference Committee,
Iowa Environmental Health Association

G & L Laboratories,
Massachusetts Environmental Health Association

Legislative Committee,
Montana Environmental Health Association

Workforce Development Committee,
Connecticut Environment Health Association

NEHA Past Presidents Award

David Dyjack, DrPH, CIH,
National Environmental Health Association

The NEHA Past Presidents Affiliate comes together annually to recognize an environmental health champion with a distinguished award. Since May 2015, Dr. David Dyjack has led NEHA as its executive director. When Dr. Dyjack came aboard, membership was stagnating and the finances of the association were on shaky ground.

Under Dr. Dyjack, membership in NEHA has grown from approximately 3,600 in 2015 to just over 6,500. The budget in 2015 was approximately $3 million. The current budget is approximately $10 million and NEHA is on a sound financial footing. NEHA's social media engagement back in 2015 was minimal. Today that engagement reaches across many platforms (e.g., LinkedIn, Twitter, Facebook, and Instagram) and has gained many followers.

Collaboration and communication with federal partners, NEHA affiliates, industry, and other associations have improved under the leadership of Dr. Dyjack. Before he arrived to take the helm of NEHA, the association had no presence in Washington, DC. Today eight NEHA staff members are working in Washington, DC, to improve environmental health capability and build capacity.

In the 2020 NEHA Annual Report, Dr. Dyjack stated, "You will observe abundant evidence of our organizational rebirth during what can best be summarized as an otherwise awful year framed by the COVID-19 pandemic." Many environmental health professionals found it difficult to obtain continuing education during the pandemic. In response, NEHA offered free continuing education to environmental health professionals, members and nonmembers alike. Under Dr. Dyjack, NEHA's credentialing has stayed strong with 450 new credentialed professionals and 2,250 environmental health professionals renewing their credentials in 2020.

This year's recipient of the NEHA Past Presidents Award has worked tirelessly to promote NEHA and the environmental health professional. The NEHA past presidents salute this year's award recipient, Dr. David Dyjack.

NEHA Presidential Citations

Certificates are given to those who have made exemplary impacts on the association during the NEHA president's term of office. President Sandra Long conferred Presidential Citations to the following individuals and groups:

Jonna Ashley
Renee Clark
Alicia Collins
Brian Collins
Kristie Denbrock
Dr. Amer El-Ahraf
Santiago Ezcurra
Soni Fink
Dr. Carolyn Hester Harvey
Roy Kroeger
Angelica Ledezma
Dustin Long
NEHA Staff
NEHA Technical Advisors
Michael Newman
Dr. Priscilla Oliver
Charles Powell
Vince Radke
Dr. Manjit Randhawa
Kristen Ruby-Cisneros
Gail Vail

NSF International Scholar

Reggie Eggen,
University of Wisconsin–Eau Claire

AEHAP, in partnership with NSF International, offers a $3,500 internship to one undergraduate student from an EHAC-accredited program. The selected student completes a 10-week research project targeting an issue of concern selected by NSF International.

Samuel J. Crumbine Consumer Protection Award

Washoe County Health District

This prominent award is given annually to local environmental health jurisdictions that demonstrate unsurpassed achievement in providing food protection services to their communities. It is named for one of the country's most renowned health officers and educators, Dr. Samuel J. Crumbine. The Crumbine Award encourages innovative programs and methods that reduce or eliminate foodborne illnesses, recognizes the importance of food protection at the local level, and stimulates public awareness in food service sanitation.

The Washoe County Health District staff.

The 2021 winner, Washoe County Health District, demonstrated clear evidence of program improvement and public health interventions, achievements in solving impactful public health-centered challenges, and a strong program focus on outcomes in addition to outputs. The selection committee praised the district for their engagement with industry and solid relationships with the community. The Washoe County Health District has jurisdiction over all public health matters in Reno, Sparks, and Washoe County through the policy making Washoe County District Board of Health.

The Crumbine Award is supported by the Conference for Food Protection, in cooperation with the American Academy of Sanitarians, American Public Health Association, Association of Food and Drug Officials, Food Marketing Institute, Foodservice Packaging Institute, International Association for Food Protection, National Association of County and City Health Officials, National Environmental Health Association, National Restaurant Association, NSF International, and UL, LLC.

Walter F. Snyder Environmental Health Award

Kevin Smith

The Snyder Award honors NSF International's cofounder and first executive director, Walter F. Snyder, who provided outstanding contributions to environmental and public health advancement. This year marks the 50th anniversary of NEHA's partnership with NSF International to recognize public health professionals who protect the air we breathe, the water we drink, the food we eat, and the environment we share with this important award. The 2021 recipient is Kevin Smith, senior advisor for food safety at the Food and Drug Administration's (FDA) Center for Food Safety and Applied Nutrition (CFSAN). Smith has dedicated his career of more than 30 years to safeguarding human health and safety.

Smith has played an essential role in the development, delivery, and advancement of national standards that guide regulatory program implementation and set the bar for the design and performance of equipment related to food protection and environmental health. In his current role at FDA, Smith advises leadership on strategic initiatives and program development that led nationwide efforts to combat food waste, promote food recovery, and protect food from contamination during transport. He has provided consulting to programs and initiatives that seek to reduce food waste while addressing food insecurity and creating jobs. His collaboration with experts in food safety, environmental engineering, epidemiology, laboratory analysis, and public health has helped to create a more integrated food safety system and promote comprehensive food safety reform.

Smith has served in several leadership positions at FDA, including director of the Retail Food Protection Staff, acting director for the Division of Cooperative Programs, and consumer safety officer on the Retail Food Protection Team at CFSAN. Before joining FDA in 2001, he was a standards development program manager at NSF International, working on standards for a range of products including food equipment, swimming pool equipment, and wastewater and stormwater treatment technologies. He got his start in public health as a sanitarian with the Ulster County Department of Health and the New York State Department of Health.

"Kevin is known across the food safety industry for his collaborative nature, deep experience in standards development, and

commitment to the broader picture. He always takes the time to thoroughly consider different viewpoints while being thoughtful, flexible, and respectful," said Dr. David Dyjack, NEHA executive director. "His abilities to engage others and enact change have been invaluable in building consensus when creating important national standards—many of which are now core to the work of food safety professionals and organizations throughout the nation."

Walter S. Mangold Award

Vincent J. Radke, MPH, RS, CP-FS, CPH, DLAAS

The 2021 Walter S. Mangold Award was presented to Vincent J. Radke. The Mangold Award recognizes individuals for outstanding contributions to the advancement of environmental health professionals. It is the highest distinction that NEHA can grant one of its members.

In keeping with the legacy of Walter S. Mangold, Radke's impressive career is an example of both professionalism and service. Radke served as president of NEHA from 2018–2019. He was nominated for the Mangold Award by Dr. Adam London, current president of the NEHA Past Presidents Affiliate. In his nomination letter, Dr. London wrote, "He is my friend to be sure, but even as a seasoned environmental health professional, I learned so much from him about the art and craft of being a better leader and a better person."

From 2001–2018, Radke was a sanitarian for the Environmental Health Services Branch of the Centers for Disease Control and Prevention (CDC) where he helped lead collaborative food safety activities, including the Environmental Health Specialists Network within CDC at the National Center for Environmental Health and the National Center for Infectious Diseases. In 2010, Radke became CDC advisor to the Conference for Food Protection (CFP) Board of Directors. In this position, he advised industry, academic, consumer, federal, state, and local representatives on food safety policies, FDA *Food Code* issues, and committee and council reports submitted to the CFP Board of Directors. He also served as CDC advisor to CFP's Council I until he retired from CDC in October 2018. In a letter to the Mangold Award Nomination Committee, John Marcello, special assistant to the director within the FDA Office of State Cooperative Programs, shared that Radke's "voice resonates to this day and is a major influence in changing the culture of regulatory food protection programs from regulatory programs with a public health component to public health programs with a regulatory component."

Radke was involved in many domestic and international emergency responses to natural and man-made disasters. Some of these responses included an earthquake and tsunami in Indonesia, Ebola in West Africa, Zika virus in the U.S. and Caribbean, Rocky Mountain spotted fever in the Western U.S., an earthquake in Haiti, the Deepwater Horizon oil spill in the Gulf of Mexico, multiple hurricanes in the U. S. and Caribbean, and the Fukushima Daiichi nuclear disaster in Japan. He provided environmental health information, surveillance, risk assessment, and analysis, including recovery information for emergency response staff and the populations impacted by these disasters.

As a surveillance and assessment officer with the U.S. Peace Corps and the World Health Organization (WHO), Radke worked with the Ethiopian Ministry of Health, tribal chiefs and schools, health clinics, and church staff to combat smallpox and establish cholera and tuberculosis immunization programs. WHO requested Radke to assist with the eradication of smallpox in Bangladesh and to document that smallpox had been eliminated in Kenya. In 1976 he was awarded the Order of the Bifurcated Needle by the WHO Director-General for his efforts in this area. WHO declared smallpox eradicated in 1980.

Presently, Radke continues his work in environmental health. He consults with the Association of Food and Drug Officials on food safety issues. He continues to be a guest lecturer on environmental health issues at the Rollins School of Public Health at Emory University. During 2020–2021, Radke conducted pro bono consulting regarding the COVID-19 pandemic with certain national companies and local restaurants in Atlanta, Georgia.

Mangold Award Nomination Committee Chair CAPT Michael E. Herring stated, "The Mangold Award Committee was greatly impressed with the extraordinary breadth of Vince Radke's career and accomplishments in the field of environmental health. From serving in vital roles for the U.S. Peace Corps and WHO that resulted in the eradication of smallpox from the planet to his extensive career and achievements working in local, state, federal, and international environmental health programs, Vince's career of more than 50 years has been exceptional in every way. His leadership and service have advanced the mission of NEHA, along with numerous other important public health and environmental health agencies and organizations. Vince Radke is a most deserving recipient of the 2021 Walter S. Mangold Award."

Did You Know?

NEHA offers several different awards that recognize and honor individuals and teams for their achievements and successes in environmental health and in forwarding the profession. In a world where environmental health professionals are unsung heroes, our awards are an opportunity to spotlight and honor your accomplishments. To learn more about the awards offered, the application periods, and past award honorees, please visit www.neha.org/awards.

NEHA **NEWS**

The NEHA-FDA Retail Flexible Funding Model Grant Program

By Jaclyn Miller (jmiller@neha.org)

Starting September 9 through November 15, 2021, the National Environmental Health Association (NEHA), in partnership with the Food and Drug Administration (FDA), will accept applications for the NEHA-FDA Retail Flexible Funding Model (RFFM) Grant Program. This new grant program offers abundant funding to assist state, local, tribal, and territorial (SLTT) retail food regulatory agencies in their efforts to reduce the occurrence of foodborne illness and increase conformance with the Voluntary National Retail Food Regulatory Program Standards (Retail Program Standards). Awarded jurisdictions will receive the funding needed to assess, learn, network, and grow, while advancing their retail food regulation practices.

The NEHA-FDA RFFM Grant Program is a tremendous opportunity to enhance retail food safety programs at the local level while transforming jurisdictions nationwide. No matter how small or short-handed, the customizable nature of this grant allows for awarded jurisdictions to both increase their effectiveness in protecting public health while making steady progress through the Retail Program Standards at a pace that best suits their situation.

Participation in this program will open the door to forward-thinking retail food safety programs that use sound science and metrics to reduce the occurrence of foodborne illness in their communities. If a jurisdiction is experiencing a shortage of full-time employees, equipment, inspection software, or funds to collaborate with industry or regulatory partners, the NEHA-FDA RFFM Grant Program can provide the funds to meet these stagnating needs and transform operational effectiveness.

Application Funding Tracks

Through the new NEHA-FDA RFFM Grant Program, jurisdictions will be able to apply for one of two base grants: Development and Maintenance & Advancement, in addition to four optional add-on grants: Mentorship, Training/Staff Development and Program Standards Engagement, Special Projects, and Capacity Building. Based on individual jurisdiction experience and achievement in the Retail Program Standards, these funding options offer three distinct eligibility tracks for application:

1. **Track 1 Development** ($5,000/year/grantee): This track is for applicants newly enrolled in the Retail Program Standards with opportunities to request funds to complete a self-assessment of all nine Standards (SA9) or a Comprehensive Strategic Improvement Plan (CSIP). Applicants following this track will also have the option to apply for two optional add-on grants to be a mentee and/or attend one of FDA's Self-Assessment and Verification Audit Workshops.
2. **Track 2 Development** ($5,000/year/grantee): This track is for jurisdictions with more experience that have already completed an SA9 and complete a CSIP to attach to their application to pursue continuous improvement with the Standards and Elements. These jurisdictions will also have the option to add on public health metric funding, offering up to an additional $5,000/year/grantee, to complete a foodborne illness risk factor study or equivalent public health measure, or to develop and implement an intervention strategy based on a risk factor study or equivalent public health measure.
3. **Track 3 Maintenance & Advancement**: This track is for jurisdictions that have a current SA9, complete a CSIP, and have met and verified at least one Standard during their most recent self-assessment period, offering 3 years of funding with the following options:
   - up to $3,000 per grantee for completion of a repeat SA9;
   - up to $3,000 per Standard per year for continuous improvement (achieving Elements within one or more Standards);
   - up to $10,000 per Standard per year to achieve conformance with one or more Standards by the end of the 3-year funding cycle; and/or
   - up to $5,000 per Standard per year to maintain conformance with one or more Standards.

Track 2 and 3 applicants will also be able to apply for all four of the optional add-on grants available:

- **Mentorship**: Up to $14,000/year/grantee for mentees and up to $24,000/year/grantee for mentors.
- **Training/Staff Development and Program Standards Engagement**: Up to $7,500/year/grantee.
- **Special Projects**: Up to $20,000/year/grantee.
- **Capacity Building**: Up to $100,000/year/grantee for a 3-year grant cycle.

Further details regarding supported activities, eligibility requirements, program resources, and actions that can be taken now to prepare a successful application can be found at the NEHA-FDA RFFM Grant Program webpage at www.neha.org/retailgrants. Registration for the 2021 NEHA-FDA RFFM application portal will open September 1. Applications will be accepted September 9–November 15 (7:59 p.m. EST).

The NEHA-FDA RFFM Grant Program's success is dependent upon the success of its jurisdictions. The program is designed to be people-centered and will consistently deliver the tools, resources, and support necessary for success. Through the duration of the application and grant cycle, the NEHA-FDA RFFM Grant Program will provide personalized support in the form of subject matter experts, webinars, Q&A sessions, and an incredibly responsive grant support team.

For questions, guidance, or direct support, please contact our NEHA-FDA RFFM Grant Program Support Team via email at retailgrants@neha.org or toll-free at (833) 575-2404.

NEHA Releases New Animated Video That Highlights Environmental Health Professionals as an Army of Unseen Protectors

By Jordan Strahle (jstrahle@neha.org)

Who makes sure that our food, water, air, homes, and communities are safe? We know that it is environmental health professionals. To most people, however, our work goes unnoticed. They trust that their water is safe to drink, that the restaurant they are eating from is clean—but they do not consider how that happens.

"Did you know that the reason our homes, schools, and communities are safe from infection and disease is because an unseen team of guardians protecting us, day and night? We are not superheroes; we're trained scientists you may not have even heard of before. And when we are doing our job as environmental health professionals, you won't notice us at all. We're invisible. Problems are prevented."

The above quote highlights the premise of this new animated video produced by NEHA that helps to expose the often overlooked and undervalued world of environmental health professionals and the ways they tirelessly work to ensure public health and safety is protected. This short video shows some of the many ways an "invisible" environmental health professional impacts and protects many of the aspects of our daily lives, from our children's day care to our oceans. It helps to not only expose the work we do but also raises the importance of ensuring that the environmental health profession is supported in a manner consistent with other public health initiatives and programs.

This video is a bridge, connecting the public and decision makers to the work that we do every day. We encourage you to share it within your communities and help make our invisible profession visible. To learn more and view the video, please visit www.neha.org/eh-animated-video.

NEHA is also pleased to announce that the video was selected for screening on-demand at the American Public Health Association (APHA) Film Festival at the APHA 2021 Annual Meeting and Expo being held October 23–27. The video was selected from a large number of submissions and was judged to be of high quality and interest. We are excited to be able to share the video to a larger audience during the APHA Film Festival.

Diversity, Equity, and Inclusion Blog Series

By Jonna Ashley (jashley@neha.org)

As environmental health professionals, you are navigating new ways of working with and serving your communities. All too often in times of change and uncertainty, diversity, equity, and inclusion are deprioritized as we make sense of new realities. It is imperative in these difficult times to center on diversity and highlight those who are making efforts to be inclusive where they live and work. The latest blog series from NEHA shines a light on members who are prioritizing diversity, equity, and inclusion in their everyday jobs. In telling the stories of these individuals we aim to support the field in building awareness while driving action towards equity and inclusion.

This limited member spotlight series on the A Day in Life of an EH Professional Blog highlights four members who are working in a variety of ways to better represent and communicate with the people in their communities. They are leveraging their leadership positions on committees, within universities, at health departments, and with international companies to connect with a diverse range of people to advocate for underserved and racial–ethnic minority groups. A common thread in each story is the concept of relationship building. Whether it is the relationship between environmental health professionals and local politicians or the relationship between a regulator and a restaurant owner, each of these members understands the value of listening, learning, and treating others with respect.

You can read the member spotlight stories of Thomas Gillam-Shaffer, Daniel Oerther, Joan Peterson, and Brian Zamora on the A Day in the Life of an EH Professional Blog at www.neha.org/dei-blog-series. While these stories focus on leaders, environmental health professionals in all stages of their careers can enact diversity initiatives in large and small ways.

We invite you to submit your story idea to be featured on the blog. NEHA's membership team will work with you to turn a summary of your work into a compelling blog story that can be shared nationally and at the local level. To learn more and submit your ideas, please contact Membership Manager Jonna Ashley at jashley@neha.org.

The Retail Food Safety Regulatory Association Collaborative Releases Food Code Adoption Toolkit and Interactive Food Code Adoption Map

By Terryn Laird (tlaird@neha.org)

The Retail Food Safety Regulatory Association Collaborative (Collaborative) is pleased to announce the release of the Food Code Adoption Toolkit and interactive Food Code Adoption Map. The Toolkit is a living resource that provides research, resources, and support to decision makers looking to adopt the most recent versions of the Food and Drug Administration's (FDA) *Food Code* to regulate the retail segment of the food industry. The interactive Food Code Adoption Map is a reference reflecting statutory or regulatory adoption of the FDA *Food Code* at the state level as of January 2021.

NEHA **NEWS**

The *Food Code* is a model code for safeguarding public health against instances of foodborne illness and is a scientifically sound, technical resource that can be used to regulate the retail segment of the food industry. Increasing the number of state, local, tribal, and territorial (SLTT) regulating bodies that have adopted the two most recent versions of the FDA *Food Code* is one of the primary aims of the Collaborative. Adoption of the latest versions of the *Food Code* is associated with many benefits including assurance that food safety regulations reflect the most current science available and will evolve to reflect new science, knowledge, and emerging technologies.

The Toolkit was developed to provide information and resources to SLTT agencies looking to adopt more recent versions of the FDA *Food Code*. The Toolkit provides background on *Food Code* adoption and features letters of support from six national associations, three industry associations, and four regulatory programs. It also provides a list of resources, places to go for support, and an area to provide additional tools and resources from Toolkit viewers.

The Food Code Adoption Map provides a quick reference for stakeholders to quickly visualize which FDA *Food Code* version has been adopted, as well as easily accessible information on statutory and regulatory citations, most recent effective or amended dates, and agencies with regulatory authority.

View the Food Code Adoption Toolkit and the Food Code Adoption Map on the Collaborative's website at www.retailfoodsafetycollaborative.org/tools/national-food-code-adoption-toolkit.

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 pages 52 and 53.

Becky Labbo

My interests in psychology started at a young age and remained throughout my education. I received my bachelor's degree in psychology and my master's degree in educational psychology. My career path took me down the road of research and evaluation. It was during my first job as a research assistant that I realized I liked that side of programs. I'm simply a very logical, analytical person who always asks for the facts and data. I want to learn about the reasons and causes of things and use knowledge and information for improvement and to make decisions. My family often jokes that they don't need to read reviews because I have painstakingly researched the pros and cons for just about everything we buy, from cars to laundry detergent.

I have spent the last 20-plus years in program evaluation with about 7 years focused on K-12 education and teacher preparation and the latter 14 years in the realm of school wellness focused on the whole child. When I saw the opportunity with NHEA it felt like an ideal fit. Even though environmental health is new to me, I believe there is an intersection between the health of our environment and personal wellness. One does not happen without the other. My position at NEHA is as evaluation coordinator within the Program and Partnership Development Department. In this role, I will not only work to ensure evaluation is incorporated in all that NEHA does but also use this information to show our successes and to improve our programs to make a positive footprint.

I am a proud Colorado native! True to where I live, I love the mountains. In the summer you will find me hiking, enjoying a good patio, and attending live music at the best music venue in the world, Red Rocks. My family and I are avid skiers so in the winter you will find us at our favorite Colorado ski resorts. And of course, in addition to my husband and two kids, I stay busy trying to tire out our beloved goldendoodle, Cosmo Kramer.

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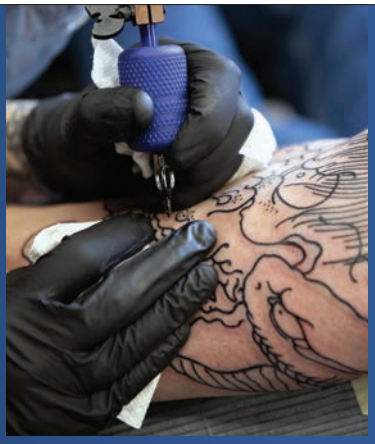

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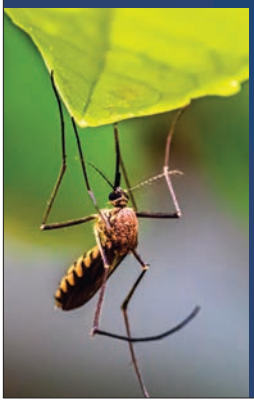

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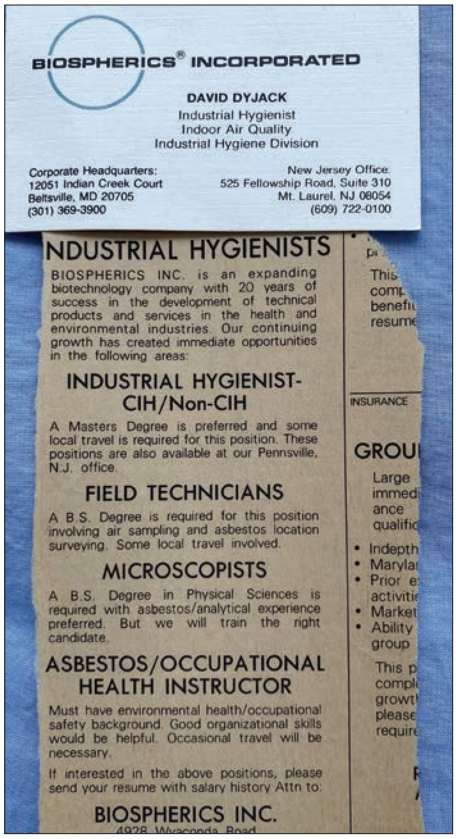
6. **Women are society's change agents.** There is an old saying in the international nongovernmental organization crowd that rings true to me. My version is: Give a man a dollar and he will spend it at the local pub. Give a woman a dollar and she will feed her family, start a small business, and create a rainy-day fund. Investing in female children is critical. My observation is that when young adults complete high school, are in a committed relationship, and start a family, in that order, society and the environment benefit.
7. **Weed out evil in the workplace.** This one is certain to upset many readers. Narcissists (self-love), those with Machiavellian tendencies (manipulators), and sociopaths (lack of a conscience) must go. The irony is that these individuals are often highly visible, productive, and influential employees. People with these traits cannibalize organizations from the inside out as altruistic team players choose to work elsewhere.
8. **The best ideas and solutions frequently arise from those with the least impressive titles, degrees, and visibility.** I once worked on a project where we charged Chesapeake and Potomac Telephone (back in the days of human telephone operators and landlines) hundreds of thousands of dollars to identify the source of carbon monoxide in a building. I was interviewed on television (Dave Dyjack featured live at 5 p.m.!)—oh, those were the halcyon days. After considerable study and pontification, the sad fact was that we never identified the source. Approximately one year after the event, I was in the neighborhood of the building in question and stopped by for a social call to see if there had been any additional detection of combustion products. I started a conversation with the individual in charge of building maintenance. He beamed one of those Cheshire Cat smiles when I inquired with him. He described in considerable detail that when the wind blows from a certain direction, the exhaust from the boiler would be entrained into the building HVAC system. Throughout the duration of our study, including an expensive and complex tracer gas analysis, he suspected the source of the carbon monoxide. When I inquired why he didn't say anything, his response was, "No one asked me." Lesson learned.
9. **Action is in the space between the professions.** For most of us, the single largest professional contribution we will make is cultivating greater understanding and collaboration between us and nonenvironmental health sectors and professions. In my opinion, the next big opportunity is at the intersection of the clinical professions and environmental health. This juncture is where our data and electronic health records can be used to make better and more informed patient care decisions.
10. **You matter.** In a world of almost 8 billion humans, our individual and professional potential is lubricated by relationships. One relationship at a time. How you dress. How you act. How you treat and help those with the least ability to help you in return. As Senator Alan Simpson (R-Wyoming) was once alleged to have said, "If you have integrity nothing else matters." If you don't have integrity, nothing else matters.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The help wanted ad and business card that started it all. Photo courtesy of David Dyjack.

Well, those are my top 10 observations. I possess a multitude of stories to accompany each, but space is limited. Send me your top 10 at ddyjack@neha.org and let's start a discussion.

ddyjack@neha.org
Twitter: @DTDyjack

Did You Know?

NEHA's Government Affairs program provides members with insights on environmental health in various levels of government. The program tracks state and federal legislation, responds to federal and state inquiries on environmental health, and provides the environmental health workforce a voice in policy making. You can stay up-to-date on our work at www.neha.org/government-affairs. Check out the Your Insider in Government Affairs Blog, view one of the Government Affairs webinars, read a recent policy or position statement, or learn about recent state and federal legislative actions.

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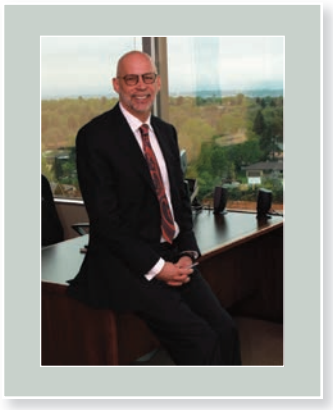

David Dyjack, DrPH, CIH

Studiis et Observatione Notari: Reflections From the Arena

It was 1986, a year that found me despondent and depressed, yet determined. My monthly apartment rent was an exorbitant $185. The Space Shuttle Challenger had exploded on takeoff in January. The meltdown of reactor number 4 in the Chernobyl Nuclear Power Plant had been front page news since April. The unemployment rate was hovering around 7%. I couldn't buy a break in my attempts at securing employment with my biology degree. Well, one that paid more than $12,000/year.

Then serendipity introduced itself. The Chesapeake Chapter of the Audubon Society inquired if I would participate with a group of pro-environment volunteers to meet with elected officials in Washington, DC. I accepted their invitation. (Yes, we stayed at the infamous Hotel Harrington.) The week would culminate with us meeting in person with Lee M. Thomas, administrator of the U.S. Environmental Protection Agency. With that meeting, everything changed. The absence of career advisement I endured was turned on its head as Thomas articulated the public health path forward for our nation, albeit under the conservative Reagan Administration. I was hooked.

So, it was 35 years ago this month that I joined the public health profession. Work has brought me to around 70 countries and most of the U.S., with the exception of South Dakota and Alaska. I endured a couple health scares this year, neither involving COVID-19. These brushes with mortality have produced a reflective mood. In that spirit, I'd like to share with you the top 10 things I've learned while working in the coolest, most interesting, and amazing profession on the planet.

> *Leaders articulate a vision and in the process, tolerate and encourage creative conflict.*

1. **Environmental Health is profoundly local.** Yes, you knew this one was coming, so let's get it out of the way. SARS-CoV-2, Ebola, *Legionella*, *Salmonella*, Zika, Lyme disease, hantavirus, harmful algal blooms, droughts, floods, and workforce decisions are hyperlocal. Enough said.
2. **The public health significance of water is underappreciated and undervalued.** Take me seriously. From handwashing to premise plumbing, private water, septic systems, droughts, floods, heavy metals such as lead, per- and polyfluoroalkyl substances (PFAS), vectors, microorganisms of all kinds, and yes, drowning. For you early career readers, dealing with too much, too little, or contaminated water will increasingly represent a sizeable part of your workday.
3. **Tribes Matter.** Humans, the public in public health, relate to each other and trust individuals as a function of their professional and personal tribes. They see life through the lens of their collective values, beliefs, and absorbed ideas. People are hard-wired to discount facts and data, and place greater relevance on the opinion of someone familiar. While on this subject, it would benefit all of society to listen and learn from Native Americans and Indigenous people everywhere who understand our natural environment and how best to manage it.
4. **No one is afraid of change.** Change is a natural part of life. No one expects to look the same as they did in their first grade class photo. Professionals generally desire to mature and take on new and important responsibilities. Alternately, people are afraid of loss. Loss of jobs. Loss of influence. Loss of access. If we consider and factor in individual values, loyalties, and losses before introducing change, much workplace drama could be avoided.
5. **Leadership matters.** But perhaps not in the way you are thinking. A pattern I have observed is that effective leaders create the conditions under which individuals, teams, and society tap into the best versions of themselves. These leaders articulate a vision and in the process, tolerate and encourage creative conflict so that the best ideas float to the surface. These leaders then get out of the way while generously extending credit to those around them. They also embrace failure as a necessity on our journey to a better world.

continued on page 69

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