PERCEPTIONS OF ENVIRONMENTAL POLLUTION IN PARKS

Surveying Houston Residents After Hurricane Harvey
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Parks benefit public health in many ways, from improving stormwater management to mitigating disparities associated with physical and mental health. Parks and recreational areas can be adversely impacted by disasters and perceptions of post-disaster environmental contamination of parks can limit resident willingness to use parks and thus their benefits. This month’s cover article, “Resident Perceptions of Environmental Pollution in Recreational Areas Flooded by Hurricane Harvey in Houston, Texas,” surveyed residents in Houston who were using parks in the months following Hurricane Harvey. The study shows that residents desire more information about potential risks to health from environmental pollution in parks and are willing to take mitigating actions if made aware of their necessity and effectiveness.

See page 8.

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2021 AEC
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The Call for Abstracts will be open from August 24 to October 2. For those that took the time to submit an abstract for the 2020 AEC, we strongly encourage you to resubmit. For more information about the 2021 AEC and abstract submission requirements, please visit neha.org/aec.
Hello from the great state of Texas! It is an honor and privilege to serve as president of the National Environmental Health Association (NEHA). I have been a NEHA member since 1994 and attended my first NEHA Annual Educational Conference (AEC) & Exhibition in Fort Worth, Texas, that year. It was exciting. I attended the 2004 AEC in Anchorage, Alaska, and was the Texas Environmental Health Association (TEHA) president at the 2006 AEC in San Antonio, Texas. The sessions, the networking, and the feel of the AEC made me excited about being an environmental health professional and wanting to be an active part of NEHA.

Let me tell you about myself. I am the environmental health manager for the Town of Addison, Texas. Addison, immediately north of Dallas, is approximately 4 square miles with a population of 16,404 and nearly 200 full-service restaurants. Prior to working for the Town of Addison, I was an environmental health supervisor for the City of Plano Environmental Health and Sustainability Department and director of environmental health for The Colony, a suburban city of Dallas.

I am a graduate of Texas Woman’s University. I hold a Professional Sanitarian license in Texas, as well as NEHA’s Registered Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety credentials. I am also a Certified Foodservice Manager Instructor and Proctor and a Food Code Standardization Trainer through the Texas Department of State Health Services. I have been an active member of TEHA since 1994, serving on its state governing council and as president from 2005–2006. I have been responsible for state proclamations providing recognition for professional sanitarians and environmental health specialists.

As an active NEHA member, I have served as vice-president of NEHA’s Region 5, which covers the states of Arkansas, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas. I have also served as a practitioner on the National Environmental Health Science and Protection Accreditation Council and as the presiding officer of the Texas Sanitarian Advisory Committee from 2002–2010.

As you can see, I have come up through the professional leadership ranks. I have taught food safety courses, conducted inspections, implemented policy, implemented and witnessed changes in the profession, made laws, and administered programs in environmental health. I am fortunate to work in a profession I am passionate about. This passion comes from a network of professionals who have provided mentoring, guidance, collaboration, and encouragement. Some of these professionals are probably familiar: Brian Collins, Dr. Carolyn Harvey, Alicia Collins, Mel Knight, and Dr. Priscilla Oliver. Others might not be as well-known but are equally as influential: Ruth Hendy (deceased), Steve Berry, Ginger Shaffer, and Mario Seminara, to name a few.

I value all the professionals who have knowingly or unknowingly contributed to my professional development. We all learn from each other and should continue to do so. I have found that collaboration is one of the best ways to foster growth and problem solving. In the north Texas area, environmental health professionals have cultivated a network where issues and challenges can be discussed in a safe environment. The group can offer ideas, suggestions, and pass on timely and valuable information. It makes everyone stronger and keeps everyone on top of environmental health issues. If you have the opportunity to collaborate with other environmental health professionals in your area, I encourage you to form a similar partnership. It is outstanding what one person can do but amazing when you have a team of professionals working together.

As a family-oriented person, many of my fondest memories are time spent with family during the holiday and at celebrations and gatherings. I am a single parent, extremely proud of my son, his wife, and my grandchildren. You do not have to ask twice: I do carry pictures and will show them to you. My son, an environmental health specialist for Frisco, Texas, was introduced to environmental health at an early age due to my professional involvement and volunteerism.

I have always believed in volunteerism and have volunteered for a number of organizations since I was a teenager. Being an active part of your community is important. I have been a parent volunteer with
my son's schools, involved in the Boy Scouts of America, and currently volunteer with my church. Being an active member of professional organizations is also part of my volunteerism.

As NEHA president, I have the opportunity to shine light on areas of interest and concern. Food safety and emergency preparedness are topics of public concern. As an environmental health professional, I recognize that each of us has an important role in the field and we should all be proud of our choice of profession.

In closing, let me say that I have lived in Texas all my life. It is a state with diverse cultures, languages, people, and geography. You name it and we probably have it somewhere.

NEHA issued a position statement on COVID-19 in May that encourages state, local, and federal leaders to follow the guidance and direction of their public and environmental health professionals in efforts to reopen the country after COVID-19 quarantine measures. View the position statement at www.neha.org/news-events/latest-news/neha-issues-position-statement-covid-19.

Did You Know?

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.

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Thank you.

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Resident Perceptions of Environmental Pollution in Recreational Areas Flooded by Hurricane Harvey in Houston, Texas

Abstract Parks benefit public health in many ways, from improving stormwater management to mitigating disparities associated with physical and mental health. Parks and recreational areas can be adversely impacted by disasters. Perceptions of postdisaster environmental contamination of parks can limit residents’ willingness to use parks and thus their benefits. In this study, teams of trained interviewers surveyed residents in Houston, Texas, who were using parks in the months following Hurricane Harvey. Data about resident perception of and emotional response to environmental pollution, as well as self-rated postdisaster mental and physical health, were collected. Respondents felt certain that Hurricane Harvey caused environmental contamination in their communities and that this contamination would impact health. Of respondents, 40% reported anger, while only 21.4% felt afraid. Survey respondents had significantly lower mental health composite scores than a national comparison group. Although residents report strong concerns and need information about hurricane-associated environmental contamination, little data have been collected or made available to residents by federal or state agencies. The use of recreational areas for flood mitigation potentially exposes residents to environmental contamination after flooding. More information is needed about risks to health from these exposures.

Introduction Hurricane Harvey made landfall along the coast of Texas as a Category 4 storm on August 26, 2017. The storm moved slowly over the Houston metropolitan area—an area larger than New Jersey with 6 million residents and >20 Superfund sites—and became the wettest tropical cyclone on record. Record precipitation resulted in flooding called “catastrophic, historical, devastating, and life-threatening” by the National Weather Service (2017). Extensive flooding potentially exposed residents of Houston to a variety of chemicals and toxins (Friedrich, 2017; Schwartz, Tuminello, et al., 2018). Flooding in Houston typically is controlled in part by Buffalo Bayou, a 500-acre watershed that includes a 53-mile “river” flowing east from Katy, Texas, to the Houston Ship Channel, as well as other creeks and bayous connected to a network of parks and trails around the city (City Parks Alliance, n.d.; University of Massachusetts [UMass], 2006). Over time, these flood control areas have become much more highly urbanized—more than 80% of Buffalo Bayou is now developed and more than 450,000 residents live there—which has led to more frequent and more extensive flooding (UMass, 2006).

In addition to providing a buffer against flooding, parks in Buffalo Bayou offer a number of public recreational activities, including nature trails, bike paths, children’s playgrounds, and dog parks. Adverse impacts on the health of residents have been documented due to the relatively poor quality of Houston’s environment, particularly in the areas adjacent to the Houston Ship Channel (Corgey, 2015; Harper, 2004; Harris County Healthcare Alliance, 2015; Linder, Marko, & Sexton, 2008; U.S. Environmental Protection Agency, 2006; Walker, Coker, Symanski, & Lupo, 2006). Unprecedented flooding resulting from Hurricane Harvey, as well as the subsequent release of floodwater from Addicks and Barker Reservoirs, led to the

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movement of contaminated sediments along Buffalo Bayou and into adjacent recreational areas. In the months after Hurricane Harvey, some parks near Buffalo Bayou had up to 6 ft of accumulated sediment covering trails (KPRC Houston, 2017; West, 2017).

Parks and other recreational spaces are an important part of urban communities, with a large body of literature demonstrating the relationship between the quality and accessibility of green spaces and public health benefits (Gies, 2006; Lee & Maheswaran, 2011; Srinivasan, O'Fallon, & Dearnry, 2003). In addition to potential physical and mental health benefits, parks and green spaces can provide a respite from urban heat (e.g., providing shade and evaporative cooling) (Brown, Vanos, Kenny, & Lenzholzer, 2015; McPherson, 1994) and can be an important element of urban stormwater management (Brody & Highfield, 2013; Yang & Li, 2013). Parks and recreational areas can also play a role in addressing disparities related to physical activity, mental health, and general public health, particularly if planners and other city officials explicitly consider factors related to accessibility and utilization (Taylor, Floyd, Whitt-Glover, & Brooks, 2007; Wolch, Byrne, & Newell, 2014).

Parks and green spaces are challenged to fulfill these many potential benefits when impacted by a disaster. Parks can be directly damaged as a result of flooding, wind damage to trees or landscaping, or blowing debris. Disaster damages to parks can potentially limit their use by residents, particularly by residents from disaster-impacted neighborhoods (Bedimo-Rung et al., 2008; Rung, Broyles, Mowen, Gustat, & Sothern, 2011). The potential public health benefits provided by parks can be counteracted by the potential or perceived risks involved in postdisaster use of parks, including an increase in exposure to disease vectors such as mosquitoes that can breed in flooded areas, injuries due to debris and unsafe environments, or environmental contamination (Paterson, Wright, & Harris, 2018). Furthermore, parks might also be utilized for other purposes as part of disaster response and recovery in ways that limit their use by residents and limit their benefits to communities. For example, 6 months after Hurricane Katrina, 20% of the parks assessed were being utilized for other purposes, including housing Federal Emergency Management Agency trailers or as trash repositories (Bedimo-Rung et al., 2008).

The use of parks for stormwater management can help to moderate flooding by increasing the area covered by pervious surfaces (Brody, Sebastian, Blessing, & Bedient, 2018). For example, the City of Mesa, Arizona, operates 133 ponds, floodways, and wetlands that serve as both stormwater management areas and parks for recreational use (Pannell, 2013). The utilization of parks and recreational areas for flood mitigation, however, can raise concerns for public health. For example, past studies in Houston have documented the presence of pesticides from agricultural runoff, indicator bacteria from sewage, and other toxic chemicals in Buffalo Bayou (Smyer, 2008; West, 2016). These types of contaminants can be transported in soils and sediments during floods and deposited along the bayou in parks used by residents for recreational activities, as well as in nearby residential neighborhoods (Horney et al., 2018).

The role of parks and green spaces in mitigating the disproportinate burden of environmental challenges experienced by low-income and racial/ethnic minorities can also be interrupted by disasters. Disasters may be viewed as an opportunity for governments to close parks or relocate recreational amenities. For example, after Hurricane Mitch, the government of Honduras relocated ethnic minority populations who had previously lived in Celaque National Park, to focus on the development of ecotourism in the postdisaster period (Timms, 2011). During the immediate postdisaster response, remediation of parks and recreational areas might not be a priority for responding organizations. According to the National Parks Conservation Association, community parks must typically use their regular recreational budgets for disaster recovery, limiting their ability to provide regular programs, services, and maintenance after disasters (Pannell, 2013). Before a disaster, parks in low-income and minority communities already have fewer and lower-quality amenities, less wooded areas, and more trash, characteristics that can be intensified by disaster impacts (Bruton & Floyd 2014; Suminski et al., 2012).

Prior research in cities such as Los Angeles, California; Baltimore, Maryland; and Greensboro, North Carolina, has demonstrated that parks in low-income or majority-minority neighborhoods are more likely to be, or to be perceived as, crowded, unsafe, or close to sources of pollution (Boone, Buckley, Grove, & Sister, 2009; Hughey et al., 2016; Sister, Wolch, & Wilson, 2010). Proximity to transportation infrastructure and other sources of pollution in parks located in low-income or minority neighborhoods can lead to higher concentrations of various contaminants, such as polycyclic aromatic hydrocarbons (Choi et al., 2009) and organochlorine pesticides (Li et al., 2008). After a disaster, urban park users can be exposed to contaminants that are redistributed to nearby recreational area soils through ingestion, inhalation, and dermal routes (Li et al., 2008).

Although parks and other recreational areas can serve as an asset to communities during recovery from disasters, few studies have considered the impact of disasters on resident perceptions of environmental pollution in parks, desire for information about the potential impacts of environmental pollution, or perceived postdisaster mental and physical health. The purpose of this study was to collect information directly from residents who were using parks after Hurricane Harvey to inform public health and other agencies’ postdisaster communications to residents about the potential health risks associated with using parks. City planners, parks programs, and regulatory authorities could use this information to develop policies or health education and behavior change programs to mitigate mental and physical health impacts in the months following a disaster. For example, although they reported a greater need for a place for both physical activity and an “escape from personal, social, or physical pressures,” residents of neighborhoods flooded by Hurricane Katrina used parks less than residents from nonflooded neighborhoods (Rung et al., 2011). After the Deepwater Horizon oil spill, surveys conducted by researchers at Columbia University’s National Center for Disaster Preparedness identified restrictions on children’s recreational activities as an important behavior modification—more than 80% of parents residing on the Gulf Coast of Louisiana and Mississippi reported limiting the amount of time children swam in the Gulf of Mexico (Abramson et al., 2010).
Following Hurricane Harvey, the Houston Health Department identified six parks in Houston’s Buffalo Bayou, Cypress Creek, and adjacent to the Houston Ship Channel that were potentially impacted by flooding and the accumulation of redistributed sediments due to flooding (Figure 1). In February and March 2018, teams of at least two trained graduate student interviewers from Texas A&M University attempted to complete 20 surveys of residents who were approached while using each of the six parks, for a total sample of 120. To limit response bias, surveys were conducted on both weekdays and weekends. Respondents provided oral consent prior to the start of each interview. The survey and all associated materials were reviewed and determined to be exempt by the Texas A&M University Institutional Review Board (IRB 2018-005M).

The survey consisted of 44 questions organized into three sections. The first section asked respondents to assess their emotional response to environmental pollution in Houston in general (e.g., scared, nervous, angry, proud), as well as if their feelings about environmental pollution had changed since Hurricane Harvey (Afifi & Weiner, 2004; Watson, Clark, & Tellegen, 1988). Respondents were also asked about actions that they might be willing or able to take to limit their exposure to environmental pollution when using parks, ranging from taking shoes off inside their house to speaking to elected representatives to change environmental regulations (Witte, Cameron, McKeon, & Berkowitz, 1996).

The second section of the survey included questions about self-rated physical and mental health from the Medical Outcomes Study (SF-12) (Jenkinson et al., 1997; Ware, Kosinski, & Keller, 1996). The SF-12 includes measures of self-rated quality of life across eight domains that include physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality (energy/fatigue), social functioning, role limitations due to emotional problems, and mental health (psychological distress and psychological well-being). The final section collected respondent demographics, including sex (male, female, other), age (calculated from year of birth), race/ethnicity (African-American/Black, Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander, Latino or Hispanic, White, other), ZIP code, length of residence in ZIP code (continuous number of years), and whether or not the respondent had children under age 18 living at home (yes, no).

Data Analysis
Responses were recorded on paper and entered into a Microsoft Excel database. For quality assurance, we double entered 20 of the 117 records. EpiInfo 7.2 was used to calculate frequencies, percentages, and 95% confidence intervals (CIs) for each survey question. Responses from the SF-12 questions were imported into SAS 9.4 and the physical and mental health composite scores were calculated using the code written by Spritzer (2003) and described by Ware and coauthors (2005). Not all participants answered every survey question; however, all participant survey data were recorded regardless of survey completion.

Results
Demographics
A total of 117 individuals completed the survey. The age of respondents ranged from 19–69 (median = 36). Of respondents, 64.6% (73 of 113) were female and 68.5% (76 of 111) reported having at least one child under the age of 18 living at home (Table 1). The majority of respondents were Hispanic (60.9%, 67 of 110). Of the 111 respondents who reported their residential ZIP code, 52 different ZIP codes in the Houston metropolitan area were reported. Nearly one half of respondents (51 of 111, 46.0%) reported they had lived in that ZIP code for <5 years.

Resident Perceptions
Respondents were asked how certain they currently are and how certain they want to be in the future about pollution caused by Hurricane Harvey and its potential health effects. One half of respondents (49.6%, 58 of 117) reported that they felt certain or very certain that Hurricane Harvey caused environmental pollution in their community (Table 2). Addi-
tionally, two thirds of respondents reported a desire to be certain about the pollution caused by Hurricane Harvey and the potential health effects of such pollution.

When asked about their emotional response towards environmental pollution in their community, about two in five respondents reported that the pollution made them feel angry (39.3%, 42 of 107), while only one in five reported that the pollution made them feel afraid (21.4%, 19 of 89) (Table 3). Although there was extensive attention to the way civic groups and local volunteers came together to respond to and recover from Hurricane Harvey (Aldrich, 2018)—including the Houston Economic Development Council’s reintroduction of “Houston Proud” as a grassroots campaign after Hurricane Harvey in September 2017—the strongest respondent disagreement was with reported feelings of pride and inspiration: 59.4% (60 of 101) of respondents disagreed that Harvey-associated environmental pollution made them feel proud and 54.8% (57 of 104) disagreed that they felt inspired.

Resident Willingness to Take Actions
A majority of respondents (71.1%, 81 of 114) reported they would be able to take individual-level actions to decrease their household’s exposure to environmental contaminants after using parks following a flooding disaster. These actions included removing shoes indoors and wiping pets’ feet after being outdoors, which have been shown to reduce levels of pollutants in house dust (Butte & Heinzow, 2002; Roberts & Dickey, 1995). Respondents also felt that these actions would be effective, with more than one half reporting that completing simple tasks like these would be effective in preventing the health effects of environmental pollution (57.8%, 67 of 116) and reducing the respondent’s risk of health-related effects of environmental pollution (54.8%, 63 of 116) from park-based exposures. Respondents were also asked to indicate their ability to undertake larger-scale actions to decrease community- or state-level environmental pollution, such as contacting an elected representative to urge them to take action or change policy. More respondents agreed (46.6%, 54 of 116) than disagreed (30.2%, 35 of 116), but these differences were not statistically significant.

**Demographic Characteristics of Respondents to a Houston Parks Survey (N = 117)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th># (%)</th>
<th>95% Confidence Interval (CI)</th>
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<tbody>
<tr>
<td><strong>Sex (n = 113)</strong></td>
<td></td>
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<tr>
<td>Female</td>
<td>73 (64.6)</td>
<td>55.1, 73.4</td>
</tr>
<tr>
<td>Male</td>
<td>40 (35.4)</td>
<td>26.6, 45.0</td>
</tr>
<tr>
<td><strong>Race/ethnicity (n = 110)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American/Black</td>
<td>8 (7.3)</td>
<td>3.2, 13.8</td>
</tr>
<tr>
<td>Hispanic</td>
<td>67 (60.9)</td>
<td>51.1, 70.1</td>
</tr>
<tr>
<td>White</td>
<td>27 (24.6)</td>
<td>16.8, 33.7</td>
</tr>
<tr>
<td>Other</td>
<td>8 (7.3)</td>
<td>3.2, 13.8</td>
</tr>
<tr>
<td><strong>Length of residence (n = 111)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5 years</td>
<td>51 (46.0)</td>
<td>36.5, 55.7</td>
</tr>
<tr>
<td>5–9 years</td>
<td>19 (17.1)</td>
<td>10.6, 25.4</td>
</tr>
<tr>
<td>10–19 years</td>
<td>29 (26.1)</td>
<td>18.3, 35.3</td>
</tr>
<tr>
<td>≥20 years</td>
<td>12 (10.8)</td>
<td>5.7, 18.1</td>
</tr>
</tbody>
</table>

**Level of Certainty and Desired Certainty Regarding Hurricane Harvey’s Environmental Pollution and Health Effects (N = 117)**

<table>
<thead>
<tr>
<th>Level of certainty (n = 117)</th>
<th># (%)</th>
<th>95% Confidence Interval (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certain</td>
<td>58 (49.6)</td>
<td>40.2, 59.0*</td>
</tr>
<tr>
<td>Neutral</td>
<td>30 (25.6)</td>
<td>18.0, 34.5</td>
</tr>
<tr>
<td>Uncertain</td>
<td>29 (24.8)</td>
<td>17.3, 33.6</td>
</tr>
<tr>
<td>Health effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certain</td>
<td>54 (46.2)</td>
<td>36.9, 55.6</td>
</tr>
<tr>
<td>Neutral</td>
<td>21 (18.0)</td>
<td>11.5, 26.1</td>
</tr>
<tr>
<td>Uncertain</td>
<td>42 (35.9)</td>
<td>27.2, 45.3</td>
</tr>
<tr>
<td>Desired level of certainty (n = 116)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certain</td>
<td>78 (67.2)</td>
<td>57.9, 75.7*</td>
</tr>
<tr>
<td>Neutral</td>
<td>27 (23.3)</td>
<td>15.9, 32.0</td>
</tr>
<tr>
<td>Uncertain</td>
<td>11 (9.5)</td>
<td>4.8, 16.3</td>
</tr>
<tr>
<td>Health effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certain</td>
<td>75 (64.7)</td>
<td>55.2, 73.3*</td>
</tr>
<tr>
<td>Neutral</td>
<td>24 (20.7)</td>
<td>13.7, 29.2</td>
</tr>
<tr>
<td>Uncertain</td>
<td>17 (14.7)</td>
<td>8.8, 22.4</td>
</tr>
</tbody>
</table>

*Statistically significant at p < .05.
With regard to efficacy, approximately one third (37.4%, 43 of 115) of respondents agreed that contacting governmental representatives would be an effective way of changing environmental pollution regulations in Texas, while one third disagreed (32.2%, 37 of 115) and one third were neutral (30.4%, 35 of 115). The results were similar when respondents were asked if contacting governmental representatives would make it likely that environmental regulations in Texas would change: (32.4%, 37 of 114 agreed; 28.1%, 32 of 114 were neutral; and 39.5%, 45 of 114 disagreed).

**Physical and Mental Health Outcomes**

All respondents reported statistically significantly lower overall mental health scores than national averages (Table 4). Physical health scores for women, however, were significantly higher than national averages. In multiple linear regression models assessing associations between physical and mental health composite and demographic covariates, there were no statistical differences in scores when adjusted by sex, age, ethnicity, or length of residence in the ZIP code (data not shown).

**Discussion**

Residents of Houston, Texas, using public parks in the months following Hurricane Harvey report feeling certain that their communities, including parks and recreational areas, were impacted by pollution associated with flooding. Although they consistently report a desire for more information about potential contamination and health effects, even at the time of the survey that was conducted 6 months after Hurricane Harvey, residents have a positive outlook about dealing with contamination and its subsequent health effects. Additionally, residents report a willingness to take individual- and household-level actions to mitigate any associated health impacts.

We found significantly lower self-reported mental health composite scores compared with a national sample. Therefore, resources to address the hurricane’s impacts on emotional health, social functioning, distress, and psychological well-being continue to be important—even months or years after the initial impacts (Shultz & Galea, 2017). While it is not possible to assess the impact that the hurricane had on mental health scores without baseline measures, other studies have indicated that experiencing a major hurricane is significantly associated with an increased risk of poor mental health outcomes, both immediately following and years after a disaster (Heid, Pruchno, Cartwright, & Wilson-Genderson, 2017; Schwartz, Rasul, et al., 2018; Schwartz, Tuminello, et al., 2018). Mental health resources should be readily available to residents of Houston not only in the immediate aftermath of Hurricane Harvey when this type of assistance is usually supported by state and federal disaster funds but also into the future (Texans Recovering Together, 2018).

While some instances of contamination have been documented following Hurricane Harvey (Bajak & Olsen, 2018; Friedrich, 2017; Schwartz, Tuminello, et al., 2018), little is known about the extent of the contamination or the potential for long-term health consequences. As of March 2018, the State of Texas had investigated approximately 90 incidents of potential contamination but had taken no enforcement or regulatory action (Bajak & Olsen, 2018). By August 2018, a year after Hurricane Harvey’s landfall, state environmental authorities finally began enforcement actions (Olsen, 2018). In a November 2018 report issued by the Governor’s Commission to Rebuild Texas, however, the focus at the state level remained on documenting regulatory waivers granted, with a focus on expediting suspensions of regulations in response to future disasters (Sharp, 2018).

Many more areas that were inundated with floodwaters have either not been tested or results have not been disseminated to the public. Clearly, it remains important to continue to provide information to residents, even when many areas of the city are perceived as successfully recovering. Information should include recommendations for practical and easily actionable ways of decreasing exposure, as the majority of respondents desire to feel certain about the

<table>
<thead>
<tr>
<th>Emotional Response Toward Environmental Pollution Caused by Hurricane Harvey (N = 117)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emotional Response</strong></td>
</tr>
<tr>
<td>Afraid (n = 89)</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Angry (n = 107)</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Inspired (n = 104)</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Proud (n = 101)</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Agree</td>
</tr>
</tbody>
</table>

*Statistically significant at p < .05.
environmental pollution caused by Hurricane Harvey and the health impacts associated with such pollution, and report that they are able to complete household-level tasks in order to prevent health impacts.

Based on the results of this study, as well as the limited data available from New Orleans following Hurricane Katrina, it is important to document both physical damage and potential environmental contamination in public parks and recreational areas impacted by a disaster. During normal times, parks can provide physical and mental health benefits to those who use them, benefits that could be amplified postdisaster. As a way of coping with disaster impacts, residents continue to use recreation facilities after disasters, even when they are concerned about the impacts of environmental pollution on the parks. Future research should explore creative ways local public health agencies and other organizations involved in disaster response and recovery at the community level can use parks as an avenue to disseminate information and resources following a disaster. Public health messaging should include information about the health impacts associated with environmental pollution as well as practical, household-level tasks people can do to decrease their exposure.

This study has several important limitations. Although interviews were conducted on both weekdays and weekends, selection bias might have been introduced if certain types of residents were more likely to use the parks during the times when surveys were conducted. Surveys were conducted up to 6 months after Hurricane Harvey affected the Houston area. Given the catastrophic nature of the flooding that impacted Houston and surrounding areas, however, it is unlikely that recall bias would be an issue. We used the term “community” to spatially define the area around the parks, with survey questions asking residents about their perceptions to environmental contamination in the surrounding area, and not the specific park they were using when interviewed, which may have resulted in misclassification. Using ArcMap version 10.4.2, we geocoded the residential address of each respondent and estimated the distance from the center of each participant’s residential ZIP code to the park where the participant was surveyed. Most of the respondents lived near the park where they were interviewed, with the residential mean center of the respondent’s home address being between 1.25 and 8.54 miles of the park where they were surveyed.

**Conclusion**

In an effort to mitigate the growing risk of urban flooding associated with increases in the proportion of impervious surfaces, cities frequently use recreational areas for flood control. Following a disaster, this practice could potentially expose residents using parks to environmental contamination from transported sediments, pesticides from runoff, or bacteria from sewage. Our study

<p>| TABLE 4 |
|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th><strong>Two-Tailed t-Test of Mean Values of Physical and Mental Health Composite Scores Compared With National Mean Values (N = 117)</strong></th>
<th>( t )-Test Value</th>
<th>Mean</th>
<th>95% Confidence Interval (CI)</th>
<th>( p )-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Health T-Score (SF-12) (n = 113)</strong></td>
<td>( t )-Test Value</td>
<td>48.88</td>
<td>45.99, 51.77</td>
<td>.44</td>
</tr>
<tr>
<td>Male</td>
<td>-0.78</td>
<td>50.90</td>
<td>49.22, 52.58</td>
<td>.29</td>
</tr>
<tr>
<td>Female</td>
<td>2.25</td>
<td>52.33*</td>
<td>50.25, 54.41</td>
<td>.03</td>
</tr>
<tr>
<td>Age</td>
<td>1.06</td>
<td>52.52</td>
<td>50.05, 54.98</td>
<td>.05</td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>2.07</td>
<td>49.78</td>
<td>47.49, 52.08</td>
<td>.85</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-0.19</td>
<td>50.72</td>
<td>48.24, 53.19</td>
<td>.56</td>
</tr>
<tr>
<td>Length of residence &lt; 5 years</td>
<td>0.58</td>
<td>51.25</td>
<td>48.73, 53.76</td>
<td>.32</td>
</tr>
<tr>
<td>Length of residents &gt; 5 years</td>
<td>1.00</td>
<td>51.25</td>
<td>48.73, 53.76</td>
<td>.32</td>
</tr>
<tr>
<td><strong>Mental Health T-Score (SF-12) (n = 113)</strong></td>
<td>( t )-Test Value</td>
<td>43.76*</td>
<td>40.67, 46.85</td>
<td>.00</td>
</tr>
<tr>
<td>Male</td>
<td>-4.09</td>
<td>45.49*</td>
<td>42.96, 48.01</td>
<td>.00</td>
</tr>
<tr>
<td>Female</td>
<td>-3.58</td>
<td>44.92*</td>
<td>43.01, 46.83</td>
<td>.00</td>
</tr>
<tr>
<td>Age</td>
<td>-5.28</td>
<td>46.50*</td>
<td>43.76, 49.24</td>
<td>.01</td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>-2.59</td>
<td>43.83*</td>
<td>41.18, 46.48</td>
<td>.00</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-4.67</td>
<td>43.83*</td>
<td>40.92, 46.74</td>
<td>.00</td>
</tr>
<tr>
<td>Length of residence &lt; 5 years</td>
<td>-4.27</td>
<td>43.83*</td>
<td>40.92, 46.74</td>
<td>.00</td>
</tr>
<tr>
<td>Length of residents &gt; 5 years</td>
<td>-3.09</td>
<td>45.89*</td>
<td>43.22, 48.57</td>
<td>.00</td>
</tr>
</tbody>
</table>

*Statistically significant at \( p < .05 \).
showed that residents desire more information about potential risks to health from these exposures and are willing to take mitigating actions if made aware of their necessity and effectiveness.

**Acknowledgements:** Dedicated to the memory of our friend and colleague, Emily A. Rauscher. Research reported in this article was supported by the National Institute of Environmental Health Sciences within the National Institutes of Health (NIH) under award numbers P30 ES023512-04 and P42 ES027704. The content is solely the responsibility of the authors and does not necessarily represent the official views of NIH. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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**References**


References continued from page 15


For 24 years, NEHA and the American Academy of Sanitarians (AAS) have partnered to offer scholarships to deserving environmental health students. The purpose of the NEHA/AAS Scholarship Program is to encourage students to make an early commitment to a career in environmental health and to inspire graduates to pursue postgraduate studies in environmental health sciences. Three scholarships were awarded this year. Meet the 2020 scholarship awardees at www.neha.org/membership-communities/get-involved/day-in-life/meet-2020-student-scholarship-awardees.

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An Assessment of Disinfection-Related Water Chemistry at Public Pools and Spas in Louisville, Kentucky

Thomas Gerding, MPH  
Department of Environmental Health Science, Eastern Kentucky University  
Tim Wilder, RS  
Department of Public Health and Wellness, City of Louisville  
Jason W. Marion, MS, PhD  
Department of Environmental Health Science, Eastern Kentucky University

Abstract  The growth in the number of pools to more than 7.4 million in the U.S. has been accompanied by a rise in recreational water illnesses (RWIs). Effective pool management, though, can mitigate RWI risks. Inadequate management presumably occurs more frequently where training is less formalized and/or pool operation is a minor aspect of the job of the responsible pool manager(s). During summer 2018, weekly evaluations were performed at public venues in Louisville, Kentucky. Disinfectant levels and other items were monitored and compared with venue-specific (pool or spa) criteria. Among 1,312 venue surveys, 1,173 (89.4%) met criteria and 139 (10.6%) did not meet criteria. Overall, multivariable logistic regression showed a significant association between the likelihood of a venue meeting criteria and setting type. Specifically, hotels had 120% increased odds of not meeting criteria (adjusted odds ratio = 2.2; 95% confidence interval [1.3, 3.8]) compared with other settings. Despite spas having an 80% elevated odds of not meeting criteria compared with pools in a univariate analysis, upon adjusting for setting, spas were not associated with an increased risk of not meeting criteria. Research identifying reasons for these differences in meeting criteria between settings would be beneficial for informing public health interventions for aquatic environments.

Introduction  With more than 7.4 million swimming pools in the U.S. as of the mid-2000s (Otto, 2006) there are typically between 300 million and 350 million swimming instances occurring annually in the U.S., making swimming one of the top four recreational activities in the U.S. (Otto, 2006; U.S. Census Bureau, 2009). With a substantial proportion of the U.S. population using pools, an accompanying substantial number of recreational water illnesses (RWIs) have been documented, including 27,219 illnesses and 8 deaths attributable to 493 reported outbreaks of RWIs from treated recreational water environments from 2000–2014 (Hlavsa, Kunz, & Beach, 2017). The frequency of RWIs is underestimated by outbreak reporting alone, as many RWIs are one of the following: not reportable conditions, not severe enough in affected patients to seek clinical evaluation, not able to be associated with recreational water exposure, and/or not part of a reported recreational water-related outbreak.

Effective pool management decreases the risk of users contracting RWIs. In studies examining 22,131 and 84,187 pool inspections in the U.S. from 2002 and 2013, respectively, 8.3% and 12.3% of the inspections warranted immediate closure of the pool being inspected (Centers for Disease Control and Prevention [CDC], 2003; Hlavsa et al., 2016). The most frequent violations observed in both studies were related to disinfection inadequacies specifically pertaining to disinfectant concentrations, pH, and chemical feeders. Inadequacies pertaining to pool disinfection can present harmful chemical exposure opportunities or enhance the survivability and/or growth of pathogens including but not limited to Pseudomonas aeruginosa, Cryptosporidium, Giardia, norovirus, and toxigenic E. coli (Black, Keirn, Smith, Dykes, & Harlan, 1970; Hlavsa et al., 2015; Seyfried & Fraser, 1980; Shields, Gleim, & Beach, 2008). Therefore, inadequate adherence to sound disinfection protocols enhances risks for respiratory, ocular, and cutaneous ailments among pool visitors and workers (Fantuzzi et al., 2010; Nickmilder & Bernard, 2007). Furthermore, swimmer shedding of microbial flora (including potential pathogens) occurs in aquatic environments (Gerba, 2000; Smith & Dufour, 1993) and when coupled with insufficient disinfection, this situation presents an increased infectious disease risk to recreators. Studies on untreated recreational waters have demonstrated a positive association between densities of fecal indicator organisms in water and the risk of experiencing a swimming-associated gas...
traintestinal illness (Pruss, 1998; Wade, Pai, Eisenberg, & Colford, 2003), and this risk is greater when the contamination is of human origin (Soller, Schoen, Bartrand, Ravenscroft, & Ashbolt, 2010).

An analysis of treated recreational water-associated outbreaks by Hlavsa and coauthors (2017) indicates that the leading setting associated with 32% of the outbreaks from 2000–2014 were within hotel environments. Data on the population size recreating in hotel environments could be unknown, which limits recreational water-associated illness risk comparisons with other settings. Furthermore, among outbreaks with unidentified etiologies, hotel settings were linked to 56% of these 108 outbreaks between 2000 and 2014 (Hlavsa et al., 2017). In 2016, it was noted that studies on inspection failures could hold some utility for understanding setting-specific intervention opportunities that might reduce setting-specific RWIs including outbreaks; however, these types of data analyses were not possible due to their inspection forms and subsequent data being limited to pool category and not including setting (Hlavsa et al., 2016). Upon using data with pool setting documented, as done in a Georgia statewide analysis (N = 4,441), hotels and motels (n = 1,133) led the state in noncompliance related to disinfection residual concentrations and pH levels with 287 and 205 violations, respectively. In comparison, subdivision pools were the most numerous setting type in the 2014 Georgia database (n = 1,179) and had 113 and 64 events related to noncompliance in the disinfection residual concentrations and pH levels, respectively (Shack, Redmond, & Rustin, 2016).

While there has been much evidence published on the relationship between improperly managed swimming facilities, bacterial growth, and its association to outbreaks of RWIs, little research exists demonstrating the role of pool setting and how local health departments (LHDs) can tailor educational interventions with their business sectors and various pool operators so together they can be partners in protecting and promoting public health while preventing disease. Prior to developing sector-specific interventions related to pool health, data can help inform need. In this study, based upon prior observations reported in the literature, it was hypothesized that hotel swimming pools would be at greater risk for inspection failure than other settings and thus could be an area or sector whereby future in-depth study or tailored interventions might be warranted.

**Methods**

During summer 2018, data were collected from approximately one third of the public pools present in the Louisville metropolitan area of Jefferson County, Kentucky. Overall, 143 locations, many with more than one body of water (venue), were visited once per week from the end of May 2018 until the middle of August 2018. Each location was visited on the same day of the week, excluding days with inclement weather. During each visit, the pH, free chlorine, and alkalinity were screened using a LaMotte Insta-Test test strip. If free chlorine levels were out of range after the screening, either <1.00 ppm or >3.00 ppm (or <2.00 ppm or >6.00 ppm if the pool used bromine instead of chlorine), the water was then measured using a DPD (anhydrous N,N-diethyl-p-phenylenediamine) method, thereby providing a more accurate result.

For spas, the Louisville Metro Department of Public Health and Wellness states that standard spa chlorination should range from 2.0–3.0 ppm and the temperature should not exceed 104 °F (40.0 °C) (Louisville–Jefferson County Metro Government, 2020). Beyond pool chemistry, additional observations regarding pool environment safety were made during these visits. For any issues warranting further investigation in the interest of public health and safety, the health inspector in-charge was immediately notified for follow-up and intervention as needed.

The data collected throughout the day were logged daily into Microsoft Excel denoting the following:

1. survey location;
2. date of visit;
3. survey route used;
4. presence or absence of chlorine/bromine;
5. if the disinfectant was within, above, or below range;
6. general comments;
7. indoor or outdoor facility;
8. the facility setting (e.g., apartment, gym, swim school, hotel, etc.);
9. the inspection venue (i.e., pool or hot tub/spa);
10. number of water bodies present (e.g., pools, spas, etc.);
11. the pool pump manufacturer; and
12. pool filter manufacturer.

Data were unavailable for a majority of the pump and filter manufacturers and were therefore not included in the data analysis. Stata 15 was used for performing the statistical analysis. Descriptive statistics including means and frequencies were first examined to explore the value in later hypothesis testing. Crude and multivariable logistic regression analyses were then performed. For multivariable analyses, data were treated as clustered by primary sampling unit (PSU) with the svyset command in Stata. PSUs were the sample location identifiers previously established by the health department.

Upon developing the most parsimonious multivariable model, a saturated model was developed using all the significant (p < .05) and marginally associated (p < .15) terms from the individual crude analyses and then variables were removed sequentially by backward elimination. The independent variable of interest was the categorical variable pertaining to setting type (e.g., hotel, apartment/condominium, other) and the dependent variable was compliance (coded dichotomously for did or did not meet criteria). Continuous terms such as the number of venues (sum of the pools and hot tub/spas) at a setting and water body size were also examined in the models as categorical and/or on a log5 scale. Final models were examined for model fit using the Hosmer–Lemeshow goodness of fit test and model discrimination using the area under the receiver operator characteristic (ROC) curve.

**Results**

Overall, a total of 1,312 surveys were performed across 142 different settings. Complete data were gathered and entered for 1,284 (98%) of these surveys. Most surveys involved pools or hot tubs/spas in apartment complexes and condominium communities (n = 544), followed by other settings (n = 402), and hotels/motels (n = 366). Within the classification of “other,” fitness centers, clubs, and community/neighborhood pools represented 318 of the 402. Results from t-testing and Mann–Whitney testing demonstrated that hotel pools were on average and by rank (smallest to largest) significantly smaller in size (by volume) than both apartment/condominium pools and the other
pools (p < .0001). In gallons, the median size hotel venue (pools and spas) was 12,600 gallons versus 31,600 gallons for apartments/condominiums and 79,400 gallons for other pools (Table 1).

Overall, among the 1,312 venue surveys, 1,173 (89%) were observed to meet disinfection criteria. Among the 139 (11%) observed not meeting criteria, 66 (47%) were from observations occurring at hotel/motel settings (Table 2). The hotel setting (n = 366) represented 28% of all surveys. Univariate logistic regression provides the crude odds ratio (cOR) not adjusting for other factors and suggests that the odds of not meeting criteria were 160% (cOR = 2.6) higher in the hotel/motel setting compared with all nonhotel/motel settings and 250% higher (cOR = 3.5) than the “other” setting, which includes all settings except apartment/condominium pools. Crude analysis also suggested that indoor locations, spas, and survey routes E and L were linked to significant (p < .05) increased odds (cOR > 1.0) of not meeting criteria (Table 2). Chlorine treatment, more pools/spas, and larger venues were associated with a significantly lower likelihood of not meeting criteria (cOR < 1.0) and therefore were more likely to meet disinfection criteria (Table 2).

For evaluating the relationship between hotel/motel settings and meeting disinfection criteria more thoroughly, the most parsimonious multivariable model was created, which accounted for the clustering effect of sampling by the 142 PSUs and adjusting for significant covariates. Table 3 demonstrates that venue size in log10 gallons, survey route, and number of venues at a location were significant (p < .05) covariates. The other covariates that were significant in Table 2 but not present in the model in Table 3 were removed sequentially using the backward elimination approach as they were no longer significant, possibly being explained better by the terms that remained. Ultimately, the final multivariable model provides adjusted odds ratios (aOR), demonstrating that the adjusted odds of not meeting criteria were 120% higher (aOR = 2.2; 95% confidence interval [CI] [1.3, 3.8]) among hotels/motels than nonhotel/motel settings. Larger water volumes and more venues at the survey locations were associated with an increased likelihood of meeting criteria. The overall model discrimination using the area under the ROC curve was 69% and the model achieved adequate fit whereby there was no difference (p > .05) between the fitted modeled results and the actual observations.

Spas and indoor pool settings did not appear to significantly influence the final model in Table 3. When in the adjusted model, neither spas (p = .652) or indoor pools (p = .720) were significant and were dropped. In the crude univariate analysis (Table 2), both terms were associated with a significant increase in the odds of not meeting criteria (OR > 1.0; p < .05). Furthermore, hotel settings are significantly more likely to have hot tubs/spas and indoor pools than other settings (chi-square p < .05). Specifically, among 946 surveys in nonhotel environments, only 23 (2.4%) occurred at spas versus 110 (30%) of 366 in hotel environments. Overall, 82% of hotel pool surveys occurred at indoor venues versus 17% of surveys in nonhotel/motel environments. To further explore this issue, additional stratified analyses occurred.

In the case of both pools and spas, the frequency of not meeting criteria was higher in all hotel venues compared to nonhotel setting venues; whereby the frequency of not meeting criteria, regardless of venue, was >18% across hotel strata (Tables 4 and 5). Among hotels, of greatest risk were the outdoor pools with a 23% failure frequency and a 200% greater likelihood of not meeting criteria than nonhotel outdoor pools (aOR = 3.0; 95% CI [1.3, 7.0]; Table 5). Spas in nonhotel settings were not significantly different than pools in nonhotel settings in univariate (cOR) or multivariable analyses as demonstrated by the 95% CI including numbers both below and above 1.0 (Table 4). Similar findings were demonstrated in Table 5 whereby in nonhotel settings, there was no difference in the frequency of meeting criteria among indoor and outdoor pools.

**Discussion**

This study was specifically limited to approximately one third of the public swimming pools and hot tubs/spas located in the Louisville metropolitan area, as these venues were assigned to the lead study investigator before the summer season as part of a defined geographic region. Overall, 10.6% of the total surveys yielded results that indicated disinfection criteria were not being met. While 18% of hotel pool surveys did not appear to meet criteria related to disinfection, the frequency was lower: 9% among apartment/condominium pools and 6% among other setting types. The descriptive results demonstrate that across all sectors there are opportunities for improvement in meeting public health standards. Beyond the apparent challenges observed among hotel/motel settings with respect to meeting disinfection criteria, our study demonstrates that locations with more venues and larger volumes of water are more likely to meet criteria (Tables 2 and 3).

It is plausible that large facilities with larger pools, such as waterparks or recreation centers, view ensuring compliance with greater emphasis because the larger pools are likely to be more essential to their visitors’ experi-

**TABLE 1**

<table>
<thead>
<tr>
<th>Setting Type</th>
<th>Setting Attribute</th>
<th>#</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel/motel</td>
<td>Venues per location</td>
<td>366</td>
<td>1.6</td>
<td>2.0</td>
<td>1.0–2.0</td>
</tr>
<tr>
<td>Hotel/motel</td>
<td>Venue size (log10 gallon)</td>
<td>366</td>
<td>3.9</td>
<td>4.1</td>
<td>0–5.9</td>
</tr>
<tr>
<td>Hotel/motel</td>
<td>Venue size (log10 L)</td>
<td>366</td>
<td>4.5</td>
<td>4.7</td>
<td>0–6.5</td>
</tr>
<tr>
<td>Apartment/condominum</td>
<td>Venues per location</td>
<td>544</td>
<td>1.2</td>
<td>1.0</td>
<td>1.0–3.0</td>
</tr>
<tr>
<td>Apartment/condominum</td>
<td>Venue size (log10 gallon)</td>
<td>544</td>
<td>4.3</td>
<td>4.5</td>
<td>0–5.6</td>
</tr>
<tr>
<td>Apartment/condominum</td>
<td>Venue size (log10 L)</td>
<td>544</td>
<td>4.9</td>
<td>5.0</td>
<td>0–6.2</td>
</tr>
<tr>
<td>Other setting</td>
<td>Venues per location</td>
<td>402</td>
<td>2.8</td>
<td>2.0</td>
<td>1.0–6.0</td>
</tr>
<tr>
<td>Other setting</td>
<td>Venue size (log10 gallon)</td>
<td>402</td>
<td>4.6</td>
<td>4.9</td>
<td>0–5.8</td>
</tr>
<tr>
<td>Other setting</td>
<td>Venue size (log10 L)</td>
<td>402</td>
<td>5.2</td>
<td>5.5</td>
<td>0–6.4</td>
</tr>
</tbody>
</table>
ence and therefore to the venue’s business model than a hotel with a five-person-capacity pool. Additionally, smaller venues might be more likely to experience challenges in terms of both quantity and water volume due to more rapid changes in water quality for a variety of reasons.

The results here are among a few studies that have assessed disinfection-related data with consideration of aquatic setting (Shack et al., 2016). Our results demonstrate a need to assist small pool operators and hotel operators with meeting disinfection criteria. Furthermore, our results appear congruent with reporting related to the Centers for Disease Control and Prevention’s Network for Aquatic Facility Inspection Surveillance, whereby 11.9% of the 64,580 routine inspections performed in 2013 resulted in noncompliance in meeting disinfection standards (Hlavsa et al., 2016). In this study, looking at the 2018 Louisville Metro data, we observed 10.6% of the surveys performed to have not met disinfection criteria.

Beyond inspecting facilities on a regular basis, strategies that put greater emphasis on encouraging the certification of pool operators likely would enhance pool water chemistry simply due to increased education and awareness. This approach has been demonstrated previously in a study where pH levels and combined chlorine levels of inspected pools were significantly more likely to be in compliance in facilities that employed certified pool operators versus noncertified operators (Johnston & Kinziger, 2007). Enhanced communication and stronger encouragement of pool operator certification and/or education with managers of hotels and other public swimming venues go beyond regulatory enforcement, but likely are tantamount for promoting and protecting public health.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Category</th>
<th># of Surveys</th>
<th>Not Meeting Criteria # (%)</th>
<th>cOR (95% CI)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disinfectant</td>
<td>Bromine</td>
<td>274</td>
<td>43 (15.7)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chlorine</td>
<td>1,029</td>
<td>95 (9.2)</td>
<td>0.55 (0.37, 0.81)</td>
<td>.002</td>
</tr>
<tr>
<td>Number of pools/spas</td>
<td>1</td>
<td>734</td>
<td>81 (11.0)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>376</td>
<td>50 (13.3)</td>
<td>1.24 (0.85, 1.80)</td>
<td>.269</td>
</tr>
<tr>
<td></td>
<td>≥3</td>
<td>202</td>
<td>8 (4.0)</td>
<td>0.33 (0.16, 0.70)</td>
<td>.004</td>
</tr>
<tr>
<td>Location setting</td>
<td>Other</td>
<td>402</td>
<td>24 (6.0)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apartment/condominium</td>
<td>544</td>
<td>49 (9.0)</td>
<td>1.56 (0.94, 2.59)</td>
<td>.086</td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>366</td>
<td>66 (18.0)</td>
<td>3.47 (2.12, 5.66)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hotel setting</td>
<td>Other</td>
<td>946</td>
<td>73 (7.7)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hotel</td>
<td>366</td>
<td>66 (18.0)</td>
<td>2.63 (1.84, 3.76)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Size (gallon x 1,000)</td>
<td>&lt;15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>330</td>
<td>48 (14.6)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥15–26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>323</td>
<td>41 (12.6)</td>
<td>0.85 (0.54, 1.32)</td>
<td>.462</td>
</tr>
<tr>
<td></td>
<td>≥26–53&lt;sup&gt;c&lt;/sup&gt;</td>
<td>336</td>
<td>32 (9.5)</td>
<td>0.62 (0.38, 0.99)</td>
<td>.048</td>
</tr>
<tr>
<td></td>
<td>≥53–780&lt;sup&gt;d&lt;/sup&gt;</td>
<td>320</td>
<td>18 (5.6)</td>
<td>0.35 (0.20, 0.62)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Aquatic venue</td>
<td>Pool</td>
<td>1,179</td>
<td>117 (9.9)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spa</td>
<td>133</td>
<td>22 (16.5)</td>
<td>1.80 (1.10, 2.96)</td>
<td>.020</td>
</tr>
<tr>
<td>Indoor/outdoor</td>
<td>Outdoor</td>
<td>843</td>
<td>76 (9.0)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>460</td>
<td>62 (13.5)</td>
<td>1.57 (1.10, 2.25)</td>
<td>.013</td>
</tr>
<tr>
<td>Inspection route</td>
<td>F</td>
<td>449</td>
<td>30 (6.7)</td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>410</td>
<td>62 (15.1)</td>
<td>2.49 (1.57, 3.93)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>231</td>
<td>18 (7.8)</td>
<td>1.18 (0.64, 2.17)</td>
<td>.593</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>203</td>
<td>26 (12.8)</td>
<td>2.05 (1.18, 3.57)</td>
<td>.011</td>
</tr>
</tbody>
</table>

<sup>a</sup><56,000 L.  
<sup>b</sup>≥56,000–98,000 L.  
<sup>c</sup>≥98,000–201,000 L.  
<sup>d</sup>≥201,000–295,000 L.
For instance, free chlorine and pH violations during routine pool inspections in Nebraska were twice as likely to occur at locations not requiring pool operators to be certified (Buss et al., 2009). Similar benefits of training were again observed outside the U.S. in Croatia (Bilajac, Vukić Lušić, Dokonjšček, & Rukavina, 2012).

Operator certification and training are described in the Model Aquatic Health Code (MAHC), which comprises voluntary guidelines for authorities updating or establishing codes related to aquatic facilities (CDC, 2018). The MAHC includes provisions for facilities to have qualified operators. Operators are credentialed by the authority having jurisdiction through participation in training recognized by the authority. The MAHC identifies water disinfection and water chemistry as two of the four minimum teaching elements for training (CDC, 2018). Also included in the MAHC are provisions aimed at reducing pool chemical injuries. Mini-MAHCs have been developed, including one on pool chemical injuries because there are more than 13,000 estimated annual emergency room visits associated with pool chemical exposures in public and residential environments (Laco, Hubbard, & McClenahan, 2020; Vanden Esschert et al., 2019).

Continued surveillance on public swimming pools is essential for public health, as swimming and water recreation have become more popular in recent decades. Given that more than 1,000 illnesses from RWI outbreaks occur annually, with many more occurring outside of outbreaks, it is clear that monitoring swimming facilities remains necessary (Otto, 2006). CDC and the National Environmental Health Association offer pool inspection training and an Aquatic Inspector app for iPads as a way to support monitoring efforts (Laco et al., 2020).

Based on research by Rose and Ludwig (2009), increasing regular communication between LHDs and public entities has the potential to reinforce compliance with health standards. Working together, businesses, LHDs, and nongovernmental organizations can potentially usher in a sharing of useful resources and data. This approach ultimately can improve aquatic facility staff’s understanding that environmental health professionals are willing to be partners in public health, answer questions, and share advice related to best management practices (Beatty, Harris, & Barnes, 2010).

**Limitations**

The schedule might have biased the results because each location was planned to be inspected on the same day each week based on the specific routes; therefore, the survey times could have been predicted by operators. Additionally, a higher rate of patronage would be expected on the weekend than on the weekday sample dates. Despite awareness of an impending arrival of a surveyor, not meeting pool disinfection standards remained common and more problematic pool chemistry might have existed in higher frequencies on dates where inspections were not expected or on the weekends.

Our study might not be applicable to all of Louisville, Jefferson County, Kentucky, or larger geographic areas. The pools studied were all assigned to the same surveyor covering the east side of the metropolitan area. Almost no pools or spas near the city

### TABLE 3

**Multivariable Logistic Regression Model and Associated Adjusted Odds Ratios Demonstrating the Relationship Between a Finding of Not Meeting Criteria And Various Covariates**

<table>
<thead>
<tr>
<th>Covariate</th>
<th>β</th>
<th>Wald’s t</th>
<th>p-Value</th>
<th>aOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel pool/spa</td>
<td>0.802</td>
<td>3.00</td>
<td>.003</td>
<td>2.23 (1.32, 3.78)</td>
</tr>
<tr>
<td>Pool size (log₁₀ L)</td>
<td>-0.254</td>
<td>-2.38</td>
<td>.018</td>
<td>0.78 (0.63, 0.96)</td>
</tr>
<tr>
<td>Route F</td>
<td>Referent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route E</td>
<td>0.604</td>
<td>1.77</td>
<td>.078</td>
<td>1.83 (0.93, 3.59)</td>
</tr>
<tr>
<td>Route G</td>
<td>0.263</td>
<td>0.78</td>
<td>.435</td>
<td>1.30 (0.67, 2.52)</td>
</tr>
<tr>
<td>Route L</td>
<td>0.720</td>
<td>1.97</td>
<td>.051</td>
<td>2.05 (1.0, 4.22)</td>
</tr>
<tr>
<td>Number of pools/spas</td>
<td>-0.305</td>
<td>-2.27</td>
<td>.025</td>
<td>0.74 (0.56, 0.96)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.136</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aOR = adjusted odds ratio; CI = confidence interval.

* OR values with a 95% CI range >1.0 are associated with a greater likelihood of not meeting criteria. aOR values with a 95% CI range <1.0 are associated with a greater likelihood of meeting criteria.

When expressed in log₁₀ gallon: β = 0.758; t = -2.35; aOR (95% CI) = 0.76 (0.60, 0.96); and p = .020.

### TABLE 4

**Univariate and Multivariable Analysis for Frequency of Meeting Disinfection Criteria by Hotel Pools and Spas Versus Nonhotel Pools and Spas**

<table>
<thead>
<tr>
<th>Covariate</th>
<th># of Surveys</th>
<th>Does Not Meet Criteria # (%)</th>
<th>cOR (95% CI)</th>
<th>aOR (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonhotel pool</td>
<td>923</td>
<td>72 (7.8)</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td>Nonhotel spa</td>
<td>23</td>
<td>1 (4.4)</td>
<td>0.54 (0.07, 4.0)</td>
<td>0.51 (0.21, 1.26)</td>
</tr>
<tr>
<td>Hotel pool</td>
<td>256</td>
<td>45 (17.6)</td>
<td>2.52 (1.69, 3.77)</td>
<td>2.21 (1.25, 3.93)</td>
</tr>
<tr>
<td>Hotel spa</td>
<td>110</td>
<td>21 (19.1)</td>
<td>2.79 (1.63, 4.75)</td>
<td>2.02 (0.88, 4.67)</td>
</tr>
</tbody>
</table>

cOR = crude odds ratio; aOR = adjusted odds ratio; CI = confidence interval.

*The adjusted model expressed includes covariates included in the final model from Table 3.

**Note.**Italicized numbers indicate p < .10. Italicized and bolded numbers indicate p < .05.
center were included. The results given in the study might show a greater frequency of meeting disinfection criteria than other communities due to the active nature of the health department with respect to aquatics compared with other departments. Lastly, the statistical model in Table 3 achieved nearly 70% discrimination in detecting surveys whereby the disinfection criteria were not met. More variables, such as knowledge of pumps, filter models, and other factors also could have influenced results. Due to limited operator recordkeeping of pump and filter models, some variables could not be studied. Also, when stratifying, some of the strata reflected a low number of pools. This finding suggests that larger studies, possibly even national studies, are warranted to confirm these results for informing interventions to enhance pool chemistry compliance.

Conclusion
The results from our study demonstrate the location or setting of aquatic venues (pools and spas) are linked to compliance. Statistically significant differences ($p < .05$) were observed between hotel and nonhotel settings with respect to the frequency of their venues meeting disinfection criteria. These results suggest a need for further research into why this difference exists between facility setting types, because this information could inform intervention opportunities. Additionally, our study validated the idea that as more aquatic venues are present at one location, the location is more likely to meet criteria overall. Larger facilities with aquatics being central to their operations can invest greater resources toward responsible pool maintenance and compliance for preventing pool closures; however, more research is needed to validate this claim. Larger studies with a regional or national focus could further validate the observations in our study, which could enable better interventions for protecting the health of people in the U.S. who engage in aquatic recreation.

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The Call for Abstracts for the NEHA 2021 Annual Educational Conference (AEC) & Exhibition, July 13–16, 2021, in Spokane, Washington, will be open from August 24–October 2. Those that submitted abstracts for the canceled 2020 AEC are strongly encouraged to resubmit. Visit www.neha.org/aec for information about the 2021 AEC and the abstract submission process.
Carbon Monoxide Exposure and Reported Health Conditions Among Filling Station Attendants in Ibadan, Nigeria

Abstract

High carbon monoxide (CO) concentrations can elicit adverse health effects. We assessed CO concentrations at filling stations and determined carboxyhemoglobin (%COHb) levels and health problems reported by filling station attendants (FSAs) via questionnaires. This cross-sectional design studied 20 filling stations from Ibadan North Local Government, Nigeria. Outdoor CO concentrations (ppm) were measured for 8 weeks in August–September 2015 from 8:00–10:00 a.m. and 12:00–2:00 p.m., and %COHb levels were measured among 100 FSAs. Data collected were analyzed using Student’s t-test and analysis of variation (p = .05) and compared with relevant guideline limits. Mean CO concentrations in morning (15.4 ± 2.1 ppm) and afternoon (11.6 ± 1.4 ppm) were higher (p < .01) than the World Health Organization (WHO) guideline of 9.0 ppm. Mean %COHb for FSAs (11.1 ± 2.6) was significantly higher (p < .01) than the WHO guideline of 2.5%. Among respondents, 13.4% of FSAs vomited and 14.9% of FSAs experienced nausea. FSAs need personal protective equipment and filling stations should modernize pump delivery systems to minimize exposures.

Introduction

Carbon monoxide (CO) is a widely distributed air pollutant. It is a colorless, odorless, and tasteless gas that is poorly soluble in water. CO has a high affinity to hemoglobin and reacts readily by binding reversibly to one of the heme proteins to form carboxyhemoglobin (COHb) in the human body and thus reduces oxygen-carrying capacity of the blood. In humans, COHb is a biomarker and indicates exposure to CO. Upon reaching the lungs, CO diffuses rapidly across the alveolar and capillary membranes into the bloodstream and readily crosses placental membranes. CO exposure is a significant cause of accidental poisonings and causes many deaths annually in Europe and the U.S. (World Health Organization [WHO], 2000).

Banjoko and coauthors (2008) investigated %COHb levels among smokers and non-smokers in Ibadan city, Nigeria, and reported significantly different (p < .05) %COHb mean values of 4.1 ± 0.99 and 2.0 ± 0.89, respectively, while the overall range was reported to be 0.7–6.5% among the exposed (smokers) and unexposed (nonsmokers) groups. Furthermore, the overall mean %COHb of respondents (2.7%) exceeded the World Health Organization’s (WHO) guideline limit of 2.5% COHb (WHO, 2000).

There are an estimated 5,000 petrol stations in Nigeria with more than 100,000 filling station workers exposed to petrol fumes and air pollutants from vehicle exhaust as they dispense fuel into tanks of automobiles and trucks on a daily basis (Akintonwa & Oladele, 2003). According to the Government of Canada (2020), approximately 3,950 persons work as service station attendants in the province of Ontario, Canada, with nearly half (49%) of them working year-round. In comparison, the U.S. Bureau of Labor Statistics (2020) estimated the number of service station attendants in the U.S. at 20,070. These numbers raise a serious public health concern regarding concentrations of air pollutants that filling stations workers are exposed to and subsequent adverse health outcomes. These adverse outcomes are not easily determined due to the absence of pre-employment health examinations and routine medical checkups (Udonwa, Uko, Ikpeme, Ibanga, & Okon, 2009).

Limited information on ambient air quality in smaller cities/urban areas in less developed countries exists, especially with respect to specific outdoor work microenvironments and the health and safety of susceptible, vulnerable population subgroups. Therefore, this study assessed and provided information on the exposure levels of workers at filling stations (filling station attendants [FSAs]) to CO and the likelihood of these attendants developing adverse health outcomes, particularly acute symptoms, in Ibadan, Nigeria. Currently, there are no local standards or guidelines protecting occupational health and safety of FSAs in Nigeria. Additionally, Kuranchie and coauthors (2019) described
neighboring Ghana’s occupational safety and health laws for pump workers as weak.

In the U.S., the risk of exposure remains relevant, for example, in the State of New Jersey, where people must pay paid attendants to pump unleaded and diesel gas. In New Jersey, the Retail Gasoline Dispensing Safety Act and Regulations (Retail Gasoline Dispensing Safety, n.d.) is aimed at protecting FSAs in New Jersey and mitigating risks of exposure to hazardous conditions.

**Methods**

**Study Area**
The study area was Ibadan North Local Government Area in Ibadan city, Nigeria. Ibadan (7°22’39” N; 3°54’21” E) is approximately 119 km (74 miles) northeast of Lagos and 120 km (75 miles) east of the Nigerian international border with the Republic of Benin. The city ranges in elevation from 150–275 m above sea level. Ibadan has a tropical wet and dry climate with a lengthy wet season and relatively constant temperatures throughout the course of the year. The mean total rainfall for Ibadan is 1,420 mm. There are two peaks for rainfall, June and September. The mean maximum temperature is 26.5 °C, minimum is 21.4 °C, and the relative humidity is 74.6%.

**Sampling and Selection of Filling Stations**
We used a systematic sampling procedure to select filling stations for this study. We randomly selected a local government area and then chose 50% of the 40 active filling stations (at the time of the study) within the selected area for the study. Therefore, 20 active filling stations were selected for the study by selecting every other filling station on the list. We recruited 100 FSAs who were nonsmokers, approximately 50% of the total number of survey respondents, from the 20 selected filling stations for human exposure assessment using a convenience sampling method whereby only willing consenting persons were recruited.

**Questionnaire Survey**
A semistructured, interviewer-administered questionnaire was given in order to determine the sociodemographic characteristics and specific health problems experienced by FSAs over the year prior to answering this study’s questionnaire. We recruited 201 FSAs who were nonsmokers as voluntary participants from the 20 filling stations we had selected for the survey.

**Carbon Monoxide Monitoring**
CO measurements were taken from 8:00–10:00 a.m. and 12:00–2:00 p.m. using a CO 10 Extech meter. Measurements were taken 5 days a week for a period of 8 weeks between August and September 2015 across the 20 filling stations.

**Carboxyhemoglobin Determination**
A noninvasive pulse CO-oximeter Rad-57 was used to assess the %COHb levels of each of the 100 study participants. The equipment had a sensor with which measurement was taken by placing the sensor on the fingertip of the person. Rad-57 had built-in software to automatically calibrate the equipment. The sensor was placed on the subject’s index finger and readings from the CO-oximeter Rad-57 were automatically displayed on the screen. These readings were then recorded.

**Statistical Analysis**
Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS).
Descriptive statistics were used to initially summarize data, including the CO concentrations at the filling stations. Analysis of variance (ANOVA) was used to compare CO concentrations across the filling stations. Mean ± standard deviation and range of %COHb was determined for FSAs and then compared with the WHO guideline limit of 2.5% COHb. Student’s t-test was used to compare %COHb levels of FSAs and guideline limits at .05 level of significance.

This study was approved by the University of Ibadan Institutional Review Board.

Results

Sociodemographic Characteristics of Respondents

The sociodemographic characteristics of the respondents are presented in Table 1. Of the respondents, 60.7% were male and 39.3% were female. As shown in Figure 1, the age of FSAs ranged between 18 and 41 years, with a mean age of 24.8 ± 5.5 years. Marital status among FSAs was: single (67.2%), married (30.8%), divorced (1.5%), and separated (0.5%). Educational status among FSAs showed that 0.5% had no formal education while 7.5%, 45.8%, and 46.3% had primary (elementary), secondary (high school), and tertiary (college or university) education, respectively.

Common Symptoms and Health Conditions

A summary of the distribution of symptoms and health conditions among survey participants is shown in Table 2. During the year prior to this study, 41.8% and 15.9% of FSAs experienced coughing and shortness of breathing, respectively. Furthermore, 23.4% of FSAs had suffered from a sore throat, while 45.8% of FSAs had sneezed frequently. Of respondents, 13.4% and 14.9% of FSAs vomited and had experienced nausea, respectively. Moreover, 59.7% of FSAs experienced headaches, while 32.8% of FSAs had chest pain. Additionally, 8.0% of FSAs had dermatitis, while 31.8% of FSAs experienced eye irritations. Only 7.5% of FSAs had other forms of allergies.

When asked about their current state of health, an excellent state of health was reported by 36.8% of respondents. Many FSAs (48.8%) reported a good state of health, while only 14.4% reported a fair state of health. Regarding current symptoms, 64.7% of respondents did not know when they experienced relief from symptoms; however, 10.4% did experience relief right after leaving the filling station, while 18.9% experienced relief overnight, 3% on weekends, and 3% never had relief. In addition, to manage symptoms, 57.2% of FSAs self-medicated, while 22.4% visited hospitals for treatments. Regarding other treatments, 11.4% of respondents visited local pharmacists/chemists for treatments, while 2.5% of FSAs consulted herbalists for treatments. No form of treatment was reported by 6.5% of FSAs.

### Table 2

<table>
<thead>
<tr>
<th>Symptom/Condition</th>
<th>Yes # (%)</th>
<th>No # (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>120 (59.7)</td>
<td>81 (40.3)</td>
</tr>
<tr>
<td>Sneezing</td>
<td>92 (45.8)</td>
<td>109 (54.2)</td>
</tr>
<tr>
<td>Cough</td>
<td>84 (41.8)</td>
<td>117 (58.2)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>66 (32.8)</td>
<td>135 (67.2)</td>
</tr>
<tr>
<td>Eye irritation</td>
<td>64 (31.8)</td>
<td>137 (68.2)</td>
</tr>
<tr>
<td>Sore throat</td>
<td>47 (23.4)</td>
<td>154 (76.6)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>32 (15.9)</td>
<td>169 (84.1)</td>
</tr>
<tr>
<td>Nausea</td>
<td>30 (14.9)</td>
<td>171 (85.1)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>27 (13.4)</td>
<td>174 (86.6)</td>
</tr>
<tr>
<td>Dermatitis</td>
<td>16 (8.0)</td>
<td>185 (92.0)</td>
</tr>
<tr>
<td>Other allergies</td>
<td>15 (7.5)</td>
<td>186 (92.5)</td>
</tr>
<tr>
<td>Asthma</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Filling Station Location</th>
<th>Morning (8:00–10:00 a.m.) Mean ± SD (ppm)</th>
<th>Afternoon (12:00–2:00 p.m.) Mean ± SD (ppm)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.8 ± 2.9</td>
<td>9.3 ± 0.5</td>
<td>.029</td>
</tr>
<tr>
<td>2</td>
<td>15.3 ± 3.9</td>
<td>11.5 ± 2.2</td>
<td>.068</td>
</tr>
<tr>
<td>3</td>
<td>18.5 ± 2.2</td>
<td>13.2 ± 0.8</td>
<td>.001</td>
</tr>
<tr>
<td>4</td>
<td>16.3 ± 3.0</td>
<td>11.7 ± 0.8</td>
<td>.011</td>
</tr>
<tr>
<td>5</td>
<td>13.5 ± 1.4</td>
<td>9.5 ± 0.6</td>
<td>.000</td>
</tr>
<tr>
<td>6</td>
<td>17.3 ± 1.2</td>
<td>14.2 ± 1.0</td>
<td>.001</td>
</tr>
<tr>
<td>7</td>
<td>12.5 ± 0.6</td>
<td>10.8 ± 11.7</td>
<td>.065</td>
</tr>
<tr>
<td>8</td>
<td>15.3 ± 1.2</td>
<td>11.7 ± 1.9</td>
<td>.003</td>
</tr>
<tr>
<td>9</td>
<td>13.7 ± 1.5</td>
<td>10.5 ± 1.4</td>
<td>.003</td>
</tr>
<tr>
<td>10</td>
<td>13.0 ± 0.9</td>
<td>10.7 ± 0.8</td>
<td>.001</td>
</tr>
<tr>
<td>11</td>
<td>18.0 ± 0.6</td>
<td>12.7 ± 1.0</td>
<td>.000</td>
</tr>
<tr>
<td>12</td>
<td>23.7 ± 2.0</td>
<td>18.2 ± 0.4</td>
<td>.001</td>
</tr>
<tr>
<td>13</td>
<td>16.0 ± 1.5</td>
<td>10.7 ± 1.5</td>
<td>.000</td>
</tr>
<tr>
<td>14</td>
<td>13.2 ± 0.8</td>
<td>9.8 ± 1.0</td>
<td>.000</td>
</tr>
<tr>
<td>15</td>
<td>17.3 ± 0.8</td>
<td>13.3 ± 0.5</td>
<td>.000</td>
</tr>
<tr>
<td>16</td>
<td>16.2 ± 1.3</td>
<td>12.8 ± 2.4</td>
<td>.018</td>
</tr>
<tr>
<td>17</td>
<td>15.3 ± 1.6</td>
<td>11.7 ± 0.5</td>
<td>.002</td>
</tr>
<tr>
<td>18</td>
<td>13.3 ± 0.8</td>
<td>10.3 ± 2.3</td>
<td>.021</td>
</tr>
<tr>
<td>19</td>
<td>12.5 ± 0.6</td>
<td>9.3 ± 0.5</td>
<td>.000</td>
</tr>
<tr>
<td>20</td>
<td>13.7 ± 1.2</td>
<td>10.2 ± 0.4</td>
<td>.000</td>
</tr>
</tbody>
</table>
Carbon Monoxide Concentrations

The range and mean ± standard deviation values for morning and afternoon CO concentrations for each of the 20 filling stations are shown in Table 3. Mean morning and afternoon sampling period CO concentrations across the 20 filling stations as compared with the WHO guideline limit are graphically represented in Figure 2. There was a significant difference (p < .05) in the mean CO concentrations between mean morning and afternoon concentrations for each of the 20 filling stations except at location 2 (p = .068) and location 7 (p = .065). CO concentration ranged from 10–26 ppm in the morning and 8–19 ppm in the afternoon. There was also significant difference (p < .01) between the total mean concentration in the morning (15.4 ± 2.1 ppm) and WHO guideline limit of 9 ppm. Total mean concentration in the afternoon (11.6 ± 1.4 ppm) and the WHO guideline limit of 9 ppm was also significantly different (p < .01).

Carboxyhemoglobin Levels

%COHb levels among FSAs ranged between 1.0% and 21.0%, with a mean value of 11.1% ± 3.6%. Mean %COHb for FSAs was 4 times higher than the WHO guideline limit of 2.5% and the difference was statistically significant (p < .01). About 99% of FSAs had a %COHb exceeding the WHO guideline limit. CO recorded a positive but not statistically significant relationship with COHb (r = .02, p > .05).

Discussion

To our knowledge, respiratory problems were more prevalent in this study than in other studies elsewhere. In our study, 41.8% of FSAs experienced cough in the 12 months preceding our survey. In earlier studies, Akintonwa and coauthors (2005) and Abou-Elwafa and coauthors (2015) reported lower proportions (26.9% and 1%, respectively) of FSAs who experienced cough. Shortness of breath was reported by 15.9% of FSAs in our study, unlike in a previous study (Abou-Elwafa, Albadry, El-Gilany, & Bazeed, 2015) where only 1% of FSAs had experienced shortness of breath. Similarly, sore throat was more common among our study participants (23.4%) than FSAs (8%) in a study by Tunsaringkarn and coauthors (2012). Chest pain was also more common in our study (32.8%) than among FSAs (3.2%) in Ile-Ife, Nigeria (Adeniyi, 2014). In addition to particulate matter, several other factors such as seasonal factors and the period of recall might have contributed to higher prevalence of respiratory problems among FSAs in this study.

Similarly, FSAs (14.9%) in our study had less nausea reported as compared with 32.9% in Lagos (Akintonwa, Ojo, Emeka, Coker, & Sofola, 2005), but more nausea reported as compared with 4% in Bangkok, Thailand (Tunsaringkarn, Siriwong, Rungsriyothin, & Nopparatbundit, 2012). The prevalence of headaches in their studies (47.7% and 47.0%, respectively) was similar to our study, while the study in Mansoura reported a much lower prevalence (Abou-Elwafa et al., 2015).

Additionally, eye irritation was reported by 31.8% of FSAs. Akintonwa and coauthors (2005) reported a similar proportion (33%) of FSAs with eye irritation. This number, however, was higher than findings in Adeniyi’s study (2014) at Ile-Ife where it was reported that 22.7% of FSAs experienced eye irritation. Occupational exposures to petrochemicals and other vehicular emissions could be responsible for the higher proportions of observed symptoms and health conditions in FSAs. Higher proportions of respondents with symptoms and health conditions from their study could also have been impacted by a relatively larger sample size.

Mean CO concentrations in the morning across study sampling locations were above the WHO guideline limit of 9 ppm and peaked at location 12, which had a CO concentration of 23.7 ± 2.0 ppm. CO concentration across study locations in the afternoon were above the WHO guideline limit and also peaked at location 12, which had a CO concentration of 18.2 ± 0.4 ppm. The values at location 12 were more than 2 times higher than the WHO guideline limit. There was a significant difference (p < .05) in the mean morning and afternoon CO concentrations at a majority of the filling stations—except at locations 2 and 7 (p > .05).
Generally, mean CO concentration was significantly higher ($p < .05$) in the morning than in the afternoon. This finding agrees with studies conducted in Benin City by Ukpebor and coauthors (2010) and Asheshi (2012) in Lafia metropolis, which reported ambient CO concentrations to be higher in the morning than in the afternoon, but differed from other studies that reported lower CO concentrations in the morning when compared with afternoon (Asheshi, 2012; Nwadiogbu, Eze, Ezidinma, & Echegi, 2013; Olamijulo & Ana, 2013). The higher morning CO concentrations can probably be attributed to rush hours that culminated in vehicular traffic at the filling stations and nearby roads, and consequently higher CO (and other) emissions.

%COHb levels among FSA respondents ranged between 1.0 and 21.0%. This range was higher than the 0.7–6.5% range reported by Banjoko and coauthors (2008) in a study assessing %COHb levels among smokers and nonsmokers in Ibadan city, Nigeria. Overall, the mean %COHb of respondents (11.1 ± 3.6) significantly ($p < .01$) exceeded the WHO guideline limit of 2.5%; this finding is line with Banjoko and coauthors (2008), who reported that the overall mean %COHb of respondents (2.7%) was higher than the WHO guideline limit.

The high %COHb levels among FSAs can be attributed to the frequent occupational exposure to air pollutants arising from vehicular emissions at the filling stations and from nearby traffic. This finding has been associated with cases of congestive heart failure and fatigue of skeletal muscles (Morris & Naumova, 1998; WHO, 1999). The relationship between CO and %COHb was positive though not significant ($p > .05$).

**Limitations**

This study did not formally assess weather conditions and weather possibly could have influenced prevailing CO concentrations at the filling stations during the data collection period. This limitation was due to the unavailability of a weather station for assessing key weather parameters.

**Conclusion**

FSAs suffer from various symptoms and health conditions associated with frequent occupational exposures to air pollutants from vehicular emissions at and around filling stations, such as CO as assessed in the present study in Ibadan city, Nigeria. FSAs in this study had elevated %COHb levels, indicating the risk of CO poisoning and/or an increased likelihood of experiencing adverse health conditions such as dizziness and nausea.

Personal protective equipment should be provided for workers at filling stations and appropriate fit, use, maintenance, and storage should be enforced by employers and regulatory bodies. Regular medical examinations should be conducted on workers at filling stations to aid early detection of deviations in health status. Improved regulations protective of worker safety and health are warranted.

**Acknowledgements:** The authors are grateful to staff and students in the Department of Environmental Health Sciences, Faculty of Public Health, College of Medicine at the University of Ibadan who contributed to the successful completion of this research. The technical support from concerned individuals within and outside the university is also gratefully acknowledged. Funding for some equipment in this study was from a grant to D.G. Shendell from The Atlantic Philanthropies (2007–2008, while at Georgia State University).

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References


Disinfectant Overload?

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Nondiscrimination, diversity, and inclusion are among the most important elements that influence organizational change, direction, and success. Many organizations neglect or minimize the importance and benefits of these organizational elements and fail to make them part of their administrative or operational assessments, much less strategic planning. Understanding diversity and inclusion in organizations helps develop and support the changes needed to elevate equality and create an organization that fully utilizes employee talents and portfolio skillsets (Roberson, 2006).

In the seminal article, “Uncovering Environmental Health: An Initial Assessment of the Profession’s Health Department Workforce and Practice,” issues such as challenges, characteristics, leadership, and demographics of the 21st century environmental health workforce were identified (Gerding et al., 2019). Among many notable highlights included was that minorities in environmental health departments are not proportionately reflective of the environmental health workforce as a whole, especially in management and leadership roles. In addition, half of all respondents were ≥46 years. These disparities, although not surprising, illustrate that interaction, representative integration, and inclusion in environmental health are no longer driven by regulatory mandates. Instead, a socially and culturally driven mandate that bears direct relationship to the 360° perception of the environmental health profession’s commitment to the future is needed.

To that end, Dr. Priscilla Oliver, National Environmental Health Association (NEHA) immediate past-president, initiated a call to action in an effort to “develop and implement..."
measures to improve diversity in environmental health” (Oliver, 2019). Driven by Dr. Oliver’s challenge, the American Academy of Sanitarians (AAS) chair and chair-elect ruminated on the rallying cry as to how it might apply to AAS. Subsequent to research, the chairs presumed that a few introspective first steps were necessary to create a path for AAS to improve diversity and inclusion in its administration, operations, and membership. AAS does not have a formal nondiscrimination, diversity, and inclusion policy or statement; however, AAS does have a bylaw statement related to nondiscrimination in its membership section.

After some background inquiries, it became apparent that AAS had not conducted a diversity assessment to determine what current policy and status look like, how or if policy is applied, or what diversity and inclusion should look like within the organization and among its membership. By contrast, NEHA’s executive director has made concerted and fruitful efforts to educate and advocate for nondiscrimination, diversity, and inclusion over the last 5 years and has changed the diversity landscape within NEHA. This might, at least in part, be responsible for increased productivity within the organization and most certainly, increased membership. Dr. Oliver’s call to action is an extension of this effort.

In August 2020, subsequent to the AAS annual board meeting, a Respect, Integrity, Service, and Equality (RISE) Task Force consisting of the AAS executive secretary and approximately six past and/or present governance board members and diplomats will be appointed by the AAS chair. Appointees will be considered for nomination (self or otherwise) by a nomination letter of interest and qualifications form. Favored considerations for nominees include those who are thought leaders, diverse in opinion, and independent in thought, as well as have varied backgrounds and experiences and understand that aggregated outcomes result in better decisions (Surowiecki, 2004). Once the RISE Task Force has been seated, a chair will be elected for governance and as a point of contact to the AAS board. The RISE Task Force will meet as often as necessary for 8 months and will affect the following:

- Conduct an objective assessment of the current state of diversity and inclusion in AAS, strategically determine desired outcome for the future, and recommend a path forward. Conducting an internal assessment and analyses of a familiar organization might provide critical insight pertaining to diversity practices and status, as well as shortcomings in various program areas (Harvey & Allard, 2015). When conducting assessments, Kalev and coauthors (2006) note three approaches that might be considered key in promoting and increasing diversity within organizations: 1) establishing a responsible lead in diversity, 2) reducing isolation and increasing emphasis on women and minorities, and 3) temper managerial bias through training and educational feedback. These approaches help limit stereotyping and discriminatory actions/practices and help organizations achieve strategic goals. The information gathered from such an assessment can serve as a tool in constructing guidance and a way forward to improve diversity within an organization.
- Create, adopt, and implement an inward-looking nondiscrimination, diversity, and inclusion policy. The policy will apply to AAS employment and membership and will ultimately be adopted and integrated into AAS bylaws. Create, adopt, and implement an outward-facing nondiscrimination, diversity, and inclusion statement. The statement will specifically address the value of nondiscrimination, diversity, and inclusion to the environmental health profession. This statement will become a part of AAS values and with optimism, guide and encourage other environmental health professional associations and perhaps, the profession itself. In the end, the RISE Task Force will have examined common values, beliefs, identities, objectives, and missions for the organization, its culture, and the profession. With regard to nondiscrimination, diversity, and inclusion, the RISE Task Force will have asked: Who we are? What do we look like? What/who do we represent? What are our perceptions and priorities versus our realities?

Importantly, by this time in 2021, the RISE Task Force and AAS should be comfortable showing that the status quo was assessed, challenged, and changed for the benefit of AAS and the environmental health profession.

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References
Uncovering Environmental Health Needs and Opportunities

Editor’s Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, the National Environmental Health Association (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.

Maggie Byrne is a communicator in the Water, Food, and Environmental Health Services Branch at CDC’s National Center for Environmental Health. Kayleigh Hall is an Oak Ridge Institute for Science and Education (ORISE) fellow in the same branch. Dr. Natasha DeJarnett is the interim associate director of Program and Partnership Development at NEHA. Reem Tariq and Madelyn Gustafson are project coordinators in Program and Partnership Development at NEHA.

Health departments represent the frontline of public health but how much do we really know about the professionals working there? Profiles of state and local health departments provide helpful information about health department services and programs. In fact, these profiles document that environmental health is one of the largest segments of the public health workforce (Association of State and Territorial Health Officials, 2017; National Association of County and City Health Officials, 2017). Detailed information about the environmental health profession, however, is beyond the scope of those assessments.

To better understand environmental health professionals and the programs they lead, the Centers for Disease Control and Prevention’s (CDC) National Center for Environmental Health, the National Environmental Health Association (NEHA), and Baylor University partnered to conduct a first of its kind assessment of this critical group within governmental health departments. The initiative became known as Understanding the Needs, Challenges, Opportunities, Vision, and Emerging Roles in Environmental Health (UNCOVER EH).

Contacting environmental health professionals across the nation turned out to be no small undertaking. Overall, the final results included responses from 1,700 environmental health professionals from governmental public health programs at state, tribal, local, and territorial levels.

What Did They Find?
The initial UNCOVER EH article (Gerding et al., 2019) focused on demographic and programmatic information. Key takeaways included the following:
• Food safety is the most common program area environmental health professionals work in and many work in more than one program area.
• While balanced between men and women, the environmental health workforce has opportunities to become more racially and ethnically diverse.
• The environmental health workforce is aging and presents recruitment needs (Figure 1).
• The environmental health workforce is well educated but degrees are not always in environmental health.
• Most respondents hold the Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential.

Further analysis reported by NEHA yielded insight into salaries and credentialing (National Environmental Health Association, 2019a, 2019b). Subsequent articles summarized themes from focus group discussions with environmental health professionals about challenges they face. Environmental health staff reported challenges in six key areas: drinking water quality, wastewater management, healthy homes, food safety, vectors and public health pests, and emerging issues (Brooks et al., 2019). Challenges
were reported in six professional areas: effective leadership, workforce development, use
of data and information, technology and instrumentation, program support, and part-
nerships (Gerding et al., 2020).
Results might not be generalizable to
the entire environmental health workforce
because of response and other potential
biases. Regardless, the results offer detailed
feedback from environmental health pro-
fessionals and present a window into the
practice gaps and challenges faced by the
profession.

**Strengthening Environmental Health Programs**

Tim Callahan (see photo), evaluation and
support program director for the environ-
mental health section at the Georgia Depart-
ment of Public Health, feels the UNCOVER EH
assessment highlights important trends
that need to be addressed. “There are two
cracks in the foundation of public health: the
combination of people retiring and not being
able to hire people who will work until they
retire. We’re going to have to really shift how
we recruit and maintain staff.”

While 64% of UNCOVER EH respondents
hold the REHS/RS credential, Callahan would
like to see an even greater percentage in this
area. He hopes the UNCOVER EH results
will increase the percentage of environmental health professionals who are credentialed as
programs compare their numbers to those of
the national assessment.

The UNCOVER EH articles noted several
recommendations to strengthen environmen-
tal health programs and address challenges
facing the profession. These recommenda-
tions center around four core areas:

1. **Training and workforce development:**
   Developing a strategy for standardizing
   environmental health professional
   qualifications, educational requirements,
   and credentialing, as well as enhancing
   leadership development and mentorship
   opportunities.

2. **Partnerships and collaboration:**
   Expanding and strengthening partnerships
   with other public health disciplines, academic
   and government researchers, and nongov-
   ernmental partners.

3. **Data-related tools and guidance:**
   Establishing methods for sharing information
   and resources on the use and benefit of
   various environmental health inspection
   equipment and technologies.

4. **Research:**
   Conducting studies to determine the impact of environmental health
   services on health outcomes.

CDC, NEHA, and Baylor University have
designed several products to make the
research findings, data, and recommenda-
tions more accessible and easier to use for
environmental health staff and supervi-
sors, decision makers (e.g., local boards
of health), and even those in industry (see
sidebar). CDC is learning that health
departments are using these data to set
workforce and program benchmarks. Hav-
ing a target can help improve practice in
these areas. Ultimately, improving the prac-
tice of environmental health is the name of
the game.

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**References on page 36**
References

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Did You Know?

NEHA is hosting a virtual conference—Digital Defense: Education for a Safer World—on August 18–19. This virtual conference will focus on food and water safety and will examine various impacts and lasting implications of the COVID-19 pandemic. Join your fellow colleagues and peers for this comprehensive and engaging virtual conversation. Details about the virtual conference, registration, and the agenda will be posted as it becomes available. Learn more at www.neha.org/digital-defense.

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We are orienting ourselves to a new world. We are amidst a global pandemic and economic contraction, and are immediately concerned about our families, communities, and futures. As our perspectives are narrowed, however, by the urgency of COVID-19, our other big challenges, especially the climate health emergency, have not gone away.

If we look at addressing these challenges in tandem, the COVID-19 crisis provides useful guidance for addressing our climate health emergency. The stimulus money we are indebting ourselves with has the potential to go a long way to solving climate change. Comprehensive COVID-19 and economic solutions with a longer-term perspective can lead us to climate solutions—a more prosperous, healthy, thriving, and just America.

It can reignite the true spirit of America’s leadership.

Environmental health professionals have a critical role to play in climate leadership, especially at the local level. They are a trusted group of messengers who understand the science, as well as health impacts. Solutions to climate change lie in resiliency and adaptation initiatives in local governments, in food safety specialists adapting the field to prevent contamination and shortages, and working professionals bringing this message to their elected officials at all levels of government. Those of us who can continue to work on climate solutions during this time must. The consequences of inaction are too high.

What have we learned from the COVID-19 pandemic that helps us better prepare for the slower moving threat of climate change?

- **We can tackle monumental challenges:** The most important lesson overall is that we can muster society, policies, and financial resources to quickly address problems of significant importance—namely our climate and health emergency. Once leadership listened to the experts and understood the implications of the COVID-19 pandemic, the U.S. acted with extraordinary speed and scale. Congress aligned and mustered up a $2 trillion action plan to address the immediate health and economic implications in less than two weeks. Climate solutions would actually cost less and provide greater health benefits.

- **Timing matters:** With COVID-19, quick action by health and governmental officials in places like Singapore flattened the curve. Delayed action by mere weeks in places like Italy and the U.S., however, has resulted in explosive outbreaks, increased mortality in patients, and harm to providers. The longer we wait to dedicate significant resources to mitigating and preparing for the climate health emergency, the more it will cost us both in lives and livelihoods.

- **Crises highlight injustices in society:** COVID-19 is shining a light on the health, economic, societal, and racial inequities embedded in our society. Systemic disinvestment in some communities has directly contributed to the health disparities that make people more susceptible to COVID-19, as well as more vulnerable to climate impacts. Wealthier people can comfortably self-quarantine in their large homes and their vacation homes. The disadvantaged among us face far higher and disproportionate health risks, cannot
work from home, and can least afford the economic harms of losing their jobs and healthcare. This situation is a moral challenge and responsibility.

• **Preparation matters**: Countries that were prepared with good public health systems and pandemic trained professionals who were ready with testing, protection, and treatment equipment and supplies had much lower COVID-19 incidence and much quicker recovery than we have had in the U.S. We must prepare for climate change with similar mastery. One idea is a U.S. recovery authority charged with foreseeing and preparing for calamities. As we head into hurricane season, it is important to prepare for extreme weather events that could impact physical distancing requirements and safe shelter-in-place orders.

• **Science matters**: Trust in experts and science has been critical for the successes in COVID-19 response and public welfare. Many political leaders in places like Italy, UK, and the U.S. did not listen to experts, believing their judgements of the situation were better. Leaders and health professionals who took the science seriously and made evidence-based decisions are saving thousands of lives. The lack of consistent messaging and informed risk communication has resulted in critical errors and lives lost.

• **Leadership matters**: Chief executives are the people who can act in the moment and make a difference. With COVID-19, prime ministers, presidents, governors, and mayors who made the right decisions and acted promptly reduced impacts. They surrounded themselves with experts and understood the people they represented. We need our leaders to step up and champion the information, plans, and resources to effectively address climate change.

• **Transparency and honesty matter**: Labeling COVID-19 as an emergency has triggered historic national and worldwide collaboration and action. When political leaders, the media, and other decision makers suppress science, however, they have distracted people and organizations from action and driven up morbidity, mortality, and a myriad of individual and societal injustices.

• **Communities matter**: Most Americans are self-quarantining and many are making room to care for and connect with others beyond their own families. They are providing moral outrage that is forcing governments to act with people as a priority. Their individual and collective actions have made governments realize that social welfare is a primary responsibility.

Of course, there are many general questions still unanswered about COVID-19 and our response to it. How long will it last? Will there be a second wave, perhaps larger than the initial pandemic, in the fall or next year? Can we develop immunities, vaccines, or treatments that will protect us? What will we learn from this pandemic? How can we “multisolve” and address health, climate, and equity issues with COVID-19 solutions? How will we mitigate the possibility of and prepare for future crises?

There are also specific questions for the environmental health profession. How can we advance food safety practices to prevent the next pandemic? How can we prepare buildings for reentry? How will vector season and hurricane season be impacted by reduced workforce activities? How can we address the mental burden of seeing the suffering and responding to the pandemic? The next pandemic might have significantly higher morbidity and mortality rates than COVID-19. And climate change will assuredly have even greater impacts if left unaddressed.

We will establish a new normal post-COVID-19, which can be better or worse for us. This virus is causing us to change almost everything we do—how we work, connect, travel, shop, go to school, worship, and more. At least one half of the environmental health workforce is being pulled into immediate response mode while some health departments are closing completely. We hit the pause button on our everyday lives but certainly not the snooze button. In many ways, we have awoken and are thrust into new ways of being, punctuating the equilibrium of the past. We must translate these learnings to equitable climate solutions.

We are in the middle of the story and can write our own ending. There are certainties that can guide our action. We are interconnected, interdependent, and empowered to multisolve. Here are a few guiding principles for addressing climate change that we have learned or have been reinforced after being faced with the COVID-19 pandemic:

• **Act and react with empathy and kindness**: In our personal interactions, in our communities, and with our policy solutions, we need to treat others, especially the less fortunate, as we would like to be treated if we were in their shoes. We need to build a more personal and broader sense of equity and justice to our climate work. Listen well to both optimize your efforts and help others adjust.

• **Keep equity at the core of our responses**: Start with people. Listen to and work from their priorities. Prioritize healthy housing, make school lunch programs available for at-home learning, shore up public health, create work opportunities, and build shared and sustainable prosperity.

• **Base our decisions on facts, science, and experts**: Political and financial interests are experts in propaganda. They obfuscate facts and confuse and misdirect the public to line their pockets with our money while increasing harms to the rest of us. The facts, science, and experts should guide all our decisions.

• **Inspire, empower, and take action**: People will not act on any issue if they think it will not impact them or if they cannot make a difference. As with COVID-19, the exact opposite is true with climate change. We need to lean in and move our families, workplaces, congregations, communities, and the country toward effective climate mitigation, restoration, and justice. Show up for others. On an individual level, we can donate to food banks, help neighbors get groceries, help folks apply for economic assistance, and press government at all levels for regenerative solutions. On a professional level, environmental health practitioners can participate in online learning to build a new skill and engage colleagues in keeping up the steady drumbeat on climate solutions.

• **Elecct leadership with a strong record on public and environmental health**: Primary to solving COVID-19 is leadership that places the public’s well-being as an essential priority. Ineffective leadership exacerbates problems and increases harm. The most critical thing we can do to address climate change is elect people who understand the climate health emergency—and the cost of inaction—and will take the necessary measures to build equitable climate solutions.
• Communicate and collaborate: We have at hand all the money, technology, and policy solutions we need to address climate change. What we need is a social tipping point. Activists alone are not enough. We need to reach out through our spheres of influence to motivate others to act and to act together for climate solutions.

• Capitalize on the moment: Social disruptions open space for rapid, massive social change. By structuring solutions to crises in ways that multisolve for other issues, we can create self-reinforcing benefits. We need to realize that we and our problems are interconnected and interdependent, and so are the solutions. We must all embrace our critical roles as advocates. This guidance from ecoAmerica, a partner of NEHA, is a work in progress. There is a lot to learn from our compound crises and sharing learning will help us get through them. We welcome your thoughts and recommendations as we continue to work in partnership to address these dual threats.

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

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Enacted 2019 State Environmental Health Legislation

Summary
State legislatures introduced 2,624 bills in 2019 related to environmental health and enacted or adopted close to 400 bills. Legislatures in every state, Puerto Rico, and Washington, DC, introduced environmental health legislation and bills were enacted in 48 states, Puerto Rico and Washington, DC. The legislatures in Ohio and Wisconsin did not enact any bills on environmental health.

New Jersey introduced 508 pieces of legislation related to environmental health, the most in the nation. This number was followed by New York with 460 bills, Massachusetts with 276 bills, California with 155 bills, Hawaii with 119 bills each, and Minnesota with 115 bills. On the lower end, Wyoming and South Dakota introduced 6 bills each, Alaska introduced 4 bills, and Idaho introduced the least with 3 bills.

Food safety was the most popular topic for 2019 legislation: 798 bills were introduced in every state and 148 were enacted. Labeling of cell- or plant-based meat led to several laws being introduced and enacted on the labeling of these products.

The second most common environmental health topic for legislatures in 2019 was toxics and chemicals. Legislatures in 49 states introduced 793 bills related to some aspect of toxics or chemicals with 216 bills on lead hazards or lead poisoning. Legislation regarding per- and polyfluoroalkyl substances (PFAS) was one of the foremost issues addressed with over 40 bills introduced and 17 enacted.

More than 413 bills related to drinking water were introduced in 43 state legislatures. New Jersey introduced the most bills on this topic (77). The leading topics included the replacement of lead service lines and managing perfluoroctanoic acid (PFOA).

Other popular environmental health topics addressed by state legislatures included indoor air quality (385 bills introduced and 45 enacted), wastewater (323 bills introduced and 39 enacted), and pesticides (193 bills introduced and 17 enacted). Topics such as body art (79 bills introduced and 16 enacted), asthma (59 bills introduced and 19 enacted), environmental health laboratories (34 bills introduced and 8 enacted), and swimming pools (9 bills introduced and 4 enacted) were less common environmental health topics addressed in 2019 by state legislatures.

As of March 2020, 49 state legislatures introduced 3,526 bills on environmental health. Due to space limitations, a condensed version of the full listing of enacted 2019 state environmental health legislation is presented here in alphabetical order by topic. Readers can access a complete listing on the National Conference of State Legislatures (NCSL) Environmental Health State Bill Tracking Database at www.ncsl.org/research/environment-and-natural-resources/environmental-health-legislation-database.aspx.

Asthma
In regard to asthma, a total of 59 bills were introduced and 19 were enacted. The foremost issue for state legislatures regarding asthma was permission to allow students and school administrators to administer emergency asthma medications. Other enacted bills include Maryland’s H 1160, Act 724 that established the Breathe Easy East Baltimore Pilot Program and Pennsylvania’s HR 256 that recognized May 7, 2019, as World Asthma Day.

Body Art
Legislatures enacted 16 bills related to body art. Examples of these bills include:
• California’s A 647, Act 60 requires the manufacturer of a hazardous substance that constitutes a cosmetic to post the material safety data sheet on its website.
• In Illinois, S 241, Act 303 makes it unlawful for a manufacturer to import for profit, sell, or offer for sale any cosmetic that was developed or manufactured using animal testing.
• Minnesota’s S 326, Act 29 modifies requirements for supervisors of temporary body art technicians.
• Nebraska (L 449) and Washington (H 1856, Act 307) prohibit scleral (the white part of the eye) tattooing.
• New Mexico’s S 142, Act 245 requires that an applicant for a body art tattoo or piercing scarification license be granted credit for equivalent training or experience obtained outside the state.
• South Dakota’s H 1176, Act 55 provides for the regulation of saline tattoo removal by municipalities.

Drinking Water
A total of 113 bills related to drinking water were introduced to state legislatures in 2019 and 61 bills were enacted. The foremost issue was the funding of water infrastructure. Examples of enacted bills related to drinking water include:
• California enacted the Safe and Affordable Drinking Water Fund (S 200, Act 120) to assist water systems in providing adequate and affordable supplies of water.
• In Illinois, H 2650, Act 143 amends the state’s Environmental Protection Act to adopt rules to expand the usage of federally allowable set-aside programs within the Water Revolving Fund, including programs that provide financial assistance to utilities exploring consolidation for the purpose of improving efficiency, sustainable water management, and equitable water rates.
• New Hampshire enacted the Drinking and Groundwater Trust Fund Study (S 164, Act 238) that establishes a committee to study unprotected drinking water sources and estimate the costs of protecting such sources.
• Puerto Rico enacted SJR 196 to provide emergency assistance loans or credit facilities to power and sewer authorities in response to the challenges caused by Hurricanes Irma and Maria.
• Texas enacted the Drinking Water Protection Laws (S 530, Act 519) that increase the civil and administrative penalties assessed or imposed for violations of laws protecting drinking water, public water supplies, and bodies of water.

Environmental Health Laboratories
A total of 6 states enacted legislation regarding environmental health laboratories and the foremost issue was biomonitoring programs.
• Maine’s H 1043, Act 277 seeks to use biomonitoring to test for PFAS in food packaging.
• Minnesota’s H 13a, Act 12 and S 7a, Act 4 authorizes perfluorochemical biomonitoring in eastern metropolitan communities.
• Vermont’s S 55, Act 75 evaluates chemical inventories and identifies potential risks through the use of biomonitoring.

Food and Food Safety
Laws regarding food were enacted in 42 states, Puerto Rico, and Washington, DC. There were 798 bills introduced in 2019 and 148 were enacted. Topics included the Food Safety Modernization Act (FSMA), changes to the retail food code, inspectors for produce safety, and responses to allergens. New Jersey and New York had the most bills related to the topic (63 and 59, respectively), followed by Hawaii with 46.

The foremost issue regarding food was food safety. Legislatures reviewed many aspects of food safety, from the adoption of the Food and Drug Administration’s Food Code to state efforts to implement FSMA. Laws regarding food establishments and retail food locations were also popular with 130 bills introduced and 14 enacted.

The most interesting issue in 2019 was cell- and plant-based meat laws. Cell-based meat is produced by taking a small sample of animal cells and replicating them in a culture outside of the animal. It is also referred to as “clean meat.” Plant-based meat is an animal-free alternative to common processed foods that are typically made of animal parts. They are designed and created to look, taste, and cook like conventional meat. The popularity of plant-based meats led to several laws being introduced and enacted on the labeling of these products. Many of these laws involve cell-based meats as well, even though such products are not readily available. States that enacted these types of bills included: Alabama (H 518), Arkansas (H 1407, Act 501), Colorado (HR 1005), Kentucky (H 311, Act 42 and HR 105), Louisiana (S 152, Act 273), Mississippi (S 2922), Montana (H 327, Act 273), North Dakota (H 1400 and HCR 3024), Oklahoma (S 392), South Carolina (H 4243), South Dakota (S 68, Act 181), and Wyoming (S 68, Act 100).

Limiting a state’s oversight of food safety regulations was another popular topic with 59 bills introduced regarding cottage foods. With the exception of New Jersey, every state, Puerto Rico, and Washington, DC, have enacted cottage food laws that exempt small-scale food production from regulatory oversight. A total of 59 bills were introduced in 2019 to expand or define the scope of cottage food operations. Allowing for larger operations to be eligible for cottage food protections, permitting hazardous food products, and altering rules on food handling all were reviewed by state legislatures. Examples of these bills include:
• In Illinois, S 2088, Act 425 amends the Food Handling Regulation Enforcement Act by prohibiting a public health district from regulating the preparation and service of food in a private residence that is prepared by or for the lessees and their guests.
• Maryland’s S 290, Act 370 alters the definition of cottage food products to include food sold to retail food stores or food cooperatives. The law requires the owner of a cottage food business to submit information to the Maryland Department of Health before selling a cottage food product to a retail food store. Also, H 527, Act 370 alters the definition of cottage food products to include food sold to retail food stores or food cooperatives and requires that a specific label be applied to cottage food products.
• In Texas, H 1694, Act 373 limits food regulations applied to farms, farmers markets, and cottage food production operations.
• West Virginia’s S 285, Act 3 authorizes the production and sale of homemade food items under certain circumstances. The law establishes conditions for exemption from licensure, permitting, inspection, packaging, and labeling laws; provides required notices to the consumer; and permits local health departments to inspect reported foodborne illnesses.

One of the more interesting laws in 2019 came from the legislature in Maine. Maine’s H 583 proposes an amendment to the state’s constitution related to rights to food and food sovereignty and freedom from hunger. It declares that all individuals have a natural, inherent, and unalienable right to food, including the right to acquire, produce,
process, prepare, preserve, consume, barter, trade, and purchase the food of their own choosing for their own nourishment, sustenance, bodily health, and well-being. The bill will be subject to a statewide vote if passed by the legislature.

Indoor Air Quality
Legislatures in 29 states and Puerto Rico enacted 45 bills related to indoor air quality. The main issues addressed were related to vaping, radon, and indoor smoke. Examples of these bills include:

- Colorado enacted the Residential Tenants Health and Safety Act (H 1170, Act 229) that defines mold in housing.
- Connecticut’s H 7269, Act 19 funds a program to reduce health and safety hazards in residential dwellings, including lead, radon, and other contaminants through removal and remediation.
- Florida’s S 7012, Act 14 prohibits vaping in an enclosed indoor workplace, revises requirements for customs smoking rooms, and requires the proprietor to implement a policy regarding specified smoking and vaping prohibitions.
- Indiana’s S 632, Act 21 requires the State Department of Health to distribute a manual of best practices for managing indoor air quality at schools—including recommendations for radon testing—to the legislative council, Department of Education, and facilities manager and superintendent of each school.
- In Maine, the legislature prohibited the possession and use of electronic smoking devices on school grounds (A 39, Act 61).
- Nebraska adopted the Radon Resistant New Construction Requirements bill (L 130).
- Puerto Rico’s S 147, Act 69 prohibits smoking in motor vehicles that have passengers under 18 years old.
- Virginia’s H 1885, Act 279 directs the Department of Health to develop programs to educate the public about radon, sources of radon, potential adverse health impacts of radon exposure, and options for radon testing and mitigation.

Pesticides
Legislatures in 12 states and Puerto Rico enacted 15 bills regarding pesticides and environmental health. Examples of these bills include:

- In California, A 320, Act 422 created the California Mosquito Surveillance and Research Program to be administered by the University of California. The law requires the university to maintain an interactive Internet website for dissemination of data on mosquito-borne viruses and surveillance control.
- Colorado enacted H 1328, Act 426 that establishes duties for landlords and tenants regarding the presence of bed bugs and requires a tenant to promptly notify the landlord when the tenant suspects that their dwelling unit contains bed bugs.
- Maine enacted the Pesticide Safety Education Program (S 393, Act 243) that awards an annual grant to the University of Maine Cooperative Extension for the development and revision of training manuals for pesticide applicator certification, licensing, and recertification.
- Nevada’s A 205, Act 317 requires the establishment of an integrated pest management policy for controlling pests and weeds on school district properties.
- Puerto Rico’s SR 281 directs the Senate Health Committee to study the effect of glyphosate on the public’s health.
- Texas enacted the Mosquito Control Waiver (S 113, Act 344) that authorizes the application of pesticides for mosquito control by municipal or county employees in an emergency.

Swimming Pools
Legislatures enacted 4 bills in 3 states on swimming pools.

- New Jersey enacted A 3772, Act 22 regarding pool and spa service contractors and provides that provisions do not apply to a property owner who performs pool and spa building and installation or swimming pool service and repair work on his own property or pool. Also, A 4191, Act 23 exempts certain facilities from regulation even if they have a diving board, water slide, or similar feature.
- Texas adopted the International Swimming Pool and Spa Code for the state through H 2858, Act 214.
- West Virginia’s H 2490, Act 213 prevents the state from a review of any repair or modernization of equipment at a public pool facility if such activity does not exceed $25,000 in planned costs.

Toxics and Chemicals
State legislatures reviewed bills related to concerns from toxics and chemicals, including asbestos, lead, PFAS, sunscreen, and ethylene oxide. Legislatures in 49 states introduced 793 bills related to this topic. Examples of these bills (not including lead hazards and PFAS as those are discussed in the following subsections) include:

- In Illinois, S 1392, Act 330 studies the threat of microplastics to human health and the environment.
- In Maine, the legislature enacted S 296, Act 47 that regards the elimination of highly toxic and hazardous chemicals in the workplace.
- Washington’s S 5135, Act 292 requires manufacturers of child and consumer products containing a state-identified priority chemical to provide notice to the state.

Lead Hazards
Lead hazards, replacements of lead water services lines, and the screening of children with elevated blood-lead levels were all addressed by state legislatures in 2019. Examples of these bills include:

- California’s A 206, Act 171 makes a property owner who participates in a program to abate lead-based paint as a result of a judgment in any public nuisance immune from liability in any lawsuit seeking to recover any cost associated with that abatement program. Also, A 72, Act 1 provides $5 million to test and remediate lead in drinking water at licensed day care centers.
- California’s S 647, Act 379 and New York’s S 4046, Act 671 regulate jewelry containing lead.
- Maine enacted H 21, Act 100 that requires a notice of any lead abatement order and when the abatement is complete. Also, S 336, Act 479 makes several changes to the state’s Lead Poisoning Control Act by changing the year for the state’s goal to eradicate childhood lead poisoning, requiring all state children be tested for unsafe exposure to lead at 1 and 2 years, increasing the lead poisoning prevention fee per gallon of paint, and allowing up to one half of the fee to be used for mandated dwelling inspections.
- Maine (S 40, Act 158), Maryland (H 1253, Act 557), and Vermont (S 40, Act 66) require schools to test their drinking water for lead.
• Maryland’s H 1233, Act 341 amends the reference level for blood lead. The law also requires the Department of the Environment to adopt regulations for conducting environmental investigations.

• New Jersey enacted a law to issue bonds to replace lead-contaminated water service lines (A 4120, Act 114). Furthermore, SR 133 urges Suez North America to aggressively replace its lead service lines in the state.

Per- and Polyfluoroalkyl Substances
One of the foremost issues addressed by legislatures in 2019 was PFAS. Over 40 bills were introduced and 17 were enacted regarding these chemicals. Examples of these bills include:

• Arizona (S 1526, Act 222), Kentucky (S 104, Act 47), Minnesota (H 359, Act 47), and New Hampshire (S 257, Act 337) prohibit firefighting foam that contains PFAS chemicals from being used for firefighting training or testing.

• Colorado’s H 1279, Act 427 requires the Department of Public Health and Environment to determine the amount of PFAS foam currently held, used, and disposed of by fire departments.

• Michigan’s Human Service Budget (S 139, Act 67) allocates grants to local public health departments to support PFAS response and emerging public health threat activities.

• North Carolina’s S 433, Act 241 requires the state to conduct an analysis for PFAS, including GenX, at all public water supply surface water intakes to establish a water quality baseline for all sampling sites.

• Vermont’s S 49, Act 21 adopts a maximum contaminant level for PFAS under the Agency of Natural Resources’ Water Supply Rule, requires the Secretary of Natural Resources to amend the quality standards to include criteria or effluent limitations for PFAS, and requires landfills to treat leachate for PFAS prior to delivery to a wastewater treatment facility or other facilities where the leachate would be discharged to state waters.

Wastewater
State legislatures enacted 39 bills addressing wastewater concerns, such as septic systems, reclaimed wastewater, and sewage systems. Examples of these bills include:

• Colorado’s H 1200, Act 78 relates to the process involved in treating reclaimed domestic wastewater for indoor nonpotable uses within a building where the general public can access plumbing fixtures that are used to deliver the reclaimed domestic wastewater.

• North Carolina’s H 268, Act 151 disapproves of certain wastewater treatment and dispersal rules adopted by the Commission for Public Health. The bill creates a task force to recommend new wastewater treatment and dispersal rules and creates standards for an onsite wastewater evaluator.

• Oregon’s S 884, Act 558 authorizes loans from Water Pollution Control Revolving Fund to finance projects to repair or replace failing onsite septic systems with connections to available sewers.

• Washington’s S 5503, Act 50 provides that a local health officer may not deny or condition a permit application related to an onsite sewage system upon the granting of an easement allowing for the inspection or maintenance of the onsite system.

• Virginia’s H 192, Act 187 directs the State Department of Health to adopt regulations regarding the use of greywater and rainwater.

Disclaimer: This column summarizes state law or legislation and is the property of NCSL. It is intended as a reference for state legislatures and their staff. NCSL makes no warranty, expressed or implied, or assumes any legal liability or responsibility for third-party use of this information, or represents that its use by such third-parties would not infringe on privately owned rights.

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Editor’s Note: Due to the coronavirus disease 2019 (COVID-19) pandemic, many conferences and events are being canceled as organizers assess health and safety issues, as well as take into consideration current state and local orders related to social distancing and gatherings. As such, the status of the conferences listed below might not be correct. Attendees are encouraged to check the websites for each conference listing for the latest information. Any cancellations that occurred prior to the time of press have been noted below.

### UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCES


### NEHA AFFILIATE AND REGIONAL LISTINGS

**Colorado**  

**Florida**  
August 2–8, 2020: 72nd Annual Education Meeting, Florida Environmental Health Association, Jensen Beach, FL, www.feha.org/2020AEM

**Illinois**  

**Indiana**  

**Iowa**  

**Jamaica**  
POSTPONED TO LATE OCTOBER 2021: One Health, One Global Environment Conference, Jamaica Association of Public Health Inspectors and the Americas Region of the International Federation of Environmental Health, Montego Bay, Jamaica, www.onehealthconference.com

**Kansas**  
September 15–16, 2020: Fall Conference, Kansas Environmental Health Association, Manhattan, KS, www.kehau.org

**Michigan**  

**Missouri**  

**North Carolina**  

**Texas**  
October 26–30, 2020: 65th Annual Education Conference, Texas Environmental Health Association, Austin, TX, www.myteha.org

**Utah**  
October 6–9, 2020: Fall Conference, Utah Environmental Health Association, Ogden, UT, www.ueha.org/events.html

**Wisconsin**  

### TOPICAL LISTINGS

**Climate Change**  

**Recreational Water**  

**Water Quality**  
RESCHEDULED: January 20–22, 2021: Legionella Conference 2020, NSF Health Sciences and NEHA, Chicago, IL, www legionellaconference.org

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**Did You Know?**

You can post your upcoming events, such as conferences and webinars, on NEHA’s Community Calendar at www.neha.org/news-events/community-calendar. If you need to reschedule or cancel a posted event, please e-mail webmaster@neha.org so we can update your listing.
Resident Perceptions of Environmental Pollution in Recreational Areas Flooded by Hurricane Harvey in Houston, Texas

1. Parks and green spaces can provide the following:
   a. potential physical and mental health benefits.
   b. a respite from urban heat.
   c. an important element of urban stormwater management.
   d. all the above.
   e. none of the above.

2. The potential public health benefits provided by parks can be counteracted by the potential or perceived risks involved in postdisaster use of parks, including
   a. environmental contamination.
   b. increased exposure to disease vectors.
   c. injuries due to debris and unsafe environments.
   d. all the above.
   e. none of the above.

3. The purpose of this study was to collect information directly from residents who were using parks after Hurricane Harvey to inform public health and other agencies’ postdisaster communications to residents about the potential health risks associated with using parks.
   a. True.
   b. False.

4. In February and March 2018, teams of at least __ trained graduate student interviewers from Texas A&M University attempted to complete __ surveys of residents who were approached while using each of the six parks.
   a. 2; 10
   b. 2; 20
   c. 4; 10
   d. 4; 20

5. To limit response bias, surveys were conducted on
   a. weekdays.
   b. weekends.
   c. both weekdays and weekends.

6. The first section of the survey included questions to assess respondents’
   a. emotional response to environmental pollution in Houston in general.
   b. changes in feelings about environmental pollution since Hurricane Harvey.
   c. self-rated physical and mental health outcomes.
   d. a and b.
   e. all the above.

7. A total of __ individuals completed the survey.
   a. 117
   b. 120
   c. 125
   d. 127

8. The majority of respondents were
   a. African American.
   b. Hispanic.
   c. White.
   d. Other.

9. Of the respondents, ___ reported that they felt certain or very certain that Hurricane Harvey caused environmental pollution in their community.
   a. one quarter
   b. one third
   c. one half
   d. two thirds

10. Of the respondents, ___ reported a desire to be certain about pollution caused by Hurricane Harvey and the potential health effects of such pollution.
    a. one quarter
    b. one third
    c. one half
    d. two thirds

11. When asked about their emotional response toward environmental pollution in their community, about ___ respondents reported that the pollution made them feel angry.
    a. one in five
    b. two in five
    c. three in five
    d. four in five

12. All respondents reported statistically significantly ___ overall mental health scores than national averages.
    a. lower
    b. similar
    c. higher

JEH Quiz #5 Answers
March 2020
1. b 4. c 7. c 10. d
2. a 5. b 8. a 11. c
3. c 6. a 9. b 12. d
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 NEHA’s online Bookstore for additional information about these and many other pertinent resources!

National Environmental Health Association (2014)

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

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

**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

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 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

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
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Chris Kochtitzky
The National Environmental Health Association (NEHA) was saddened to learn that Chris Kochtitzky, MSP, passed away on May 3, 2020. He was one of the founders of the field of built environment and health at the Centers of Disease Control and Prevention (CDC) where he worked for over two decades. He grew up in Jackson, Mississippi. He received a bachelor’s degree in political science from Millsaps College in 1989 and earned a master’s degree in planning with a focus on urban and regional planning from Florida State University in 1992.

Kochtitzky started at CDC in 1992 and worked for several years as a policy analyst in the Agency for Toxic Substances and Disease Registry. In 1997, he moved to the National Center for Environmental Health’s (NCEH) Office of Policy, Evaluation, and Legislation where he served as its deputy director. In 2003, after serving for 2 years as the associate director of policy for the Division of Emergency and Environmental Health Services, he served 1 year as the branch chief of the Disability and Health Branch, and later became the deputy director of the Division of Human Development and Disability.

From 2009–2017, Kochtitzky served as the associate director for program development for the NCEH Division of Emergency and Environmental Health Services before joining the Division of Nutrition, Physical Activity, and Obesity as a senior advisor. In this position he served as an expert on the development of evidence-based guidelines and recommendations to increase physical activity across the country. Kochtitzky provided technical and subject-matter expertise to state and community programs in the areas of policy, systems, and environmental interventions designed to promote active living.

Throughout his career, Kochtitzky worked tirelessly as a bridge between the fields of planning and public health. In 2010, he served as an adjunct professor at Emory University and taught a course on public health and the built environment. He was known for the strength of the partnerships he developed and maintained. His networks allowed for the spread and scale of science and implementation of programs across federal, state, and local agencies, as well as private and nonprofit sectors.

Kochtitzky contributed to the planning and public health fields through several influential articles, book chapters, and numerous presentations given throughout the U.S. He was recognized by CDC in 2018 as a Public Health Agent of Change. Furthermore, he helped organize CDC’s Built Environment and Health Group in 2008 and was a key contributor to the Surgeon General’s Call to Action to Promote Walking and Walkable Communities in 2015. Most recently, he was a driving force in organizing the Transportation Research Board’s conference on active transportation and health. He also was an active member of NEHA since 2002.

The following quotes provide further insight into Kochtitzky’s character and passion, as well as his impact.

“The character, generosity, and presence of Chris was boundless, timeless, and transcendent. He asked for nothing in return. He was a voice in a generation characterized by echoes. He was not a mirror of who we are but a molder of who we should be. He inherently understood and taught me that knowledge and understanding are not synonymous. For that Chris, I am eternally grateful,” Dr. David Dyjack, NEHA executive director.

“Chris was my project officer on my first grant from CDC/NCEH. We quickly became friends and stayed in touch. He always had a mission and gave his all to his missions. Given to him by his father, his mantra in life was, ‘You must comfort the afflicted and afflict the comfortable.’ He lived by those words,” Doug Farquhar, NEHA Government Affairs director.

“Chris was a member and friend of NEHA who believed in our vision and mission. He would go out of his way to lend support to NEHA. Like many, I was fortunate to have worked with Chris while at CDC. Chris would occasionally challenge me on my assumptions about environmental health and tell me to get out of ‘my box.’ While it may not be meaningful to many, I enjoyed having lunch with Chris in the 106 Cafeteria on the NCEH campus. I will miss that,” Vince Radke, NEHA past president.

“My relationship with Chris shaped my professional career. He had a great passion for developing and elevating the environmental health workforce. Chris was very generous with his time and expertise. He was the most honest provider of feedback I have ever worked with but it never felt like criticism. The thing that is important in any memorial about Chris is to provide a call to action for the environmental health workforce to take up his call to work across the professions to address upstream prevention,” Dr. Sandra Whitehead, professor and interim program director.

A memorial fund for Kochtitzky has been set up by the CDC Foundation and will focus on building the bridge between urban planning and public health. To learn more, please visit https://give.cdcfoundation.org/give/285616/#/donation/checkout. Furthermore, a Caring Bridge website has been created to share information and help friends, family, and colleagues communicate during this difficult time (www.caringbridge.org/visit/chriskochtitzky/journal/view/id/5eb5b2281ce4e7b1f455906b5).

NEHA extends its deepest sympathies to Kochtitzky’s family, friends, and colleagues. He was a generous and caring person and a tenacious public health professional who pursued his life and work with passion, wisdom, and intelligence. He will be greatly missed.
Bailus Walker, Jr.
The National Environmental Health Association (NEHA) was saddened to learn that Bailus Walker, Jr., MPH, PhD, passed away on April 11, 2020. Dr. Walker was a distinguished researcher, teacher, and environmental and public health professional. He was a retired professor of environmental and occupational medicine and toxicology in the College of Medicine at Howard University. He received his undergraduate degree in biology and chemistry from Kentucky University. He went on to earn a Master of Public Health from the University of Michigan and a doctorate in occupational and environmental health from the University of Michigan.

Dr. Walker's career spanned several decades across academia and state and federal health agencies. From 1979–1981, he was director of the Occupational Health Standards Division within the Occupational Safety and Health Administration. He was the first nonphysician to be appointed commissioner of public health for the Commonwealth of Massachusetts and chairman of the Massachusetts Public Health Council. Prior to that he was appointed state director of public health for Michigan. From 1988–1990, Dr. Walter was a professor of public health policy at the State University of New York at Albany. He then went on to be appointed dean of the College of Public Health at the Health Sciences Center of the University of Oklahoma, Oklahoma City, from 1990–1994.

Dr. Walker was actively involved in the environmental and public health profession. He was a National Institutes of Health advisor on environmental and community health aspects of bio-defense research. He was a senior science advisor for environmental health to the National Library of Medicine. Dr. Walker was also elected to membership in the Institute of Medicine, National Academy of Sciences in 1989 and served on numerous commissions and committees.

Professional development and the value of professional associations were important to Dr. Walker. He was a past president of the American Public Health Association, a distinguished fellow of the Royal Society of Health, and a distinguished fellow of the American College of Epidemiology. Dr. Walker was also an active NEHA member for over 50 years. He provided further impact to the profession through publication of over 100 articles in peer-reviewed journals on environmental and occupational health.

Throughout Dr. Walker's career, he was the recipient of many awards and accolades including the Distinguished Alumni Award from the University of Michigan (UM) School of Public Health and the UM Department of Environmental Health Sciences Award. In 1984, Dr. Walker was the recipient of the Walter S. Mangold Award, NEHA's highest honor.

The following quotes from colleagues and friends showcase his contributions and dedication to environmental and public health, as well as the lasting impact he had many individuals and the profession.

“Dr. Walker was an outstanding individual with such a warm and outgoing personality. I feel very blessed to have had the opportunity to meet him. My thoughts and prayers for his family,” Sue Beck, wife of the late Professor Joe Beck.

“As we celebrate the life of Dr. Walker, my memories of him began when I was a graduate student. He interviewed me for a position with the newly forming Consumer Product Safety Commission. Having previously met with Dr. Walker when he was in consideration for commissioner of that organization, I became impressed with his demeanor and his genuine interest in environmental health. I stayed in touch with Bailus throughout my careers, often seeking his counsel and valuable advice. He quickly became an inspirational figure in my career offering guidance, encouragement, and praise that found me at times when I needed it the most,” Gary Coleman, NEHA past president.

“Dr. Walker taught the first environmental health course at the New York State Department of Health in Albany. He believed that schools of public health should be located in governmental public health institutions where students can see how public health policy emerges, programs are managed, and practices are applied. I was lucky enough to have taken that class. Many people are responsible for my turning to public health, he is responsible for my focus on environmental health. His environmental health class was the beginning of my career as an environmentalist that now spans nearly three decades,” Dr. Larry Figgs, division chief.

“Dr. Bailus Walker, Jr. was a legend in public and environmental health. He deserves as many tributes as one can receive. He was a great leader, professor, researcher, administrator, consultant, writer, and champion in public and environmental health. Dr. Walker pushed strongly for diversity and the best in environmental health all of his career. He was an advisor to me and many others in the environmental, public health, and medical professions. I am thankful and grateful that he came my way and adopted me as a part of his circle of friends and professionals. We miss him,” Dr. Priscilla Oliver, NEHA immediate past-president.

“Dr. Walker was one of my environmental health heroes and an inspirational figure,” Vince Radke, NEHA past president.

NEHA extends its deepest sympathies to Dr. Walker's family, friends, and colleagues. His contributions to environmental and public health are numerous and will continue to influence our profession for many years. He will be greatly missed.

Editor's Note: We thank the individuals who provided quotes and information regarding the lives of Chris Kochtitzky and Dr. Bailus Walker, as well as the agencies and organizations that provided biographical information. If you would like to share information about the passing of an environmental health professional to be mentioned in a future In Memoriam, please contact Kristen Ruby-Cisneros at kruby@neha.org. The Journal will publish the In Memoriam section twice a year in the June and December issues, or in other issues as determined appropriate.
The board of directors includes NEHA's nationally elected officers and regional vice-presidents. Affiliate presidents (or appointed representatives) comprise the Affiliate Presidents Council. Technical advisors, the executive director, and all past presidents of the association are ex-officio council members. This list is current as of press time.

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Engage and Share Resources on NEHA's COVID-19 Response Online Community

The COVID-19 pandemic has profoundly impacted the environmental health workforce, including changes to how local and state regulatory agencies conduct training and engage in regulatory inspections. In the rapidly changing world of COVID-19 response, we recognize that many agencies and organizations have created excellent training resources and inspection forms that, should they be readily accessible, would help ease the burdens of other jurisdictions. While guidance from federal agencies is very important, putting this information to use within state and local areas requires countless resources to create the forms and tools to serve each specific jurisdiction. This process has been the case regarding restaurant reopenings and similarly is being repeated for swimming pools, body art, hotels, schools, correctional facilities, HVAC units, and wastewater, to name just a few.

The National Environmental Health Association (NEHA) recognizes the need for a credible resource repository that can help environmental health professionals gain access to best practices on COVID-19 response, recovery, and resilience building and as they relate to environmental health. Based on feedback we have received from many of you, we are pleased to announce the launch of the COVID-19 Response Online Community (ROC) for you to engage in peer-to-peer learning and resource sharing.

Through this platform, users can access a resource library where participating state, tribal, local, and territorial (STLT) public health agencies and environmental health programs are able to share their communication, training, inspection forms, and other such resources developed for COVID-19. We are working to collect and collate user submitted resources into different categories—restaurants, body art, swimming pools/recreational waters, etc.—allowing environmental health professionals and safety specialists to engage with their peers through an interactive discussion forum that facilitates resources sharing, information exchange, and making connections that create opportunities for technical assistance.

This virtual community of practice has multiple features that facilitate collaboration and professional development in emergency management. Membership to the virtual community is free and does not require NEHA membership to join and participate. Individuals who sign in through the MyNEHA portal can directly upload the materials they have created. The COVID-19 ROC is an extension of our COVID-19 website (www.neha.org/covid-19) where we provide access to NEHA’s COVID-19 resources and resources we have curated from across our nationwide network of STLT agencies, organizations, industry partners, and academic institutions.

Features of the COVID-19 ROC include a discussion forum, resources library, events calendar, member directory, and community-wide search option. Members of the community can engage on the virtual platform by uploading or downloading relevant materials, engaging in discussions, connecting with peers, and promoting relevant events. The discussion forum on the online community will serve as an interactive social storehouse to help local and state agencies share resources and templates on COVID-19 communication, training, and inspections. The discussion forum also allows users to comment on posts and cast positive votes on responses to recommend a response or highlight it as a “best answer.” The follow button allows a user to follow a discussion thread as it develops.

The COVID-19 ROC is monitored by NEHA to provide a safe, secure, and productive virtual environment that is conducive for peer-to-peer learning and knowledge sharing. The membership of NEHA’s COVID-19 ROC is diverse and is open to STLT governmental environmental and public health agencies and programs, other state agencies and departments, federal agencies, national organizations, industry personnel, and academic institutional partners.

To join the COVID-19 ROC, visit https://emergency-neha.org/covid19/communities.

NEHA Staff Profile

As part of tradition, NEHA features new staff members in the Journal around the time of their 1-year anniversary. These profiles give you an opportunity to get to know the NEHA staff better and to learn more about the great programs and activities going on in your association. This month we are pleased to introduce you to one NEHA staff member. Contact information for all NEHA staff can be found on page 56.

Madelyn Gustafson

I officially joined NEHA in August 2019 as a project coordinator in Program and Partnership Development. Prior to this opportunity, I worked as a preceptor at NEHA and finished up my undergraduate degree. After a summer working with NEHA, I knew this organization was exactly where I wanted to start my environmental health career.

Born and raised in Wisconsin, my family and I loved spending every possible moment outdoors. These memories range from backyard cookouts to weekends “up north.” My love for these moments continued into college at the University of Wisconsin–La Crosse as I decided to pursue a degree in public health–community health education with a focus on environmental studies. As a young public and environmental health professional, I am motivated to provide adequate needs and care to all people, grow our communities to become more sustainable, and help shape the next generations to be happier and healthier.

In my personal life, you can find me exploring the Colorado landscape, listening to music, golfing, planting and gardening, and cheering on the Milwaukee Brewers, Milwaukee Bucks, and the Green Bay Packers. Go Pack go!
Celebrating the 50th Anniversary of Earth Day
By the NEHA Earth Day Committee

The National Environmental Health Association’s Earth Day artwork was created by staff members Lexi Nally and Seth Arends.

NEHA proudly celebrated Earth Day 2020 with the Earth Day Network on April 22, marking 50 years of Earth Day. Since the first Earth Day in 1970, the U.S. has made tremendous progress improving air quality, cleaning up contaminated lands, and protecting our water resources. The Earth Day 2020 theme was “Climate Action.”

In honor of this historic celebration, NEHA organized several interactive activities.

NEHA Staff Emissions Survey
NEHA conducted an internal emissions survey with Denver and Washington, DC, staff regarding their morning and evening commutes to work. The results from this survey display the positive environmental impact of our teleworking and highlight potential areas where we can grow this impact. Figure 1 summarizes the results from the survey.

FIGURE 1
Teleworking Impact of National Environmental Health Association Staff

<table>
<thead>
<tr>
<th>Total gallons of gas saved per day of teleworking</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total pounds of CO2 saved per year of NEHA staff teleworking one day per week</td>
<td>25,520</td>
</tr>
<tr>
<td>Total pounds of CO2 saved per day of NEHA staff teleworking</td>
<td>601</td>
</tr>
<tr>
<td>Total distance NEHA staff commute everyday</td>
<td>855 miles on average</td>
</tr>
</tbody>
</table>

Based on the NEHA Emissions Survey of staff’s morning and evening commutes.
Earth Day Twitter Chat (#EarthDayChat)
NEHA, the Environmental Law Institute, and Climate for Health hosted an Earth Day Twitter Chat on April 21. In total, 123 Twitter users from around the world gathered to discuss climate action and what steps they are taking to combat the challenges of climate change.

The #EarthDayChat resulted in the following:
• 188 posts,
• 103,444 unique users reached, and
• 233,778 impressions (i.e., the number of times posts were seen).

Thank you to everyone who participated in the chat and made the informative discussion a success. To read answers and responses from the chat, search for the hashtag #EarthDayChat on Twitter.

What Earth Day Means to Me
NEHA created the What Earth Day Means to Me campaign to hear from members, affiliates, staff, and all environmental health professionals and learn what Earth Day means to them. Responses from the campaign are posted on a blog at www.neha.org/membership-communities/get-involved/day-in-life/what-earth-day-means-me.

Earth Day 2020 Lunch & Learn
NEHA invited Jessica Lally, a program administrator at the City and County of Denver in the Department of Transportation and Infrastructure, to speak about recycling during a staff presentation on Earth Day 2020. Lally educated staff on best practices for recycling in our personal lives, as well as in the office. As NEHA continues to improve our impact, we were grateful to collaborate with local partners to work toward bettering our sustainability measures. Visit www.neha.org/earth-day-recap for a full recap and to download the Lunch & Learn recycling presentation.

Thank you to all who participated in our Earth Day 2020 activities and made it a successful and memorable celebration. We look forward to Earth Day 2021!

Just in Time From NEHA Video Series
By Kim Koenig (kkoenig@neha.org)
NEHA has introduced a new training tool for environmental health professionals. The Just in Time From NEHA Video Series serves up timely environmental health insight in digestible bites. NEHA is partnering with agencies and experts to develop informational videos that break down important topics, provide best practice tips, and even offer some perspective. With an eye towards educating and supporting environmental health professionals, each video comes with helpful links for deeper dives and printable resources to use and share.

Michele DiMaggio, NEHA Region 2 vice-president and retail health supervisor in Contra Costa County, California, brought her experience to the COVID-19: Farmers Market Safe Operations video. This Just in Time From NEHA video addresses issues and practical solutions for farmers markets, swap meets, and produce vehicle operations during the pandemic. DiMaggio clarified that farmers markets are considered essential businesses and offered a wealth of practical advice and reusable tools to help markets adjust their operations.

“Many environmental health professionals have the same questions and concerns. Hearing about our experiences and work might help other environmental health professionals in their daily decision making,” stated DiMaggio, highlighting the benefit of these easy-to-access training videos. “I received many positive responses after the farmers market video was posted.”

The first Just in Time From NEHA Video Series—COVID-19—will cover a range of pandemic-related public health concerns, policy highlights, and suggested practices. Subjects include Food and Drug Administration temporary guidance, preventing COVID-19 transmission in the workplace, and challenges faced by environmental health professionals as federal, state, and local responses to the pandemic evolve.

The complete Just in Time From NEHA library, including additional links and printable resources, can be found at www.neha.org/just-in-time. NEHA will continue to expand this educational collection and would like to hear from you and the environmental health community. Visit the Just in Time From NEHA web page, view a video or two, and submit ideas for educational topics and environmental health trends that deserve the spotlight.

In continued support of environmental health professionals during the COVID-19 pandemic, NEHA has posted an updated COVID-19 page at www.neha.org/covid-19. The page provides information on COVID-19 updates, resources for environmental health professionals, guidance resources, articles, and more. You can also find a list of NEHA resources that include the COVID-19 Response Online Community, Just-in-Time From NEHA Video Series, and COVID-19: Essential Functions of the Environmental Health Workforce Live Chat Series.
DirecTalk
continued from page 62

space we currently lease. I sense with some exceptions, like human resources, our Journal archive, accounting, and possibly membership functions, we can entertain a more decentralized and dispersed employee model. We have largely proven it can work in the Washington, DC, area; however, that team does benefit from routine face-to-face interactions that occurred under normal circumstances through our arrangement with the Association of Schools and Programs of Public Health.

Most of our portfolio of organizational income is anchored in grants and contracts with the Centers for Disease Control and Prevention and Food and Drug Administration. These grants and contracts have been a blessing during the pandemic as our funding has not been greatly affected. We successfully negotiated with the hotel in New York City to return our 2020 Annual Educational Conference (AEC) & Exhibition deposit. The federal Paycheck Protection Program was helpful and essential to us in bridging a gap in income created by the cancellation of the 2020 AEC. Not one employee has been laid off or furloughed.

Our capacity building work has been redirected from a largely face-to-face environment to virtual, just in time trainings. And while we were slow off the mark, we are beginning to get traction in delivering digital training and education. In short, we seem to be adjusting to the new normal. I believe we should mold and shape our future, not be victims of circumstance, a pandemic, or anything else. Our new offices should reflect a nimble, cost sensitive, and member-centered ethos.

Each spring, like clockwork, purple martins return to our yard from their several month vacation in Brazil. These gregarious, chirping insectivores devour biting horse flies, hornets, and dragonflies by the truckload. They fledge their young along the perimeter of our property before embarking on a migration to South America around the beginning of August. They possess an amazing internal compass that guides them to the exact location where their birdhouse was the prior year. Over the last 3 years I have replaced each of the existing, dilapidated birdhouses with new ones and the martins do not seem to care, their homing instincts are world class. Whatever we decide with our office space and though the journey will likely be fraught with twists and turns, please know we will remain true to our homing instincts and remain committed to identifying and serving your needs.

Purple martins. Photo courtesy of David Dyjack.
Television has not played a major role in my family’s daily routine since the late 1990s when our Sony gave up the ghost and returned to the purgatory of deceased electrical devices. We chose not to replace it and have lived our lives sans TV for over 20 years. This choice has been a blessing and a curse. Among the curses is that I am often out of touch when our staff and business colleagues are ensconced in deeply animated conversations around the Game of Thrones, Tiger King, and during my lifetime, The Office.

I found myself visiting a relative many years ago and with some free time, decided to discover what all the fuss was about and started to watch an episode of The Office on DVD. I felt something was wrong—the characters were talking to the camera. It was surreal. I expressed to my family that I must have been provided an incorrect copy of the sitcom because clearly something was awry as television characters do not talk to the guy operating the camera. Of course, I was mistaken, the world had changed. Joke on me.

Our association office lease is up for renewal in July 2021 and the joke was almost on me, yet again. Let me explain. Tradition in the office leasing universe is for organizations like the National Environmental Health Association (NEHA) to retain a real estate broker who negotiates the lease for new office space. The broker is paid a finder’s fee by the building’s owner, so in this case, we (NEHA) do not pay for the service. Likewise, when the building is identified, the lessee (NEHA) works with an architect to design the space and in most cases, the building management pays for most or all that service.

My e-mail inbox is inundated by brokers who desire to represent us: it is annoying. Given that we have about a year to move or remodel, selecting a broker is not a trivial decision. In January we retained a broker, chose an architect, and created a staff committee to work on the office issue. We factored in telework and my sensibilities of a casually elegant office. We threaded in longtime member Bob Powitz to determine if we could embed some of his historical environmental health artifacts into our new conceptual office design. The relocation train was chugging down the tracks. We surveyed staff to secure their preferences for where in the Denver metroplex they found desirable and what attributes, physical characteristics, and amenities would enhance their work life. As I jetted off for Wellington in early March to speak at the New Zealand environmental health conference, the general sense was that we needed more office space than we currently provide to accommodate expressed staff needs. Then, COVID-19 happened.

Since March 16, 2020, we have been in a 100% telework environment. Our Washington, DC, area staff work entirely at home, as most of our Denver area employees do now. A handful of our staff visit the office intermittently to take care of essential tasks such as fulfilling book orders, printing, signing checks, and other odds and ends. In other words, perhaps we did not actually need more space after all. Our leadership team connects each Monday morning and as a routine, we discuss how telework is sorting out for each of our operational units. The consensus is that employees prefer the 100% telework environment and that supervisors seem pleased with staff productivity.

This consensus brings me back to the office. We currently spend around $24,000/month on rent. It was a lease I inherited. I gasp at the number, as I have for the last 5 years, and have made efforts to terminate the contract. This train of thought leads us to several existential questions. How much space do we really need to create and deliver value to NEHA members? How many days of telework are the magic number that give rise to team effectiveness? How do we onboard new employees in an effective manner to ensure they know who NEHA members are and what they desire of us? How about our corporate culture? For those of you who read my columns, you recognize that they are typically chocked full of questions for which I have no clear answers. This one is no different and the struggle is very real.

We have recently hired a new human resource manager who started in June. Early in her experience with us, I alerted her that we needed an office that reflected 2032, not 2022, and that she would be running point on that effort. I believe we can optimize our effectiveness with half the
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