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Communicating Results of Drinking Water Tests From Private Wells

DESIGNING REPORT-BACK MATERIALS TO FACILITATE UNDERSTANDING

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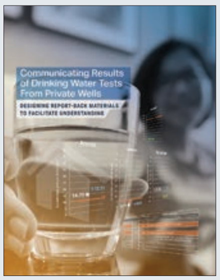

More than 42.5 million people in the U.S. rely on private wells for household water use. This month's cover article, "Communicating Results of Drinking Water Tests From Private Wells: Designing Report-Back Materials to Facilitate Understanding," assessed the effectiveness of graphic-based (i.e., pictorial) report-back materials in communicating the presence of toxic metals in private well water and soil samples. It also explored associations between recommendations in the report-back materials and appropriate actions to protect health taken by a subset of participants in an environmental monitoring pilot study. The results suggest that a simple pictorial format, in combination with more detailed supporting text, can be useful in highlighting results that require action.

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PRESIDENT'S MESSAGE

D. Gary Brown,
DrPH, CIH, RS, DAAS

An Opportunity to Educate the Public, Policy Makers, and Other Professionals

As I mentioned in a previous column, environmental health professionals were the founders of the American Public Health Association. Most people do not realize that environmental health professionals were key personnel at the start of the Centers for Disease Control and Prevention (CDC) on July 1, 1946, helping to fulfill the primary mission of CDC to prevent malaria from spreading across the nation. Environmental health professionals helped start Earth Day. Every year on April 22, Earth Day marks the anniversary of the birth of the modern environmental movement in 1970, which arose out of pollution affecting our health. The Earth Day website states, "Until this point, mainstream America remained largely oblivious to environmental concerns and how a polluted environment threatens human health."

The first Earth Day had 10% of the U.S. population participating from all political parties, walks of life, and communities throughout the land. People were participating to improve the health of people in the U.S. through a reduction in pollution. The early 1970s saw the creation of the U.S. Environmental Protection Agency and Occupational Safety and Health Act. In addition, numerous environmental laws were passed, including the National Environmental Education Act; Clean Air Act; Clean Water Act; Endangered Species Act; and Federal Insecticide, Fungicide, and Rodenticide Act.

Earth Day went global with the first World Environment Day on June 5, 1973, led by the United Nations Environment Program. This year marks the 50th anniversary of World Environment Day, which has grown into a global platform for raising environmental awareness and spurring environmental action. Millions of people from 150 countries have taken part in World Environment Days, helping drive change along with motivating national and international environmental policy. Each World Environment Day is hosted by a different country and the official celebrations focus on a particular theme. The 2023 campaign is #BeatPlasticPollution, hosted by Côte d'Ivoire, and focuses on sustainable solutions to plastic pollution.

> *We have the wonderful advantage that environmental health messages are meaningful and impactful.*

International days and weeks are a powerful advocacy tool that provides an occasion to educate the public, policy makers, and other professionals. As stated in my September column, I am asking you to assist by becoming like the Whos—shouting from the roof tops the words people must hear far and near—by talking to folks outside our sphere, especially the younger generations about this wonderful, magical career.

As environmental health professionals, we need to let our policy makers, fellow professionals, and the public know the impact pollution has on health. Air pollution causes approximately 7 million premature deaths every year. Single-use plastics make up 70% of marine litter. The CDC Waterborne Disease & Outbreak Surveillance Reporting website (www.cdc.gov/healthywater/surveillance/burden/findings.html) estimates that 17 waterborne pathogens caused 7.15 million illnesses, 601,000 emergency department visits, 118,000 hospitalizations, and 6,630 deaths in 2014. Further, CDC estimates each year that 1 in 44 people gets sick from waterborne diseases in the U.S.

The Marketing Rule of 7 states a person needs to hear a message at least 7 times before they will take action. This rule was developed by the movie industry in the 1930s when studio executives discovered a certain amount of advertising was required to compel someone to see one of their movies. Regardless of a magic number of times for people to hear a message, everyone agrees messages are more effective when repeated.

As we all know, not all messages are created equally. We have the wonderful advantage that environmental health messages are meaningful and impactful since they affect health, something near and dear to everyone's heart. The varied stories of our profession can create an emotional connection. Unlike many professions, we touch all aspects of life having thousands of jobs performed by environmental health professionals. How many other professions can claim their members work in national parks, cruise ships, amusement parks, laboratories, water and wastewater treatment, disaster management, education, and restaurants for the armed services, nonprofits, government agencies, and industry in the U.S. We are a storybook with never-ending stories that involve all genres including action, adventure, detective work, mystery, science, inspiration, hope, changing lives, and communities.

What environmental health professionals need to improve on is spreading the message. When I speak with environmental health professionals throughout the county, they all passionately talk about environmental health since they care about our profession, which is much more powerful than talking about things we are ambivalent about. The more environmental health professionals we have spreading the word, the better because people listen more closely to people they care about or are in their community. The National Environmental Health Association is developing messages you can add to your tool kit to spread the word about this wonderful, wild world of environmental health.

We all know the more positive contact you have with your audience, the better your message will be not only received but also ingrained in people's heads. Think of the slogans for Nike (Just Do It) and Wheaties (Breakfast of Champions)—when you hear these slogan you know the brand. One of our slogans could be "Environmental Health: The Profession Changing the World."

As Aristotle said, "There can be no words without images." Good storytellers make emotional connections. We have the stories, images, and storytellers to share this wonderful, wild world of environmental health. As Jimmy Cliff sang in *One More*, "I got one more story to tell; Mystery, my story; I got one more story to tell; True story, my glory; One more, one more, one more, one more." Please help spread the environmental health word day and night by sharing your story with everyone in sight.

D. Gary Brown

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Communicating Results of Drinking Water Tests From Private Wells: Designing Report-Back Materials to Facilitate Understanding

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Abstract **This evaluation assessed the effectiveness of graphic-based (i.e., pictorial) report-back materials in communicating the presence of toxic metals in private well water and soil samples. It also explored associations between recommendations in the report-back materials and appropriate actions to protect health taken by a subset of participants in an environmental monitoring pilot study. Overall, 39 residents of Stokes County, North Carolina, participated in the Well Empowered pilot study, which included water and soil testing and analysis. All participants received materials explaining the extent to which toxic metals were present in their well water and soil. A subset of participants (*n* = 14) responded to a follow-up evaluation, which showed that many found at least one component of their test results "very easy to understand." The existence of a federal standard for comparison appeared to influence participant recall of results, which was more accurate for contaminants with a federal maximum contaminant level. Our evaluation results suggest that a simple pictorial format, in combination with more detailed supporting text, can be useful in highlighting results that require action.**

Introduction

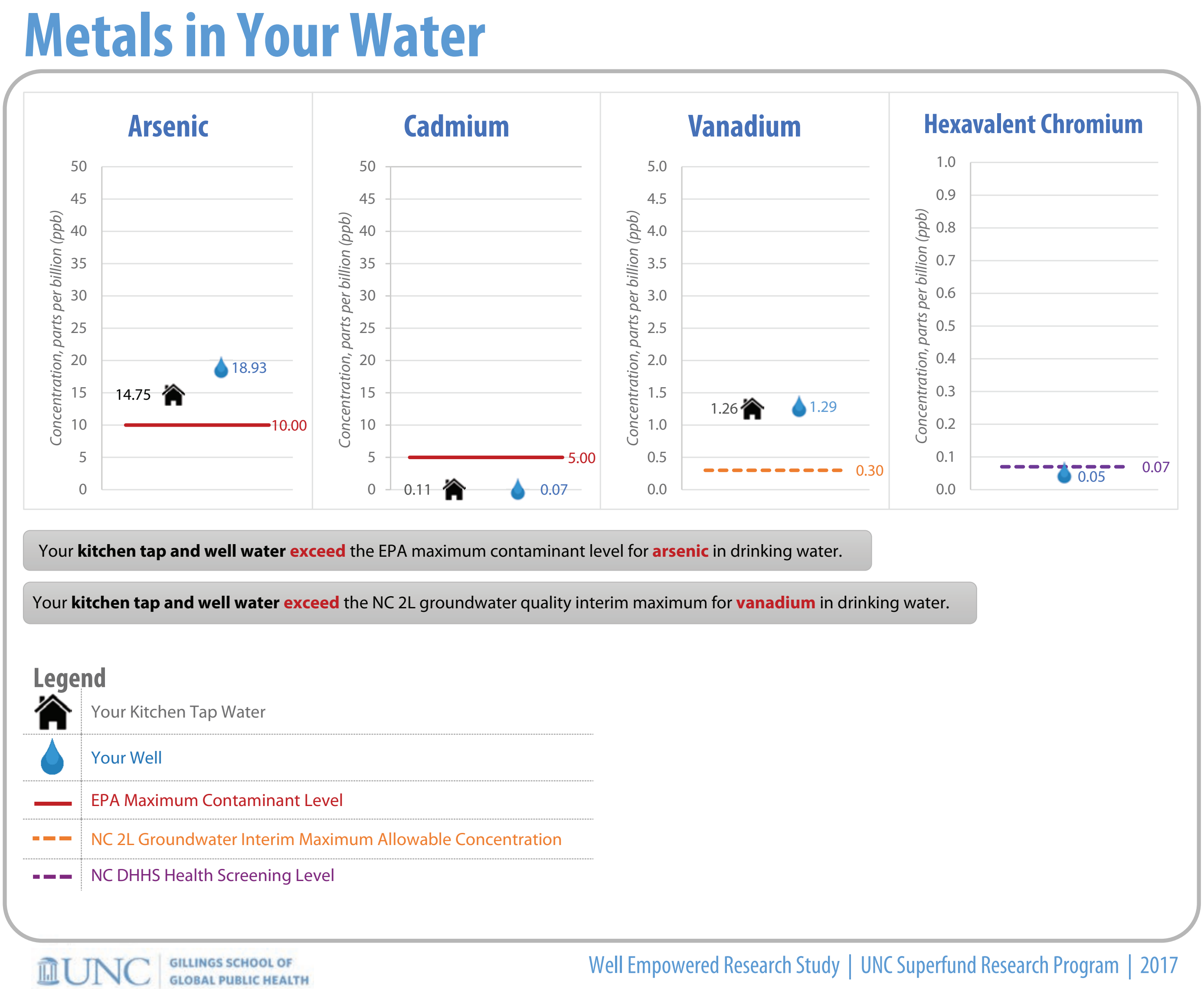
More than 42.5 million people in the U.S. rely on private wells for household water use (Dieter et al., 2018); over 20% of those wells contain one or more contaminants at concentrations exceeding health-based standards (DeSimone et al., 2009). Yet no ongoing monitoring of private wells is required, meaning well users are responsible for testing wells and remediating contamination. Without testing, residents using private wells for drinking water could be unaware of contamination. Barriers to testing include cost, convenience, and optimism bias (Fox et al., 2016; Zheng & Flanagan, 2017). Additionally, well users rely on sensory cues (e.g., taste, smell, discoloration) to determine if water is safe to drink, despite many contaminants not being detectable by such cues (Flanagan et al., 2015; Jones et al., 2006). The promise of obtaining personal results about drinking water quality might incentivize participation in well testing studies (Segev et al., 2021), but understanding the results sufficiently to take appropriate action can still be a challenge (Chappells et al., 2014; Jones et al., 2006; Kreutzwiser et al., 2011).

Increasingly, the reporting of sampling results to study participants is viewed as contributing to the development of environmental health literacy, which enables participants to make health-protective decisions (Brody et al., 2014; Gray, 2018; Morris et al., 2016; Severtson et al., 2006). Understanding well test results prepares participants to take steps to reduce harmful exposures (Ramirez-Andreotta et al., 2016), though awareness alone is not sufficient for exposure reduction (Zheng & Flanagan, 2017).

Within this context, the Well Empowered pilot study was conducted in North Carolina, a state where approximately 2.4 million people (25% of residents) access their drinking water from private wells (Dieter et al., 2018). Toxic metals from industry-derived and naturally occurring contamination have been identified in private wells across North Carolina (Sanders et al., 2012; Vengosh et al., 2016). After learning about the presence of such metals in local wells, residents in Stokes County reached out to the University of North Carolina at Chapel Hill Super-

FIGURE **1**

Example of the Pictorial Format Used to Present Results to Study Participants of Well Water Testing for Toxic Metals



Note. DHHS = Department of Health and Human Services; EPA = Environmental Protection Agency; NC = North Carolina; UNC = University of North Carolina.

fund Research Program (SRP), to help them identify potential exposures and associated health risks. SRP researchers collaborated with residents to address their concerns and develop strategies to reduce exposure (Tomlinson et al., 2019). This collaboration was informed by previous efforts to share results from exposure studies in ways that build environmental health literacy (Boronow et al., 2017; Ramirez-Andreotta et al., 2016). As part of this pilot study, a subset of participants joined an evaluation focused on: 1) the effectiveness of using pictorial materials to report well water and soil test results to study participants and 2) whether such communications were associated with recall of test results or subsequent health-protective actions.

Methods

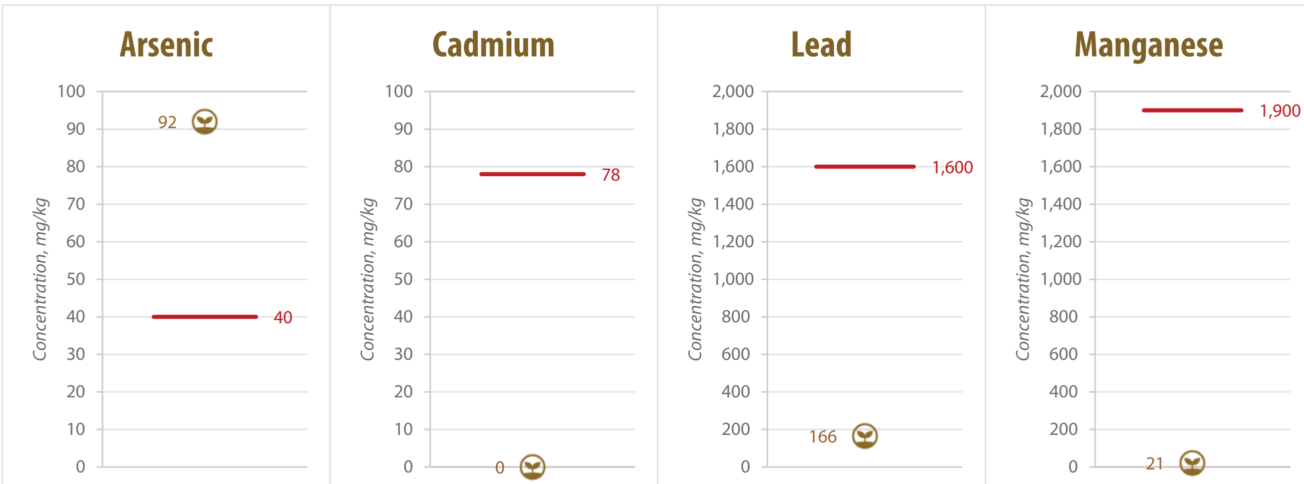
Participants in the Well Empowered pilot study (*N* = 39) were invited to participate in a follow-up evaluation to provide feedback on report-back materials provided by the study. All Well Empowered participants completed a survey documenting their usage of well water, previous well testing, and where relevant, understanding of prior test results. The sampling process has been described elsewhere (Tomlinson et al., 2019) and the study was deemed exempt by the Institutional Review Board of the University of North Carolina at Chapel Hill (IRB# 16-1721).

FIGURE **2**

Example of the Pictorial Format Used to Present Results to Study Participants of Soil Testing for Toxic Metals

Metals in Your Soil

All results are presented in milligrams per kilogram (mg/kg).



Your Soil Compared to EPA Regional Screening Levels

Any results with a gray background are considered to be above the federal screening level for that contaminant.

Contaminant	Screening Level	Your Soil
Arsenic	40	92
Cadmium	78	0
Lead	1,600	166
Manganese	1,900	21

Legend

Your Soil

EPA Regional Screening Level

UNC Gillings School of Global Public Health

Well Empowered Research Study | UNC Superfund Research Program | 2017

Note. All soil sample analysis was conducted at the EPA National Exposure Research Laboratory.

Note. EPA = Environmental Protection Agency; UNC = University of North Carolina.

In response to concerns about local industrial contamination, approximately one half of Well Empowered participants (49%, *n* = 19) had previously tested their wells for metals and a subset indicated they did not understand prior results that were provided in a text or table format by local agencies, state agencies, or private laboratories. These participants found results "confusing" or noted that they "didn't know how to read it."

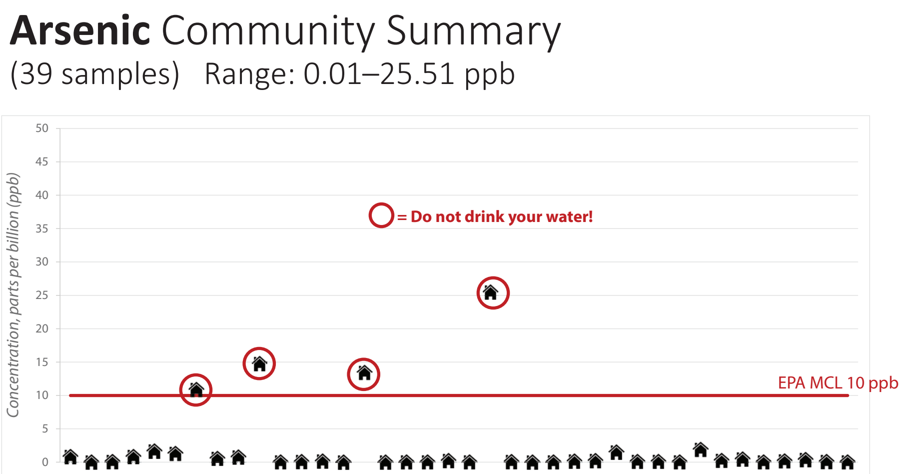
In the Well Empowered study, participants received printed report-back materials explaining the extent to which toxic metals were present in samples. Based on some participants' prior experiences of confusion, the research team aimed to develop materials that were understandable and could inform appropriate health-protective actions. Each packet contained:

- Pictorial results showing exceedances of relevant federal maximum contaminant levels (MCLs), secondary MCLs, treatment techniques, or state groundwater standards or health screening levels (Figures 1 and 2).
- Table of complete results for each water and soil sample.
- Fact sheets that explained health risks of exposure to contaminants that exceeded standards or guidelines.
- Definitions of terms that included different types of standards and guidelines.

Packets were distributed at a community presentation where aggregated results were shared with study participants and other residents (Figure 3). Research team members met individually with participants to explain

FIGURE **3**

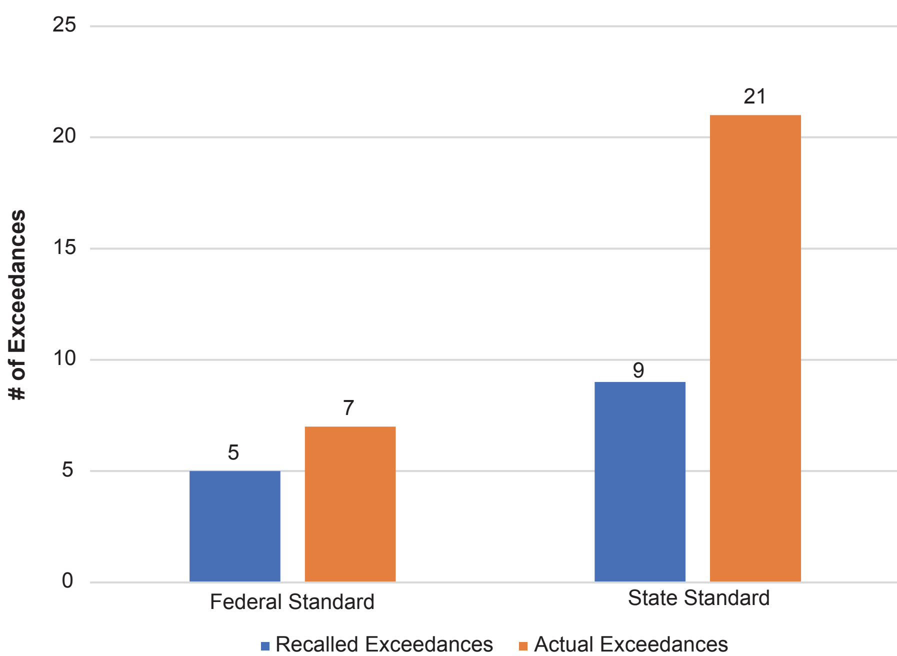
Example of a Slide Used During a Community Meeting to Present Community-Wide Well Water Test Results for a Single Contaminant



Note. EPA = Environmental Protection Agency; MCL = maximum contaminant level.

FIGURE **4**

Recalled Versus Actual Exceedances of Federal and State Standards in Well Empowered Test Results



results as needed. Residents who were unable to attend the meeting received their results via mail, with interpretation support from the project team as needed.

Within 90 days of packet distribution, an evaluation survey was sent to each participant. Respondents were asked to describe 1) their ease in understanding each component of the results packet using a Likert scale from very easy to very difficult and 2) perceived helpfulness of additional materials that were provided (e.g., contaminant fact sheets, definitions of terms). Residents also were asked to recall any exceedances in their well tests and if they had taken action in response to well test results. If the residents responded affirmatively, they were asked to describe the action(s) taken.

Results

Of the participants in the Well Empowered pilot study, 14 returned a complete evaluation survey and all had exceedances of some type. These respondents were representative of the larger pilot study sample in terms of demographics. Most respondents were White, self-identified as male, were >65 years, had at least some college education, and earned >$40,000 annually. Approximately 80% lived at their current residence for >10 years. Approximately 50% had not tested their wells in the 2 years prior.

Evaluation survey responses suggested that respondents found pictorial results and tabular results easy to understand. For water test results, 11 respondents rated their understanding of the two formats: 9 (82%) indicated that the pictorial results were "very easy to understand" and 7 (64%) indicated the table format was "very easy to understand." For soil test results, 9 respondents rated their understanding of the two formats, with 100% (n = 9) indicating that the pictorial results were "very easy to understand" and 7 (78%) indicating that the table format was "very easy to understand." Approximately 93% of respondents rated the supplementary materials (i.e., definitions of terms and contaminant fact sheets for exceedances) as "very helpful."

A total of 9 respondents attended the community meeting, along with approximately 20 other residents, and most respondents (89%) described the community presentation as "very easy to understand." During the community meeting, participants asked questions of the research team, with a subset of questions focused on how to interpret exceedances of state health screening levels or the state groundwater standard. Attendees also sought guidance in determining what actions they should take based on their results.

Even though respondents found results easy to understand, most could not correctly recall all exceedances in their results, with only two respondents accurately recalling all exceedances. Notably, respondents had a more accurate recall of exceedances of federal standards for well water or soil when compared with exceedances of state standards (73% versus 45%, respectively; Figure 4).

Among respondents who answered the question about follow-up action (n = 13), three took appropriate actions based on exceedances in their results (e.g., replaced pipes, shared results with doctor, installed filters). The well and soil results of these three respondents showed exceedances of at least one federal standard. Several respondents reported that they were still considering water filter installation. One respondent, who was drinking bottled water, indicated cost as a barrier to taking permanent action to reduce exposure to contamination.

FIGURE **5**

Adapted Version of Well Empowered Test Results

Your Well Results – Metals and Your Health

All results below are presented in parts per billion (*ppb*), which is equal to micrograms per liter (*µg/l*). Any results with an orange background are considered to be above the relevant standard. Contaminants are grouped under the relevant federal or state standard that regulates their presence in drinking water. Potential health effects are noted for any contaminants that exceed standards and for lead, which has no known safe level of exposure.

Contaminant	Standard	Your Water	Potential Health Effects
Federal Drinking Water Quality Standard (U.S. EPA Maximum Contaminant Level or Treatment Technique (TT) Action Level)			
Antimony	6	0.36	
Arsenic	10	10.89	Skin damage, circulatory system problems, and risk of cancer.
Cadmium	5	0.04	
Copper	1300 (TT)	12,748	Liver or kidney damage; gastrointestinal distress.
Lead	15 (TT)	2.45	**There is no safe level of lead in water[1].** Infants and children: delays in physical or mental development. Adults: Kidney problems, high blood pressure, and increased risk of cancer.
Selenium	50	0.05	
Uranium	30	0.32	

[1]**US Environmental Protection Agency** set a Maximum Contaminant Level Goal (MCLG) for lead at zero based on the best available science which shows there is no safe level of exposure to lead.

Note: All sample analysis was completed at the UNC Superfund Research Program Chemistry and Analytical Core Laboratory.

Note. UNC = University of North Carolina; U.S. EPA = U.S. Environmental Protection Agency.

Discussion

In the Well Empowered study, results presented pictorially, together with tables and information about health effects, were designed to support well users in taking or considering appropriate actions. Yet in follow-up surveys, many could not recall all the contaminants that were present in their water. An inability to recall specific contaminants in well water or soil could limit the ability of residents to follow up appropriately, including implementing proper filtration methods or sharing information with a healthcare professional.

Existence of federal standards (such as MCLs) might have played a role in recall, as respondents typically could recall results for contaminants that exceeded a federal standard. The federal standards were represented as a bright red line in pictorial format, signifying danger, which also could have influenced respondents' attention to those contaminants. In contrast, multiple state standards were used as benchmarks for other contaminants in the Well Empowered pilot study, including established and interim groundwater quality standards and health screening goals. In report-back materials, the state standards were represented pictorially with different colors of lines (orange or purple) depending on the type of standard (groundwater standard versus health screening goal, respectively). These variations in color also could have influenced participants' perceptions of associated danger and recall. Further, emerging contaminants, such as vanadium and hexavalent chromium, might not have been as familiar to participants, which could have influenced their ability to recall them.

These results highlight challenges associated with communicating information on emerging contaminants, specifically the lack of relevant standards and limited or lacking information on potential health effects. Without an established reference point, residents might be less able to identify and take appropriate health-protective action. This finding is supported by questions raised in the community meeting about what actions, if any, residents should take based on test results when exceedances were not based on a federal standard. Ultimately, such decisions are up to the individual and grounded in the resources available to them and the amount of risk they are willing to accept.

When discussing potential actions, the research team communicated risks in a context of uncertainty related to potential health effects of contaminants that were not well studied. Given that expert views of risk often differ from lay public views (Frewer, 2004; Johnson & Slovic, 1998), researchers who share environmental exposure data with communities could benefit from training in principles of risk and science communication. Such training could prepare researchers to engage in dialogue with residents who are seeking to understand potential health implications and then implement health-protective actions.

Since completing this evaluation in Stokes County, North Carolina, the study team has collected evaluation surveys from over 250 participants in the Well Empowered study and we are currently analyzing these data for similar trends. Individual report-back materials have been adapted to provide results in table format (Figure 5), though we continue to use pictorial representations to share aggregated data in community meetings, where educators and scientists are available to interpret pictures and respond to risk-related questions. This evaluation also informed the development of tools to understand environmental health literacy associated with toxic metal contamination of groundwater (Gray et al., 2021), with resident feedback informing the next iteration of pictorial representations of well test results. Other recent studies have highlighted the value of using visual communication tools to build trust, accurately communicate health risk, and support people in taking appropriate health-protective actions (Machida et al., 2022; Tomsho et al., 2019). Taken together, these studies underscore the importance of iterative processes to refine report-back materials in response to assessments of participant engagement, understanding, and subsequent action.

The limitations of the Well Empowered pilot study apply to this evaluation as well, in particular, the small sample size and the relative homogeneity of the study sample. While the 14 evaluation respondents were representative of the larger pilot study sample, they were not necessarily representative of the population of well owners in the region or state. Additionally, participation in the study was voluntary and residents of the study community had been exposed to local media coverage about well water contamination issues during the study time frame, and this exposure could have influenced their responses.

Conclusion

The results of this evaluation underscore the value of incorporating pictorial representations when communicating technical information about well water contamination, especially to highlight results that require action and in combination with detailed information in other formats. This evaluation also suggests that established health-based standards might serve as important benchmarks for comparison of analytical results. Going forward, repeated cycles of assessment and refinement will provide insight into the most effective use of visual communications during the report-back process.

Acknowledgements: The study team acknowledges the support of our community partner on this project, Appalachian Voices, for assisting us in developing and implementing the sampling protocol and aiding us in connecting with community members. Many thanks to the study participants for giving us access to their homes and sharing samples of their water and soil for analysis. This work was supported by the National Institute of Environmental Health Sciences (Grant Numbers: P42-ES005948, P42-ES031007, P30-ES010126). The funder was not involved in study design, implementation, or publication.

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Decreased Moderate to Vigorous Physical Activity Levels in Children With Asthma Are Associated With Increased Traffic-Related Air Pollutants

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Abstract **People with asthma, particularly young children, are more adversely affected by traffic emissions—and regular exercise reduces asthma symptoms and improves lung function. We studied the relationship between air pollution and objectively measured physical activity in children with asthma who were attending a school near a freeway. We continuously monitored air pollutants—$PM_{2.5}$, PM_{10}, nitrogen dioxide (NO_2), and ozone (O_3)—at the school for 10 weeks and measured physical activity levels via accelerometry in children ($n = 12$, ages 6–12 years). Concentrations of $PM_{2.5}$, PM_{10}, and NO_2 were negatively associated with moderate to vigorous physical activity ($PM_{2.5}$ and PM_{10}: $p < .001$; NO_2: $p = .04$) and positively associated with sedentary activity ($PM_{2.5}$ and PM_{10}: $p < .001$; NO_2: $p = .02$). Physical activity is decreased and sedentary behavior is increased in children with asthma when air pollutants are higher. Strategies are available to mitigate air pollutant impact on beneficial physical activity during the school day.**

Introduction

Exposure to Air Pollutants and Physical Activity

Physical activity is essential for overall health (Janssen & LeBlanc, 2010). Regular outdoor activities, such as walking or jogging, can lead to a significantly lower risk of cardiovascular disease and metabolic syndrome (Chen et al., 2013). Outdoor physical activity, however, also exposes people to air pollutants that can lead to adverse health problems such as cardiovascular diseases (Le Tertre et al., 2002; Sharman et al., 2004), respiratory diseases (Pope et al., 2009; Shah et al., 2013), diabetes (Bowe et al., 2018), and obesity (An et al., 2018).

During physical activity, a higher deposition of air pollutants in the lungs can occur due to increased respiratory intake (Giles & Koehle, 2014). In controlled studies, the exposure to air pollutants during exercise has led to a reduction in performance (Rundell et al., 2008) and inhalation of airborne particles during exercise has been associated with a reduction in lung function (Cutrufello et al., 2012). Increased levels of air pollutants have also been associated with self-reported inactivity (Roberts et al., 2014; Wen et al., 2009). For these reasons, exposure to an environment with an increased level of air pollution might lead to adverse health effects due to airway exposure to airborne pollutants from increased respiratory intake and also lack of physical activity.

Air Pollutants in the School Environment

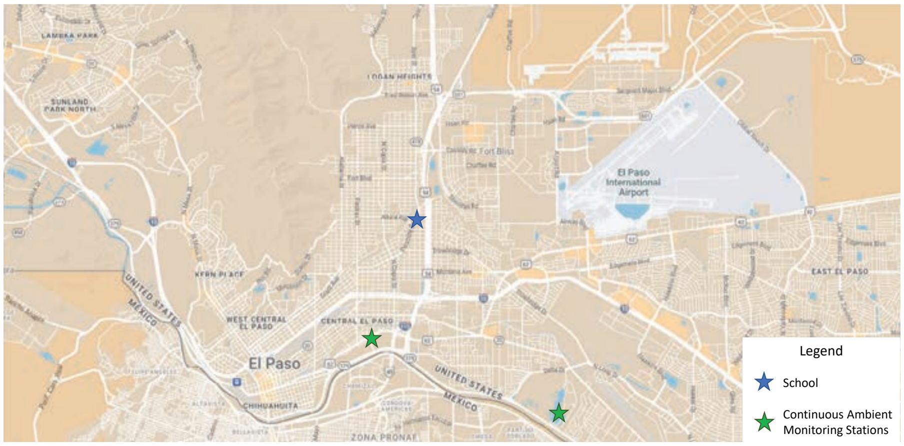
Spending time in an environment near heavy traffic is particularly harmful to children. Children attending elementary school spend 6–8 hr/day in school microenvironments that commonly also include outdoor activities. In many countries, severe conditions of air pollution frequently require the cancellation of physical or sport activities in elementary schools, which could lead to an increase in sedentary behavior (Giles & Koehle, 2014). This occurrence is particularly relevant for schools located near busy traffic intersections or freeways where children might be exposed to higher levels of air pollution from traffic. Coarse particulate matter (PM_{10} or particles <10 μm in aerodynamic diameter), fine particulate matter ($PM_{2.5}$ or particles <2.5 μm in aerodynamic diameter), nitrogen dioxide (NO_2), and ozone (O_3) are some of the traffic-related air pollutants to which children of roadside communities are commonly exposed.

Physical Activity in People With Asthma

People with asthma might engage in fewer aerobic activities and less physical activity overall due to concerns of triggering asthma symptoms (Garfinkel et al., 1992; Mälkiä & Impivaara, 1998). Given that asthma affects children at a young age when they are likely to establish their health habits, it is important to emphasize physical activity with pediatric asthma patients (Mancuso et al., 2006). National management guidelines for asthma state that most people's symptoms

FIGURE 1

Location of School and Continuous Ambient Monitoring Stations



can be controlled well enough for them to perform physical activity and that healthcare professionals can provide additional therapy options if needed (National Heart, Lung, and Blood Institute & National Asthma Education and Prevention Program, 1998, 2007).

Given the benefits of physical activity, it is in the best interest of people with asthma to achieve a balance between controlling their respiratory symptoms and regular exercise. The impact of air pollution on people with asthma, however, can also prevent them from achieving a physically active lifestyle. In controlled studies among groups exposed to higher concentrations of air pollutants, there was a higher risk of asthma attacks (Sharman et al., 2004) and lung diseases (Giles & Koehle, 2014). Furthermore, children with asthma who live in low-income communities are likely to have increased clinical asthma symptoms when they are exposed to short-term increases in air pollutants (Wendt et al., 2014).

To our knowledge, there are no studies that have assessed changes in air quality over time that examine how those changes correlate with objectively measured physical activity in children with asthma in a school setting. Our study investigated the relationship between physical activity levels and air pollution in children with asthma, along with other social, demographic, and medical factors. We expect the findings of our study to fill this gap of knowledge and inform the implementation of policies and health recommendations for communities to reduce the adverse effect of air pollution on physical activity in school settings.

Methods

Setting, Population, and Sampling

This study was conducted in El Paso, Texas, from October to December 2017 at an elementary school located within 50 ft of a freeway with heavy traffic. Air pollutants and concurrent meteorological data were continuously monitored throughout the study. Physical activity was assessed weekly during school hours. The institutional review board of The University of Texas at El Paso approved the protocol.

Children with asthma were recruited by contacting the school nurse and distributing flyers to students and their parents. The parent or legal guardian of each participant provided written consent and the children provided assent. Consent and assent forms were available in English and Spanish. The selection criteria included children between 6 and 12 years with a medical diagnosis of asthma, no other lung disease or major illness, and living in a nonsmoking household. In total, 12 children met the eligibility requirements and participated in the study.

At the start of the study, parents completed a questionnaire regarding health status, current allergies, insurance status, medication usage, household characteristics, symptoms, activity limitation due to symptoms, emergency department visits, and hospital admissions. The children answered questions weekly about medication use and symptoms using the Asthma Control Questionnaire (Juniper et al., 2010). English and Spanish versions were made available for all questionnaires.

We measured physical activity rates—categorized by activity intensity as moderate to vigorous physical activity (MVPA), light, and sedentary—using an accelerometer (wGT3X-BT, ActiGraph) placed on the participant's wrist each week between 9 a.m. and 2 p.m. We used ActiLife software (version 6.13.3) using the children algorithm (Freedson et al., 2005) to distinguish the three levels of activity.

Air pollutants were continuously measured using GRIMM Technologies Aerosol Spectrometer 11-A (for PM_{10} and $PM_{2.5}$), 2B Technologies Model 405 NO_2/NO/NO_x (for NO_2), and 2B Technologies Model 202 (for O_3) placed outdoors between the school building and I-375 highway. We collected temperature and relative humidity data from the nearest weather station located at El Paso International Airport. We used air pollution data recorded by the Texas Commission on Environmental Quality from continuous ambient monitoring stations (CAMS) at Chamizal National Memorial Park in El Paso for comparison of site-specific $PM_{2.5}$, PM_{10}, and O_3 data. We used another CAMS site at Ascarate Park, a county park in El Paso, to compare NO_2 (Figure 1). Hourly measurements were averaged to calculate values for 24, 48, 72, and 96 hr before the physical activity measurements.

Data Analysis

We performed all statistical analyses using R version 3.2.2. To explore relationships between physical activity and outdoor pollutant concentrations, we used Spearman correlations. We compared physical activity outcomes between the subjects (% time spent in sedentary, light, or MVPA) using the Kruskal–Wallis test. We examined longitudinal associations between MVPA/sedentary physical activity measures and air pollution metrics using a generalized estimating equations (GEE) approach (Liang & Zeger, 1986). We assumed the subject-specific cluster and exchangeable correlation structure for the repeated measures of the physical activity data.

We ran separate models for each pollutant variable of interest (PM concentrations, NO_2, and O_3) with various exposure periods (24-hr, 48-hr, 72-hr, and 96-hr means). Meteorological variables, such as temperature and relative humidity, were averaged over the same periods. We included exposure windows from 24-hr up to 96-hr averages of pollution before the physical activity measurements, as an effect of air pollutants on physical activity might require more exposure time to manifest a change in time spent in physical activity. We controlled for temperature and relative humidity because 96-hr means of temperature and relative humidity showed the strongest associations with the measured outcomes. Also, we considered a model using the maximum 8-hr average concentration of ozone during each exposure interval, as the 8-hr mean aligns with the safe exposure limit for human health established by agencies such as the U.S. Environmental Protection Agency. Effect estimates for each measurement are presented as the percent change in time spent performing physical activity per increase in pollutant concentrations. We considered a *p*-value of <.05 as statistically significant.

TABLE **1**

Air Pollutants Measured at the School and by Continuous Ambient Monitoring Stations (CAMS)

Air Pollutant	24-hr Mean (School)	48-hr Mean (School)	72-hr Mean (School)	96-hr Mean (School)	96-hr Mean (CAMS)
$PM_{2.5}$ (µg/m³)					
Mean	12.5	11.7	11.5	12.2	10.2
SD	3.7	2.4	1.9	2.8	5.3
Median	13.2	11.1	11.4	11.3	9.8
IQR	4.9	4.1	3.1	4.1	5.2
Maximum	18.9	15.7	14.3	17.6	18.7
Minimum	6.3	9.0	8.6	8.6	3.4
PM_{10} (µg/m³)					
Mean	45.3	43.1	42.6	44.9	36.9
SD	17.4	12.5	8.7	9.1	12.4
Median	40.3	38.5	40.3	45.8	38.7
IQR	24.6	19.1	11.9	9.6	16.8
Maximum	74.1	62.3	57.0	60.1	51.6
Minimum	24.5	25.9	31.4	28.5	13.8
NO_2 (ppb)					
Mean	17.6	18.2	18.4	18.9	17.9
SD	6.1	3.3	3.1	3.7	5.1
Median	19.2	18.6	18.5	19.0	16.3
IQR	7.8	4.8	2.8	5.0	5.2
Maximum	26.2	22.2	22.7	23.6	27.1
Minimum	7.2	12.2	12.2	11.6	13.0
O_3 (ppb)					
Mean	21.4	20.4	21.8	20.4	19.9
SD	10.5	6.7	7.3	5.5	5.1
Median	19.6	18.9	19.4	18.3	18.9
IQR	18.1	11.7	12.3	8.6	7.5
Maximum	38.9	31.1	34.5	29.7	28.4
Minimum	9.2	12.5	13.9	15.6	14.8

Note. IQR = interquartile range; NO_2 = nitrogen dioxide; O_3 = ozone.

Results

The air pollutant concentrations we measured had a considerable range and are listed in Table 1. We examined 24-hr, 48-hr, 72-hr, and 96-hr means measured at the school; these values were also compared to the 96-hr mean concentrations from the CAMS. Concentrations at the CAMS monitoring site were lower and standard deviations were higher compared with the school measurements.

The participants were 8.3 ± 1.5 years of age with a body mass index (BMI) of 17.9 ± 5.0 kg/m² (Table 2). The BMI-for-age percentile was 49.8 ± 41.2%. The physical activity levels for MVPA, light, and sedentary activity were 63.4 ± 8.2%, 10.1 ± 1.7%, and 26.5 ± 7.9% of the time, respectively. A pairwise *t*-test indicated the three activity levels were significantly different from each other (all $p < .001$ with Bonferroni adjustment).

The participant-specific factors including medication information are characterized in Table 3. We compared percent time spent in MVPA and sedentary activities by their factor levels using the Kruskal–Wallis test to examine if the mean proportions between factor levels were statistically different. The test results showed significantly different proportions for some factors (gender, BMI category, a father with asthma, siblings with asthma, having eczema, health insurance status, smoking status) and medications (leukotriene blockers, long-acting bronchodilators and inhaled corticosteroids, and nasal corticosteroids) with both MVPA and sedentary activities (see bolded *p*-values in Table 3). For example, type of insurance (i.e., Medicaid versus private) was a significant factor ($p = .003$): participants with Medicaid spent more time in MVPA (66.5%) than did those with private insurance (61.2%). Conversely, participants with Medicaid spent less time in sedentary activities (23.9%) than did those with private insurance (27.9%, $p = .04$).

Models Predicting Physical Activity Data

Table 4 presents effect estimates using GEE models, 95% confidence intervals (CIs), and

TABLE **2**

Participant Demographic, Anthropometric, and Physical Activity Data (*N* = 12)

	Mean ± *SD*	Range
Age (years)	8.3 ± 1.5	6–10
Height (in.)	54.3 ± 4.4	46.3–70.0
Weight (lb)	76.3 ± 27.3	45.8–134
BMI (kg/m^2)	17.9 ± 5.0	12.3–27.8
BMI (%)	49.8 ± 41.2	0–99.4
Physical activity (%)		
MVPA	63.4 ± 8.2	30.4–77.7
Light	10.1 ± 1.7	7.1–14.4
Sedentary	26.5 ± 7.9	13.7–61.7

Note. BMI = body mass index; MVPA = moderate to vigorous physical activity.

TABLE **3**

Participant-Specific Factors Compared With Physical Activity Levels

Specific Factor	Participant Frequency (*N* = 12)	Moderate to Vigorous Physical Activity		Sedentary Physical Activity	
	# (%)	%	*p*-Value	%	*p*-Value
Gender					
Male	7 (58)	65.8	**.001**	24.2	**.001**
Female	5 (42)	60.0		29.2	
BMI category					
Underweight and normal	8 (67)	61.9	**.010**	28.4	**<.001**
Overweight and obese	4 (33)	66.5		22.6	
Mother with asthma	5 (42)	63.2	.895	26.1	.503
No	7 (58)	63.6		26.7	
Father with asthma	3 (25)	60.9	**.041**	28.8	**.032**
No	9 (75)	64.3		25.7	
Mother with hay fever	8 (67)	63.4	.944	26.3	.595
No	4 (33)	63.5		26.8	
Father with hay fever	8 (67)	62.7	.305	26.9	.511
No	4 (33)	64.8		25.6	
Siblings with asthma	6 (50)	61.2	**.005**	28.8	**.001**
No	6 (50)	65.6		24.1	
Siblings with hay fever	8 (67)	63.0	.602	27.2	.169
No	4 (33)	64.2		25.1	
Having eczema	3 (35)	66.8	**.012**	23.2	**.011**
No	9 (75)	62.2		27.7	

continued on page 20

corresponding *p*-values. We scaled the effects to interquartile range (IQR) increases in pollutant metrics to compare the magnitude of effect across different scales of the pollutant concentrations. The 96-hr school pollutant concentrations ($PM_{2.5}$, PM_{10}, and NO_2) were negatively associated with MVPA ($PM_{2.5}$ and PM_{10}: $p < .001$; NO_2: $p = .04$), whereas they were positively associated with sedentary activity ($PM_{2.5}$ and PM_{10}: $p < .001$; NO_2: $p = .02$). The relationship between 96-hr O_3 and MVPA was not significant ($p = .7$). The 72-hr maximum O_3 data, however, were associated with a decreased rate of MVPA ($p = .001$).

The 96-hr mean ambient PM and NO_2 concentrations at the Ascarate CAMS were significantly associated with physical activity levels, showing consistent patterns of association with 96-hr school concentrations. The largest percent time spent in MVPA per school pollutant increase in IQR was observed in the association between 96-hr $PM_{2.5}$ and MVPA: 3.45% decrease in MVPA (95% CI [-5, -1.9]) as the IQR in $PM_{2.5}$ increased. We had a similar amount of percent change in sedentary activity: 3.43% increase (95% CI [1.78, 5.09]) as the IQR in $PM_{2.5}$ increased.

Discussion

Principal Findings

The 96-hr average concentration for each of the pollutants was higher compared with the CAMS (Table 1), indicating a higher exposure at the school. The proximity to a major freeway, as well as air pollutant concentrations contributed by school-specific traffic, potentially could lead to adverse health outcomes for children attending elementary school and participating in outdoor activities. In addition, as observed from the pollutant concentrations, we can infer that the larger time windows considered (72 or 96 hr) provide a better representation of the current air pollutant exposure for physical activity at the study site.

We found negative correlations between the 96-hr means of $PM_{2.5}$, PM_{10}, and NO_2 at the school and the amount of time spent in MVPA during school hours. In contrast, sedentary activity was positively correlated with air pollutant concentrations. This finding is consistent with other studies that have objectively measured physical activity using accelerometers. An increase in ambient $PM_{2.5}$ was associated with a reduction in weekly minutes of MVPA in a cohort of adolescents in Beijing, China (Yu et al., 2017), while a study among African American and Dominican children living in New York City found that those who engaged in >60 min of MVPA each day had higher personal exposure to black carbon, a pollutant associated with $PM_{2.5}$ (Lovinsky-Desir et al., 2016). Furthermore, a study conducted in California noted a positive association between wheezing and increased levels of NO_2 pollutants (Peters et al., 1999).

Positive correlations between O_3 and physical activity were no longer significant once we controlled for humidity and temperature, indicating that the O_3 levels might not directly impact physical activity but rather that the weather conditions that are usually correlated with O_3 levels can impact physical activity—as O_3 peaks at high temperature as a result of the ambient NO_2-O_3 photochemical reactions. The use of maximum 8-hr mean values of O_3, however, did yield a significant association. Another study that considered O_3 exposure showed that a high daytime O_3 concentration was consistent with an increased likelihood of new onset of asthma or exacerbation of undiagnosed asthma in physically active children (McConnell et al., 2002). This finding could mean that the effects of O_3 levels might be more significant if the values reach a specific threshold.

TABLE **3** *continued from page 19*

Participant-Specific Factors Compared With Physical Activity Levels

Specific Factor	Participant Frequency (*N* = 12)	Moderate to Vigorous Physical Activity		Sedentary Physical Activity	
	# (%)	%	*p*-Value	%	*p*-Value
Allergic phenotype (aeroallergens)	8 (67)	63.1	.597	26.7	.794
No	4 (33)	64.1		26.0	
Allergic phenotype (food)	3 (25)	61.8	.143	27.4	.366
No	9 (75)	64.1		26.1	
Caretaker education					
≤High school	6 (50)	63.8	.997	26.3	.771
≥High school	6 (50)	63.1		26.6	
Health insurance coverage (*n* = 11)					
Medicaid	6 (55)	66.5	**.003**	23.9	**.039**
Private	5 (45)	61.2		27.9	
Smoking (outside of household)	2 (17)	59.9	**.013**	29.9	**.010**
No	10 (83)	64.2		25.7	
Cooking Fuel					
Electric	1 (8)	68.7	**.035**	22.7	.127
Gas	11 (92)	62.9		26.8	
Medications					
Leukotriene blockers	7 (58)	66.4	**<.001**	23.7	**<.001**
No	5 (42)	59.4		30.3	
Short-acting bronchodilators	7 (58)	62.8	.155	27.3	.065
No	5 (42)	64.4		25.2	
Inhaled corticosteroids	6 (50)	63.2	.894	26.1	.493
No	6 (50)	63.6		26.8	
Long-acting bronchodilators and inhaled corticosteroids	2 (17)	68.1	**.012**	22.0	**.013**
No	10 (83)	62.6		27.2	
Nasal corticosteroids	4 (33)	66.8	**.003**	23.4	**.007**
No	8 (67)	61.7		28.0	
Systemic corticosteroids	2 (17)	64.6	.641	25.3	.791
No	10 (83)	63.2		26.7	

Note. The *p*-value for the mean difference in physical activity between participants was calculated using the Kruskal–Wallis test. Bolded *p*-values are statistically significant. BMI = body mass index.

Comparison With Other Studies

We noticed differences in gender in physical activity rates that are consistent with other published values (Troiano et al., 2008) but not with BMI. In our study, children who were overweight and obesity were more physically active than children who were categorized as healthy weight or underweight. We found correlations between health insurance and physical activity that could be related to asthma severity and more frequent visits in the Medicaid setting when compared with those in the private setting. A study among children ages 3 to 17 years with asthma showed that those enrolled in Medicaid were more likely to have a preventive care visit during the last year, and approximately one half of them did receive advice from a clinician about physical activity (Perry & Kenney, 2007).

Having a father or a sibling with asthma (but not a mother) was significantly correlated with more time spent in sedentary behavior and less time spent in MVPA. This finding is somewhat consistent with a study in Canada that found having a parent with asthma increased the odds of asthma and wheezing outcomes (Barry et al., 2014). This same study found increased odds of symptom severity if a mother was a previous smoker, but the study did not report any data on having either a father or a sibling with asthma. It is possible that a father's or sibling's physical activity level has more influence on a child's physical activity level (compared with the

TABLE **4**

Overall Associations Between Moderate to Vigorous Physical Activity and Sedentary Physical Activity and Pollutant Metrics

Pollutant	IQR	Moderate to Vigorous Physical Activity			Sedentary Physical Activity		
		Change in Time Spent per IQR (%)	95% CI	*p*-Value	Change in Time Spent per IQR (%)	95% CI	*p*-Value
$PM_{2.5}$							
24-hr mean (school)	4.9	0.47	[-0.54, 1.48]	.365	-0.96	[-1.92, 0.01]	.051
48-hr mean (school)	4.1	0.80	[-0.37, 1.96]	.180	-1.53	[-2.75, -0.31]	**.014**
72-hr mean (school)	3.1	-1.71	[-2.95, -0.46]	**.007**	1.43	[0.24, 2.61]	**.018**
96-hr mean (school)	4.1	-3.45	[-5.00, -1.90]	**<.001**	3.43	[1.78, 5.09]	**<.001**
96-hr mean (CAMS)	5.2	-3.86	[-6.12, -1.59]	**.001**	4.04	[1.71, 6.37]	**.001**
PM_{10}							
24-hr mean (school)	24.6	-0.43	[-1.50, 0.64]	.427	-0.06	[-0.99, 0.87]	.902
48-hr mean (school)	19.1	-0.58	[-1.66, 0.50]	.293	-0.17	[-1.18, 0.83]	.735
72-hr mean (school)	11.9	-1.32	[-2.24, -0.39]	**.005**	1.00	[0.09, 1.91]	**.031**
96-hr mean (school)	9.6	-1.59	[-2.37, -0.18]	**<.001**	1.51	[0.69, 2.34]	**<.001**
96-hr mean (CAMS)	16.8	-2.87	[-4.65, -1.08]	**.002**	3.07	[1.19, 4.95]	**.001**
NO_2							
24-hr mean (school)	7.8	-0.45	[-1.71, 0.82]	.489	0.43	[-0.62, 1.47]	.424
48-hr mean (school)	4.8	-0.28	[-1.41, 0.85]	.626	0.29	[-0.72, 1.30]	.574
72-hr mean (school)	2.8	-0.60	[-1.30, 0.11]	.098	0.66	[-0.06, 1.38]	.075
96-hr mean (school)	5.0	-1.35	[-2.62, -0.09]	**.036**	1.52	[0.25, 2.79]	**.019**
96-hr mean (CAMS)	5.2	-0.78	[-1.53, -0.04]	**.040**	0.63	[-0.12, 1.38]	.099
O_3							
24-hr mean (school)	18.1	-0.25	[-3.51, 3.01]	.881	1.16	[-2.10, 4.43]	.486
48-hr mean (school)	11.7	-1.31	[-4.01, 1.40]	.344	2.07	[-0.85, 4.98]	.164
72-hr mean (school)	12.3	-0.66	[-2.33, 1.01]	.437	1.41	[-0.37, 3.19]	.120
96-hr mean (school)	8.6	-0.33	[-1.81, 1.15]	.661	0.49	[-1.05, 2.04]	.530
96-hr mean (CAMS)	7.5	-0.04	[-1.51, 1.43]	.955	0.24	[-1.34, 1.82]	.766
72-hr mean (8-hr max.) [a]	9.9	-3.99	[-6.35, -1.63]	**.001**	4.62	[2.15, 7.08]	**<.001**

Note. Effect estimates are presented as the percent change of time spent performing moderate to vigorous physical activity or sedentary physical activity per increase in air pollutant concentrations. Bolded *p*-values are statistically significant. CAMS = continuous ambient monitoring stations; CI = confidence interval; IQR = interquartile range; NO_2 = nitrogen dioxide; O_3 = ozone.

[a] Additional model that used the maximum 8-hr average concentration of O_3 as the 8-hr mean aligns with limits established by regulatory agencies (only the significant model is shown).

mother's physical activity level)—therefore, if asthma in these relatives leads to decreased physical activity, it would have a greater impact on the physical activity of the child.

The treatment options for children with asthma depend on the severity of the child's condition (Masoli et al., 2004). Those with persistent asthma are recommended to take inhaled corticosteroids to control airway inflammation, and the addition of a long-acting β_2-agonist is an option for those who remain symptomatic with inhaled corticosteroid treatment only (Partridge et al., 2006). Higher levels of MVPA in children using some medications could be a result of increased control over asthma symptoms. Furthermore, in a study of healthy adults, pretreatment with a leukotriene blocker (montelukast) before exercise attenuated the effects of particulate matter inhalation in endothelial dysfunction, which is a cardiovascular health marker (Rundell et al., 2010).

Regarding physical activity, in a study looking into perceptions of health benefits versus detriments of exercise, researchers found participants with a more severe asthma condition were more likely to believe that exercise was not good for their asthma (Mancuso et al., 2006). In another study that included 27 adults with mild to moderate asthma, exercise participation was rated only 1.6 on a 4-point physical activity scale (Garfinkel et al., 1992). Among children with asthma, the severity of the disease and parental beliefs about physical activity and asthma predicted the activity level, although this finding was based on self-reported data (Lang et al., 2004).

Strengths and Limitations

Measuring physical activity in children is difficult. Compared with adults, children tend to have short bursts of activities that are more difficult to measure (van Gent et al., 2007). The gold standard for assessing physical activity is the double-labeled water method (Westerterp, 2009). This method, however, does not provide data about activity patterns or intensity and is expensive and logistically challenging. Accelerometers record the movement of the specific part of the body to which they are attached and thus differences in types of physical activities are mostly accurate (van Gent et al., 2007) and correlate reasonably with the gold standard technique (Plasqui & Westerterp, 2007).

The sample size was low due to the small number of students who have an asthma diagnosis attending the school. A sizeable number of repeated measurements, however, were obtained (*N* = 102) during the 10 weeks of the study. Additionally, GEE models allowed us to account for individual factors, which further validates the longitudinal associations with the mentioned traffic-related air pollutants. Although this study was longitudinal, it was observational—as such, cause and effect cannot be inferred from the results. Further controlled studies are needed to understand the cause-and-effect relationship between air pollution and the physical activity of children with asthma.

Conclusion

To our knowledge, our study is the first to characterize the effects of traffic-related ambient air pollutants in elementary school children with asthma using objective measures of physical activity. Our findings suggest that school-based monitoring of air pollutants can offer insights into the health risk of children's exposures and the impact on their physical activity. A higher concentration of traffic-related pollutants over 72-hr and 96-hr exposures was strongly correlated with time spent in MVPA in children with asthma.

During physical activity, an increased amount of air pollutant exposure could lead to increased asthma symptoms such as difficulty breathing or bronchoconstriction, which might explain a decrease in time spent in MVPA with a subsequent increase in sedentary behavior in an outdoor environment. To ensure children obtain the benefits of exercise during the school day regardless of temporal fluctuations in air quality, school districts can site new schools away from high-traffic roads, develop school zone transportation policies that minimize idling of cars, and use barriers to mitigate air pollution exposure in outdoor areas of schools.

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Did You Know?

National Public Health Week is April 3–9. This year's theme is "Centering and Celebrating Cultures in Health." During this week, the American Public Health Association brings together communities to recognize the contributions of public health and highlight issues that are important to improving our nation's health. Learn more at www.nphw.org.

GUEST COMMENTARY

Bacterial Contamination in Long Island Sound: Using Preemptive Beach Closure to Protect Public Health

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Abstract **Public health officials conduct water quality monitoring at marine beaches to reduce the risk of gastrointestinal illness. Climate change causes increased frequency of heavy rainfall events associated with pathogen-laden runoff, necessitating review of beach closure policies to ensure they are adequate to protect public health. Specifically, the lag of approximately 24–48 hr between collecting the water sample and reporting of assay results represents a period when the potentially contaminated beach remains open. Preemptive beach closure—the shutdown of beaches following a rainfall event of predetermined size—could serve as a solution.**

We surveyed 15 health departments of Connecticut towns along Long Island Sound and found that only 3 sampled after heavy rainfall events and only 6 practiced preemptive beach closure. We then used historical meteorological and water sampling data in logistic models to develop rainfall thresholds for preemptive closure for four Connecticut coastal towns and identified 2-day precipitation as the primary predictor of enterococci levels. Because preemptive beach closures can cause daily life and economic disruptions and are not widely popular, we engaged with stakeholders, town officials, and the public at each stage of the project. Through collaboration and transparency with communities, preemptive beach closure policies were implemented in two towns.

Introduction

U.S. public health officials at state and local levels are responsible for conducting water quality monitoring at marine beaches. It is evident that our changing climate and other human impacts necessitate review and revision of beach closure policies to reduce the risk of gastrointestinal illness in communities with recreational water activities.

Alterations related to climate change in weather patterns have led to increased contamination of marine waters (Heaney et al., 2014; Shehane et al., 2005). Transport and growth of enterococci—a fecal indicator bacteria distinguished by its ability to grow well in high salinity environments—is enhanced by heavy rainfall events that increase microbe-laden runoff and results in the release of fecal material into watersheds and eventually water bodies including coastal waters (Shehane et al., 2005). Sources of this potential contamination and runoff include animal agriculture, wildlife, wastewater treatment plants, central sewer failures, private septic systems, and stormwater systems (Byappanahalli et al., 2012). Predicted increases in the frequency of heavy precipitation events and water temperature (National Oceanic and Atmospheric Administration, 2023) likely will increase the frequency and magnitude of future contamination events.

The regulations and policies concerning beach closure at the federal and state level are potentially inadequate to protect public health. Current laboratory testing procedures require approximately 24–48 hr between sample collection and laboratory reporting of assay results, during which time the potentially contaminated beach remains open. Beaches are closed if enterococci levels are found to be above a threshold value; however, due to the long turnover time for analysis, beach closures based on previous-day bacteria tests are accurate only 33% of the time (Morrison, 2003). Furthermore, beach water often is tested only once per week, which suggests that local health departments do not have the necessary information to determine if their beaches are contaminated on popular beach bathing days.

Though the exposure-response association between bacterial indicators of fecal contamination in water and adverse health outcomes (e.g., gastroenteritis) among bathers has been

TABLE **1**

Summary of Recommended Preemptive Closure Thresholds for Beaches in the Towns of Branford, East Haven, Guilford, and Madison in Connecticut

Town	Preexisting Cut Point (in.)	Preemptive Closure Policy Adoption	Updated Cut Point (in.)
Branford	2.3	Yes	2.0
East Haven	2.3	Yes	2.0
Guilford	1.0	No	–
Madison	–	–	–

Note. No recommended preemptive closure threshold was provided for Madison due to insufficient data and an insufficient number of exceedance events in the available records. Overall, two of the four towns implemented preemptive beach closure policies.

studied for decades (Kay et al., 1994; Pond, 2013), the local variability of contamination and difficulty of screening for general symptoms associated with fecal bacteria exposure complicate the development of practicable guidelines to limit health risks from recreational water exposures (Fewtrell & Kay, 2015; World Health Organization, 2003). Literature review of epidemiological studies indicates that recreational water use is associated with gastrointestinal illness despite absence of reported outbreaks (Fewtrell & Kay, 2015). Children ≤10 years are at increased risk of gastrointestional illness, potentially because children are apt to swallow water, transfer water from hand to mouth after exposure, or spend more time in recreational water than adults (Wade et al., 2008).

The delay associated with water sampling, delivery of samples, and assay of the samples is a major limitation of the current protocol, but it could pose a greater threat of exposure to bathers in coming years. Given the expected increase in frequency of heavy precipitation events and increased temperatures associated with climate change (U.S. Environmental Protection Agency [U.S. EPA], 2016), reliance on regular once-weekly sampling alone likely will become even more insufficient to minimize bather contact with contaminated waters.

Preemptive beach closure—the shutdown of beaches following a rain event of predetermined rainfall intensity, duration, or amount—might be a solution to reduce bather exposure to probable high fecal bacteria counts during the time lag period between water sample collection and sample analysis and reporting (U.S. EPA, 2014). We note that to ensure safe water quality in shellfishing areas, in addition to conducting water sampling and testing for bacteria, it is standard practice to use preemptive closures based on 24-hr precipitation. Within Long Island Sound, all shellfish beds are closed with precipitation in excess of 3.0 in.

Developing Preemptive Closure Thresholds

To better understand current water sampling protocols and the use of preemptive beach closure by Connecticut towns with Long Island Sound beaches, we surveyed 15 local health departments. Overall, six departments closed their beaches when a sample was reported to be in exceedance, and beaches did not reopen until a negative resampling. Most respondents cited stormwater runoff after a rain event as their greatest source of water contamination, but only three departments specifically sampled after heavy rain events. Preemptive closure thresholds were used by six health departments: Fairfield (1.75 in.), Norwalk (1.6 in.), Greenwich (2.5–3 in. except for Byram Beach), Darien (1 in.), Stratford (1 in.), and West Haven (1 in.).

We then sought to develop preemptive closure thresholds for four Connecticut coastal towns: Branford, East Haven, Guilford, and Madison. Using historical meteorological and water sampling data, we initially developed town-specific predictive linear and logistic models through stepwise regression, modeling the dependent variable (i.e., continuous enterococci level or a binary contaminated/not contaminated variable) with our candidate independent variables of precipitation (lagged up to 1 week), beach, station (if there were multiple sampling sites at a given beach), and water temperature (lagged up to 1 week). This modeling identified 2-day precipitation (i.e., the sum of precipitation on the day of sampling and the day before sampling) as the primary predictor of enterococci levels in each town.

We then performed a cut point analysis by calculating the sensitivity, specificity, and Youden Index of cut points in 0.1-in. increments of 2-day precipitation. The Youden Index balances sensitivity (e.g., the ability to detect a beach contamination event) and specificity (e.g., the ability to detect the absence of a beach contamination event), which is appropriate for evaluation of dichotomous diagnostic testing such as the decision to close or not close a beach for a given rainfall event. The recommended cut point for preemptive closure was then selected by comparison of the positive predictive value of cut points associated with local Youden Index maximum values.

In Branford and East Haven, we recommended preemptive beach closure following 2.3 in. of 2-day rainfall, whereas in Guilford we recommended closure at 1.0 in. (Table 1). As the lag between sample collection and beach closure is >24 hr in these towns, these guidelines are anticipated to meaningfully decrease exposure of bathers to contaminated water. We did not recommend a preemptive closure threshold for Madison due to an insufficient number of exceedance events to model. Branford and East Haven implemented preemptive beach closure at 2 in.

A Local Response: Preemptive Closure

Preemptive closure is not a cure-all. Beach closure is a policy balancing act between maintaining beach accessibility by keeping beaches open and protecting bather safety with proper closures. Moreover, any rainfall cut point for preemptive closure will lead to both false negative and false positive closure decisions. Preemptive closure rainfall thresholds do not reflect other factors influencing contamination (e.g., tides, known contamination events such as sewage bypasses), and in addition to using rainfall thresholds, closure decisions must be based on the expertise of state and local public health departments. Regular sampling is still needed after adoption of preemptive closure thresholds to detect contamination events from unknown causes, to track the quality of beach water over time, and to provide data for analyses to update preemptive closure thresholds.

There is a relational, human component of successful public health policy change. Preemptive beach closures are not widely popular with communities and political leadership, as closures can be disruptive to daily life and the economy of coastal jurisdictions. Furthermore, change can create fear, which makes it essential to engage with people in the community who use the recreational bathing areas in question. This engagement needs to clearly communicate how the proposed policy—guided by science—is needed to protect public health, while at the same time listening to community concerns.

Prior to this project, the health department held informal conversations with key collaborators—including the mayors and members of local government boards, town parks and recreation departments, local state legislature representatives, and community associations—regarding our concerns that existing beach closure policies were inadequate for protecting public health. We publicly stated our intent through established public health and town public meeting venues to investigate root cause solutions, ensuring any policy changes would be grounded in solid data and science. In open and transparent discussions, we communicated the draft beach closure policy changes to town-governing entities, to the public through a public meeting process with the health department board of directors, and to community networks associated with our department's citizen science projects. Based on feedback, we improved our beach closure notification protocol to the public and town stakeholders.

Future research could investigate inclusion of additional variables in predictive contamination models, such as beach-specific variables, known contamination events, tides, and time-stamped sample and weather data. Investigation of rapid testing technology (e.g., qPCR) and live weather and water monitoring technology could in the future decrease the lag between sampling and availability of results. These improvements could potentially allow health departments to close beaches the same day as sampling and better inform weather-based preemptive closure. Incorporation of shellfish contamination data can provide additional insight. Predictive modeling and development of thresholds for preemptive beach closure could be extended to other coastal health departments. Finally, to account for temporal changes in precipitation patterns and in other factors influencing contamination, models could be updated regularly with new data.

Through collaboration and transparency with communities, practicable, research-based preemptive beach closure policies can be implemented, as was demonstrated in two Connecticut towns. These changes could improve on the benefits of preemptive beach closure and increase the safety of bathers in local recreational waters.

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PROGRAMS ACCREDITED BY THE NATIONAL ENVIRONMENTAL HEALTH SCIENCE AND PROTECTION ACCREDITATION COUNCIL

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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Note. G = graduate; UG = undergraduate.

BUILDING CAPACITY

Trusting Email to Build Capacity

Darryl Booth, MBA

Editor's Note: A need exists within environmental health agencies to increase their capacity to perform in an environment of diminishing resources. With limited resources and increasing demands, we need to seek new approaches to the practice of environmental health. Acutely aware of these challenges, the *Journal* publishes the Building Capacity column to educate, reinforce, and build upon successes within the profession using technology to improve efficiency and extend the impact of environmental health agencies.

This column is authored by technical advisors of the National Environmental Health Association (NEHA) data and technology section, as well as guest authors. The conclusions of this column are those of the author(s) and do not necessarily represent the views of NEHA.

Darryl Booth has been monitoring regulatory and data tracking needs of environmental and public health agencies across the U.S. for over 20 years. He is the general manager of environmental health at Accela.

The very first email was sent in 1971. By the mid-1980s, the world accepted email as a convenient, fast, and inexpensive means of communication. We all rely on email every day. We are experts. So why raise this topic in 2023 with the promise of building capacity?

We Still Do Not Trust Email for Important Notices

In fact, most environmental health departments (maybe most local government departments) still send paper mail by the U.S. Postal Service routinely, with the windows envelope representing the last major improvement in mailing.

My pitch, bearing testimony to the benefits of an all-digital mindset, often meets resistance. Yes, there is serious resistance to retiring paper, postage, and handling.

Here are the most common questions along with recommendations.

Can I Be Certain My Important Email Is Delivered and Read?

You cannot.

Yes, there are schemes that promise digital email read receipts and open tracking, but these are not reliable. These schemes could not be used, for example, in an enforcement case.

Aside from certified mail and other services that require a signature, even traditional mail may never be delivered, opened, read, and acted on.

Can We Avoid Important Emails Going to Spam?

This issue is something we can manage. It is not completely out of our control. In fact, getting email through to the inbox is a bit of an art and a science.

Nearly every email service scores incoming email for likely spam. Note, too, that more advanced systems (e.g., Gmail) also watch how the recipient previously responded to emails of the same type. If your previous email was moved to trash without opening it, then your next email might go straight to spam. It learns.

Follow these simple practices to increase delivery rates:

- Use a familiar from name and a meaningful subject line. Most recipients decide what to do with your email seeing only the sender, subject, and date. For example:
  From: Smith County Environmental Health Department
  Subject: 2023 Retail Food Renewal Invoice
- If you can, personalize the email greeting. Using "Dear Joe Smith" is superior to "Dear Operator."
- Design an email body with substance. Also, take the time to deliver an email body with useful information. A paragraph that explains the reason for the email and its importance weighs mightily when detecting spam.
- Reserve the last few lines of every email for the agency's name, address, and phone number.
- Use a real reply-to address (e.g., smithcountyeh@smith.co.us) that is monitored.

Image © iStockphoto: Devonyu.

Using a "noreply" address is common but less desirable.

- Make sure the sender email address is the same as the reply-to email address. And use your agency's actual domain name. You may have to ask your IT department or software vendor to align the email addresses you use.
- Rethink attachments. While sending the invoice or permit as a PDF attachment is convenient, attachments can also impact your spam score. It could be more secure to use a personalized hyperlink (e.g., to your public portal) to view and download the PDF.

What Happens When an Email Bounces?

A bounced email is a blessing. The mail systems are informing you that your important email was not delivered, either due to a bad or incorrect email address or (infrequently) that their email system is offline.

Using a reply-to email address that is monitored, either by a human or by your data system, will help you find and fill these gaps. Your data system should record a bounced email. That way, staff can see that the message was not initially delivered. If the email address was just wrong, fix it and resend. This step might require a call to the operator or even an inspector visit.

As a stopgap, agencies can always print and mail the notice via the U.S. Postal Service as a one-time service.

What if Our Operators Do Not Have Access to Email?

This issue might seem improbable but it does occur. Agencies must navigate these waters thoughtfully, taking care not to inadvertently exclude some operators.

Still, email services are free and easy. Even without a mobile phone, free internet access, public computers, or in-office kiosks could fill this gap.

While some owners, operators, or managers might not have email, they might have access to text messaging. Sending text messages in place of email is possible. There are services for pushing text messages from your data systems through pay-per-message gateways. Check with your IT department or software vendor for the best approach.

Does your agency still generate paper and physical mail in 2023? Making the switch to digital is easily defended considering the obvious savings and convenience. If you are still on the fence, take measure of similarly sized agencies.

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Did You Know?

Does your health department need an intern to help with your important work? The National Environmental Public Health Internship Program is a 400-hr paid internship opportunity that links environmental health students with internship placements at qualified health agencies. There is a rolling application process for agencies. Learn more at www.neha.org/nephip.

DIRECT FROM ATSDR

Karen Scruton, MS

Exposure Investigations Conducted by the Agency for Toxic Substances and Disease Registry

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

This information is distributed solely for the purpose of predissemination peer review under applicable information quality guidelines. It has not been formally disseminated by ATSDR. The findings in this column are those of the author(s) and do not necessarily represent any agency determination, policy, or official position of CDC or ATSDR.

Karen Scruton is the chief of the Exposure Investigations Section in the Office of Community Health Hazard Assessment at ATSDR.

Background

The Agency for Toxic Substances and Disease Registry (ATSDR) protects communities from harmful health effects related to exposure to natural and human-made contaminants in the environment. The Office of Community Health Hazard Assessment within ATSDR provides this protection by working closely with the U.S. Environmental Protection Agency (U.S. EPA), tribal agencies, state partners of the ATSDR Partnership to Promote Localized Efforts to Reduce Environmental Exposure (APPLETREE) Cooperative Agreement Program, and other partners including communities, to conduct public health assessments of hazardous waste sites.

ATSDR relies on environmental data provided by other environmental agencies, including U.S. EPA and state and local agencies, to determine if people living near a hazardous waste site are being exposed to toxic substances and if that exposure is harmful. In some instances, there are not enough site data available to complete an assessment and make a public health determination, resulting in a data gap. Data gaps can be filled at a site by recommending that other environmental agencies conduct appropriate sampling or, in some instances, by modeling exposure to the contamination. If data gaps cannot be addressed with samples collected by other agencies or exposure modeling, ATSDR will consider conducting an exposure investigation (EI).

Exposure Investigations

An ATSDR EI is a biological (e.g., blood, urine) and/or environmental (e.g., air, water, dust, soil, biota, etc.) sampling effort that is designed to fill a data gap needed to make a public health conclusion at a site. The following four questions are evaluated to determine if it is appropriate to conduct an EI at a site:

1. Can an exposed population be identified?
2. Does a data gap exist that affects the ability to determine if there is a health hazard?
3. Can an EI be designed that will address this data gap?
4. How will the EI results affect the public health decision-making for the site?

The question that is the most difficult to answer is question 4. The results of the EI sampling must be able to impact public health decisions for the site, which can be achieved in various ways:

- Recommend actions to be taken by the regulatory community to reduce exposure (e.g., treating water or providing an alternative water source if water is contaminated).
- Indicate the need for further sampling or enhanced surveillance (e.g., measuring blood lead levels in children near a site).
- Recommend a health study to be conducted to evaluate potential health effects associated with exposure.

FIGURE 1

The Exposure Investigation (EI) Process

Note. ATSDR = Agency for Toxic Substances and Disease Registry; OMB = Office of Management and Budget.

- Identify the need for community education (e.g., assisting the community in understanding how to reduce exposure).
- Provide physician education in the form of grand round presentations and/or written clinician guidance.

Methodology

The process for determining whether to conduct an EI is provided in Figure 1. Engaging the community is a critical first step to ensure that conducting an EI will work to address the concerns of the community and allows ATSDR to prepare an appropriate and feasible recruitment strategy for the investigation. ATSDR may hold a kickoff meeting in the community to provide information and begin recruitment. When the EI is complete, ATSDR conducts a public meeting to relay the results of the EI to the community.

Determining an appropriate recruitment strategy is critical to ensure that the results of the EI fill the exposure data gap and meet the concerns and needs of the community. ATSDR engages community leaders and local health agencies to determine the best way to recruit participants. Recruitment can include sending letters or postcards inviting residents to participate, making phone calls, going door-to-door, or using appropriate media (e.g., newspapers, social media) to engage the community.

EIs typically focus on sampling the most highly exposed individuals or environmental locations to determine the worst case for potential exposure in the community. The use of this strategy results in the sampling data only being applicable to the tested individuals and the results not being generalizable to the community.

After an EI request is accepted, ATSDR will prepare a protocol that provides appropriate consent forms, questionnaires, and outreach materials. Prior to collecting either biological or environmental samples, participants must complete consent forms (e.g., adult, parental permission, assent forms for adolescents) to ensure they are granting informed permission to partake in the investigation. Participants may agree in the consent form to allow ATSDR to share de-identified results with other specified entities, as appropriate.

Next, the team in the field administers questionnaires to participants, as needed, to collect exposure data needed to better interpret the results of the sampling. For instance, for an EI where we are measuring blood lead levels, we will ask about the amount of time spent in the yard by a child (if soil contamination is an issue) and hand-to-mouth habits of children. For an EI where we are measuring per- and polyfluoroalkyl substances (PFAS) in environmental samples in homes, we will ask about the participant's use of stain-resistant products and other household items that could contain PFAS.

The administration of a questionnaire prompts the need to first prepare a Paperwork Reduction Act (PRA) package to submit to the Office of Management and Budget to ensure that participation in the EI does not overburden the public and that the time spent participating is appropriate. The PRA package is only applicable if 10 or more participants are included in the EI.

Anaconda Exposure Investigation

In 2018, ATSDR conducted an evaluation of blood lead levels and urine arsenic levels in people living in Anaconda, Montana, a community with past smelting activities. Soils in the city were impacted by the smelting of copper ore in the community. Community members were concerned about exposure to heavy metals as a result of direct contact with impacted soil or exposure to indoor dust.

For lead exposure, ATSDR usually focuses on people who are at the greatest risk for harmful effects: children ≤6 years, pregnant individuals, and individuals of childbearing age. In Anaconda, older residents also were concerned about exposure because many of them have resided in Anaconda for their entire lives. Therefore, testing for the EI was offered to all Anaconda residents.

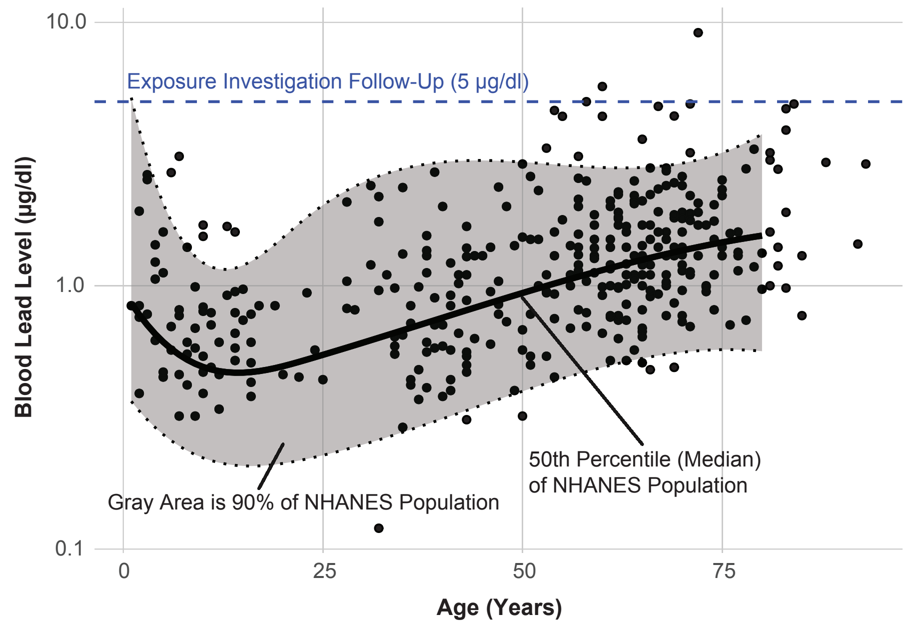
A total of 367 residents were tested for lead in blood and arsenic in urine (Figures 2 and 3). Arsenic in urine was speciated to differentiate exposure to inorganic (i.e., might be associated with arsenic in the environment) and organic (i.e., associated with arsenic in seafood) forms of arsenic. ATSDR partnered with U.S. EPA to assist in prioritizing homes for soil remediation as well as remediation inside the home (e.g., attic).

Test results were comparable to the national average reported in the 2015–2016 National Health and Nutrition Examination Survey (Centers for Disease Control and Prevention, 2023). This information was particularly useful to participants, as the results showed no immediate health threats from direct contact with the impacted soil. Additionally, U.S. EPA continued their cleanup efforts to further reduce potential for exposure. A health consultation of the EI was created, which is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, chemical release, or presence of hazardous materials (ATSDR, 2019).

EIs provide ATSDR with data needed to determine how people are exposed to contaminants at a site. Community engagement is critical for planning the EI and for ensuring community concerns are understood and addressed through the EI.

FIGURE **2**

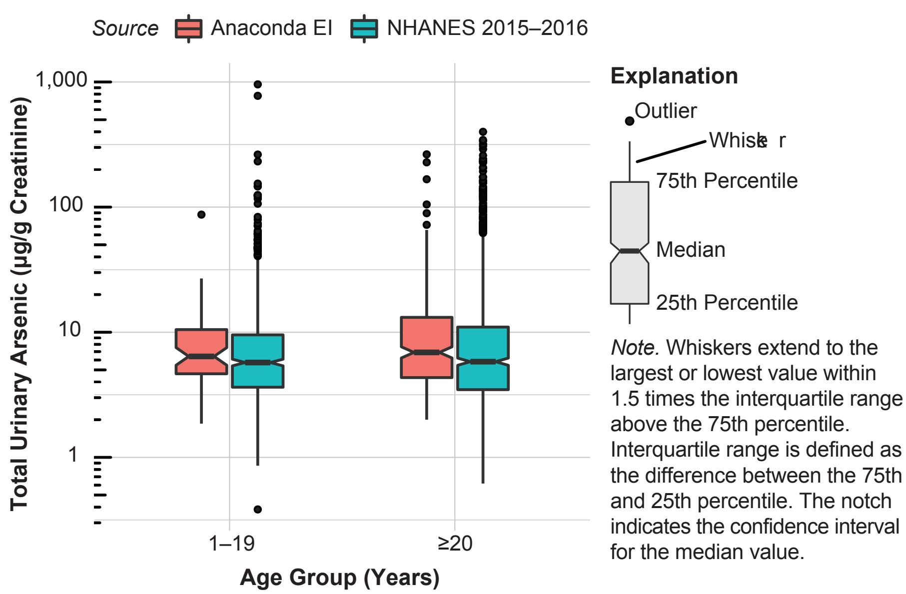
Blood Lead Levels by Age in Participants of the 2019 Exposure Investigation in Anaconda, Montana



Source: Agency for Toxic Substances and Disease Registry, 2019.
Note. NHANES = National Health and Nutrition Examination Survey.

FIGURE **3**

Total Urinary Arsenic Levels by Age in Participants of the 2019 Exposure Investigation in Anaconda, Montana



Source: Agency for Toxic Substances and Disease Registry, 2019.
Note. EI = exposure investigation; NHANES = National Health and Nutrition Examination Survey.

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Connecting Environmental Public Health With the Revised 10 Essential Public Health Services

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

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

Ana Pomales is an environmental health scientist at the National Center for Environmental Health (NCEH) within CDC. Adrienne Gill is a public health advisor with the Center for State, Tribal, Local, and Territorial Support within CDC. Justin Gerding leads the Environmental Health Practice Section within the NCEH Water, Food, and Environmental Health Services Branch.

The 10 Essential Public Health Services (10 Essential Services) provide a common understanding of what public health activities should occur in all communities. Since their release in the mid-1990s, the 10 Essential Services have helped drive public health practice in many ways, such as framing health department accreditation standards, being incorporated into state public health laws, and serving as the basis for discipline-specific modifications such as the 10 Essential Environmental Public Health Services (10 Essential EPH Services; Public Health National Center for Innovations [PHNCI], 2019).

While the 10 Essential EPH Services are closely aligned with the 10 Essential Services, a specific and direct application to environmental public health practice was interwoven into the framework. Since their release in 2007, the 10 Essential EPH Services have served as the foundation for promoting the role of environmental health in broader public health performance improvement initiatives. Specifically, the 10 Essential EPH Services led to creating the Environmental Public Health Performance Standards (EnvPHPS) and informed the work of environmental public health think tanks with the Public Health Accreditation Board (PHAB). These think tanks focused on describing and understanding the role and contributions of environmental public health to the PHAB accreditation process and standards (Gerding et al., 2020).

Understanding the Revised 10 Essential Services

By 2020, the public health landscape had changed with an accompanying evolution of performance improvement initiatives. This evolution culminated in a collaborative and comprehensive revision of the 10 Essential Services (Figure 1). These revisions were led by a task force of public health experts and guided by significant input from the field (PHNCI, 2020). Field input guided the task force to "keep but revise" the original framework and provided input on a variety of revisions needed.

Key changes in the revised 10 Essential Services released in 2020 include:

- Centering the framework around equity and including a statement underscoring the role of the 10 Essential Services in achieving equity.
- Incorporating social determinants of health and equity throughout each Essential Service.
- Updating language to better reflect current public health practice, including changes in technology, data use, and communications.
- Refocusing Essential Service #9 around evaluation, research, and continuous quality improvement.
- Adding organizational infrastructure to the framework through revisions to Essential Service #10.

Like the original, the revised 10 Essential Services framework is already playing important roles with key public health initiatives, such as defining the scope of public health practice for revised Core Competencies for Public Health Professionals and providing an updated framing for PHAB Version 2022 of the health department accreditation standards.

FIGURE **1**

The 10 Essential Public Health Services

1. Assess and monitor population health status, factors that influence health, and community needs and assets.
2. Investigate, diagnose, and address health problems and hazards affecting the population.
3. Communicate effectively to inform and educate people about health, factors that influence it, and how to improve it.
4. Strengthen, support, and mobilize communities and partnerships to improve health.
5. Create, champion, and implement policies, plans, and laws that impact health.
6. Utilize legal and regulatory actions designed to improve and protect the public's health.
7. Assure an effective system that enables equitable access to the individual services and care needed to be healthy.
8. Build and support a diverse and skilled public health workforce.
9. Improve and innovate public health functions through ongoing evaluation, research, and continuous quality improvement.
10. Build and maintain a strong organizational infrastructure for public health.

Connecting Environmental Public Health With the 10 Essential Services

Considering the revisions to the 10 Essential Services and advances in performance improvement, the National Center for Environmental Health, in collaboration with the Center for State, Tribal, Local, and Territorial Support, developed a new website (www.cdc.gov/nceh/ehs/10-essential-services/index.html) with insights into the application of the 10 Essential Services for the practice of environmental public health. While this approach moves away from having a separate set of Essential Services specifically for environmental public health, it is an opportunity to renew guidance on environmental public health connections with the revised framework, strengthen the role of environmental public health in broader public health efforts and initiatives, and highlight contributions to addressing public health priorities such as ensuring health equity.

Drawing on existing descriptions from EnvPHPS, updated language from the revised 10 Essential Services, and national accreditation standards from PHAB Version 2022, the new website from CDC describes potential ways for environmental health programs to connect with the revised 10 Essential Services. It identifies how environmental health programs can do the following:

- Help deliver the 10 Essential Services in their communities.
- Link to and support broader public health initiatives such as public health accreditation.

The website identifies potential environmental health program activities and services that could support and contribute to delivery of the 10 Essential Services. In addition, these examples highlight possible linkages between environmental public health and PHAB accreditation standards and measures. Examples are not intended to provide all definitive linkages between PHAB standards and environmental health activities, nor is it a guarantee of conformity to PHAB documentation requirements. This resource is intended to support health department leaders, environmental health leadership, accreditation and performance improvement staff, and other program staff in recognizing important areas of connection.

Environmental Public Health and the 10 Essential Public Health Services

www.cdc.gov/nceh/ehs/10-essential-services/index.html

Use this new resource to:

1. Inform development, assessment, and improvement of comprehensive environmental health programs and activities that address environmental and public health priorities and issues.
2. Educate staff about environmental public health practice, connections with the 10 Essential Public Health Services, and how they are used to protect the public from environmental hazards and concerns.
3. Describe environmental public health practice linkages with national public health department accreditation standards.

Quick Links

- Review the 10 Essential Public Health Services and learn more: www.cdc.gov/publichealthgateway/publichealthservices/essentialhealthservices.html
- Align environmental health programs and activities with the systematic framework of the 10 Essential Public Health Services: www.cdc.gov/nceh/ehs/10-essential-services/index.html
- Learn more about the revised 10 Essential Public Health Services: https://phnci.org/national-frameworks/10-ephs
- Use Version 2022 of the Standards & Measures from the Public Health Accreditation Board for initial program accreditation and reaccreditation: https://phaboard.org/accreditation-recognition/version-2022/

Environmental public health has an important and critical role in the delivery of the 10 Essential Services to protect community health. We hope this web resource will help strengthen the integration of environmental public health practice through the 10 Essential Services and in meeting the needs of all communities.

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IN MEMORIAM

Tabby Bernardo

The National Environmental Health Association (NEHA) was saddened to learn of the death of past staff member Tabby Bernardo in February 2022. Bernardo—whose full name was Lydia Mae Lilinoe Yuk Ung Choy Bernardo and whose friends called her Tabby—served as executive coordinator at NEHA from 1995–2005. She officially retired from NEHA on December 30, 2005.

While at NEHA, Bernardo worked closely with the association's leadership, including the executive director, board of directors, and affiliate presidents. She was responsible for a variety of administrative duties, as well as management of board elections, oversight of policy changes, and coordination of the Walter S. Mangold Award.

She was a key contact for the presidents of NEHA and was vital in their success. As Ron Grimes, past president of NEHA (2005–2006), stated, "I knew Tabby before I became an officer in NEHA. Having known several past presidents personally, I had always heard about this Tabby Bernardo who kept them focused on their job during their term in office. Until I became an officer and now president, I did not realize how much of an understatement those comments were." For her service, Bernardo was the recipient of the NEHA Past Presidents Award in 2005.

Bernardo enjoyed collaborating with people and being part of a team. This attitude is apparent in her reflections on her time at NEHA: "The chief joy I experienced was being allowed to meet and get to know a lot of people I normally wouldn't get to work with, such as NEHA's members."

Before joining NEHA in 1995, Bernardo was in human resources and administration with two Denver oil firms. She served for 14 years before that as director of public relations at St. Francis Hospital in Honolulu, Hawaii. Her journalism degree was from the University of Missouri and her master's in public relations and mass communications was from Syracuse University. She also held an APR (Accredited in Public Relations) credential.

For Bernardo, family, friends, her ties to Hawaii, and her church were important to her. As she stated in her staff profile, "On a personal level, I enjoy mah-jongg, travel, quiet walks, the theater, church activities, extolling the virtues of Colorado, visiting with family and friends in Hawaii, and rooting for the Denver Broncos."

We extend our sympathies to the family and friends of Tabby Bernardo. She contributed to the organization during her time through her characteristic and unassuming manner of quietly getting the job done with competence and consistency. She will be missed.

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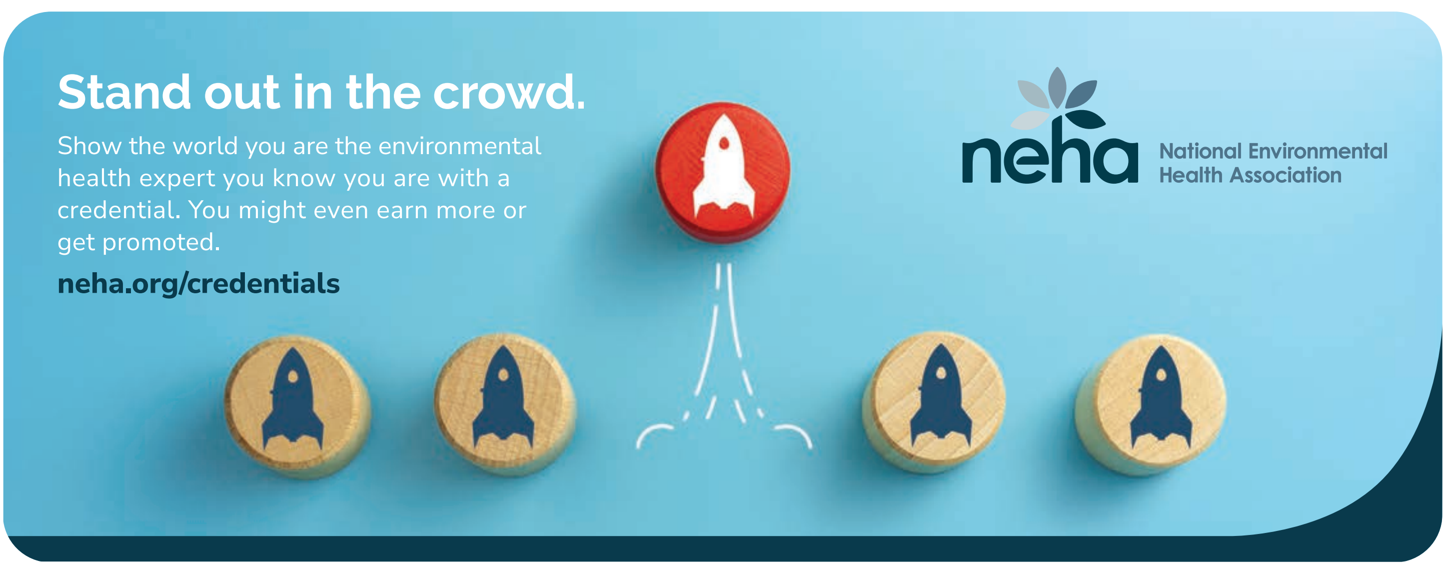
National Environmental Health Association. (2006). NEHA's executive coordinator leaves big shoes under desk. *Journal of Environmental Health*, *68*(8), 56.

Editor's Note: 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 PRACTITIONER'S TOOL KIT

Practical Field Sampling Strategies

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Editor's Note: **The National Environmental Health Association (NEHA) strives to provide relevant and useful information for environmental health practitioners. In a recent membership survey, we heard your request for information in the *Journal* that is more applicable to your daily work. We listened and are pleased to feature this column from a cadre of environmental health luminaries with over 300 years of combined experience in the environmental health field. This group will share their tricks of the trade to help you create a tool kit of resources for your daily work.**

The conclusions of this column are those of the authors and do not necessarily represent the official position of NEHA, nor does it imply endorsement of any products, services, or resources mentioned.

As environmental health practitioners and sanitarians who have been there and done that, we can honestly say that of all the mistakes we made in our careers, poor field sampling techniques, bias, and misinterpretations were probably the worst—and the most embarrassing. So bear with us while we share a bit of insight into this thorny topic.

There are two definitions of sampling:

1. The first definition is the act, process, or technique of selecting a suitable sample. Specifically, selecting a representative part of something for the purpose of finding parameters or characteristics of the whole. Taking a single temperature reading of a pan of lasagna in no way represents the temperature of the whole pan. We know that we can make anything pass or fail, depending on where we stick the thermometer.
2. The second definition goes to the heart of what we do: a small part selected as a sample for inspection or analysis. Since sampling is a part of inspection, and inspection is checking or testing something against established standards, we are compelled to do it correctly and defend what we do when we sample. The goal of sampling is to define objective measurements and refine subjective observations without bias. In other words, making sense of statements like "clean to sight and touch," ensuring that temperature-sensitive foods are not held in the temperature danger zone for any longer than necessary, or measuring physical parameters for sanitation or safety such as ventilation, adequate lighting, and slip resistance, just to name a few.

Always keep in mind the cardinal rule of sampling: Garbage in equals garbage out. Samples that are not representative of the source are of little use. Furthermore, poor collection procedures can yield unrepresentative samples, contribute to the uncertainty of the analytical results, or worse yet, result in contamination of the samples.

Errors can be calculated and are easy to interpret if our sampling strategy focuses on probability. In other words, systematic or random sampling has the least bias. For example, in sampling that lasagna pan we referred to earlier, by taking several temperature measurements (remember, there is a thermocouple response time) diagonally across the pan and averaging the temperature readings, you are taking a systematic probability sample. This sampling strategy is defensible whereas the single, judgmental nonprobability sample is not. What you are doing by sampling in this manner is defining a gradient through a repeatable grid pattern. As an environmental health practitioner, it is important for you to understand the various types of sampling strategies available for use and to have a sense of where each type should be used.

To begin, the best strategy is to prepare a sampling plan as a standard operating procedure that can be referenced in field notes and is easily used by more than one person. Organizations and agencies, such as health departments, should have a set of standard operating procedures that cover field sampling, particularly when used in routine inspections.

Sampling plans that are similar to systematic sampling include stratified and cluster sampling. These variations are used depending on the size, configuration, and convenience of the things that are to be sampled but follow the same general pattern and have the same bias. Regardless of the plan used, always try to take five or more samples with each run. In this way, you are introducing statistical relevance.

For those of us in institutional practice or who work with commercial food preparation facilities such as dairies, bakeries, or the inner workings of any food manufacturing, the luxury of time and consistency in these operations allows us to use a random sampling plan. The *Military Standard for Sampling Procedures and Tables for Inspection by Attributes* (MIL-

STD-105E, https://bit.ly/3DNQzNJ) is both easy to use and easy to understand.

The random sampling plan, while it requires the most samples, is also the least biased and most accurate. It is an important tool when evaluating, auditing, or inspecting multiple suites, rooms, and living quarters. And we use it regularly to verify hazard analysis critical control point (HACCP) plans and evaluate sanitation, safety, and maintenance activities in correctional facilities, military bases, hospitals, schools, and hospitality venues. A simple random sampling plan works extremely well in institutional food service where there is a stable population that is served by a fixed or 5-week rotational menu, along with standard sized hotel pans and chafing dishes in kitchen preparation and serving operations.

By its very nature, nonprobability sampling has the most bias and is the most vulnerable for questioning and contradiction. Nonprobability sampling plans include judgmental, snowball, and convenience sampling:

- **Judgmental sampling** should be reserved for verifying two conditions. The first condition is where there is an obvious problem. These problems can include when off temperatures are encountered, obvious spoilage and contamination such as mouse dropping in food are found, poor or absent ventilation is noted, no lighting is present, and obvious inadequate sanitation is noted, just to name a few. The second condition is when the sample is homogeneous. For instance, sampling potable tap water, recreational waters, soups and other pumpable foods in larger preparation and serving containers, or where a single sample (if properly documented) is acceptable. We advise caution.
- **Snowball sampling** (i.e., a nonrandom sampling technique) is used to identify problems to trace the possibility of organisms such as *Campylobacter*, *Listeria*, *Salmonella*, *Vibrio*, or *E. coli* in food production from raw to finished product or to identify misuse or overuse of disinfectants in living environments. Snowball sampling relies on your professional judgment to determine where a problem might exist and tracing it throughout its path to find a practical solution for remediation. The more information you provide in describing your efforts with this sampling procedure, the more cost-effective and cost-efficient are the corrective actions.
- **Convenience sampling** is used when we are interested in getting an inexpensive approximation of the truth. As the name implies, the samples are selected because they are convenient. This strategy is quite acceptable as a screening tool. It is used to get a gross estimate of the results and to design a more comprehensive sampling scheme. Unfortunately, it is often erroneously used as the final arbiter in regulatory inspections.

There are two other factors we need to consider in selecting a sampling scheme:

1. The first factor is **repeatability**, which is the ability of the measurement system to provide consistent readings when used by a single inspector at a given location. It requires the following conditions to be in place: the same location, the same measurement procedure, the same observer, and the same measuring instrument all used under the same conditions.
2. The second factor is **reproducibility**, which is the ability for multiple environmental health practitioners to achieve consistent results. Reproducibility refers to the degree of agreement between the results of inspections (including re-inspections) conducted by different individuals, at different locations, and with different but similar instruments. Simply put, it measures our ability to replicate the findings of others.

In either case, the sampling strategy needs to be concisely documented. For example, "The lasagna pan in the kitchen bain-marie was systematically sampled on the diagonal, taking five readings, using the validated needle K-probe on the thermocouple. Sampling was completed at 1320 hours." This type of documentation makes it both repeatable and reproducible.

A good sampling strategy also helps us define observations. So much of what we do is subjective, where the information or observation is ill-suited and based on opinion, interpretations, points of view, emotions, and judgment. Sampling, whenever possible and practical, gives us information that is fact-based, measurable, and observable. Objective data are usually suitable for decision-making and are less likely to be disputed or challenged on an inspection report. By presenting objective measurements, accurate data are collected, presented, and compared on repeated inspections.

The best sampling strategy and the most careful sampling technique are worthless if the field documentation of the strategy and the sampling is not carefully done. Recording the technique, times, data, and conditions are necessary to get an accurate interpretation of those data and to allow reproducible results. All data should be recorded in a bound field sampling book with numbered pages (waterproof is best).

Included in the discussion of this topic is where are the best sampling locations? The selection of the sampling location is as much an art form as it is a science. This question is best answered using common sense and a good knowledge of the mechanisms of cross-contamination. What set us on a course of forensics was watching an individual "aseptically" sample food while touching everything but the sample. The act of sampling should be carefully choreographed so not to contaminate other foods, critical surfaces, or put yourself at risk of injury. While we are considering location, we must also consider sample sequence, particularly if we are to validate a HACCP plan. The sampling locations should always be selected in sequential order from processed to raw, cleaned to soiled, and sanitized to contaminated.

Finally, the interpretation of sampling results brings us back to the sampling objective. In presenting the collected data, consider five data quality indicators:

1. Precision
2. Bias
3. Representativeness
4. Completeness
5. Comparability

Each of these indicators is sensitive to the way sampling is done, and each is a reflection on the thoroughness of the answers we provide to the questions posed by the sampling objective. The variability of monitoring data should also be interpreted to reflect consideration of the possible sources of sampling error. These errors include sampling design, sampling implementation, and data analysis. This consideration is particularly significant when decisions are made that result from regulatory inspections. Now you know. Make your next inspection a stellar professional model.

Contact: toolkit@sanitarian.com.

ENVIRONMENTAL HEALTH CALENDAR

UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCE

July 31–August 3, 2023: NEHA 2023 Annual Educational Conference & Exhibition, Hilton New Orleans Riverside, New Orleans, LA, https://www.neha.org/aec

NEHA AFFILIATE AND REGIONAL LISTINGS

California

June 19–22, 2023: Annual Educational Symposium (AES), hosted by the Superior Chapter of the California Environmental Health Association, Sacramento, CA, https://www.ceha.org

Colorado

October 11–13, 2023: 67th Annual Education Conference, Colorado Environmental Health Association, Estes Park, CO, https://ceha49.wildapricot.org

Georgia

September 20–22, 2023: Annual Educational Conference, Georgia Environmental Health Association, Jekyll Island, GA, https://geha-online.wildapricot.org

Illinois

April 11, 13, 18, and 20, 2023: Spring Virtual Conference, Illinois Environmental Health Association, https://www.iehaonline.org

November 8–9, 2023: Annual Educational Conference, Illinois Environmental Health Association, Oglesby, IL, https://www.iehaonline.org

Indiana

April 13, 2023: Spring Conference, Indiana Environmental Health Association, Fort Harrison State Park, IN, https://www.iehaind.org

September 25–27, 2023: Fall Educational Conference, Indiana Environmental Health Association, Muncie, IN, https://www.iehaind.org

Montana

April 3–5, 2023: Confluence 2023: Learn, Lead, and Speak for Health, Montana Environmental Health and Public Health Associations, Billings, MT, https://mehaweb.wildapricot.org

New Mexico

April 4–5, 2023: Vector Course 2023, New Mexico Environmental Health Association, Albuquerque, NM, https://nmeha.wildapricot.org

North Carolina

September 27–29, 2023: Fall Educational Conference, North Carolina Public Health Association, Concord, NC, https://ncpha.memberclicks.net

North Dakota

October 17–19, 2023: NEHA Region 4 Environmental Health Conference, hosted by the North Dakota Environmental Health Association, West Fargo, ND, https://ndeha.org

Ohio

April 13–14, 2023: Annual Educational Conference, Ohio Environmental Health Association, Dublin, OH, http://www.ohioeha.org

Texas

October 16–20, 2023: 67th Annual Educational Conference, Texas Environmental Health Association, Georgetown, TX, https://myteha.org

Utah

May 10–12, 2023: Spring Conference, Utah Environmental Health Association, Richfield, UT, https://sites.google.com/ueha.org/ueha/home

Washington

May 8–10, 2023: Annual Educational Conference, Washington State Environmental Health Association, Tacoma, WA, https://www.wseha.org

TOPICAL LISTINGS

Food Safety

April 24–28, 2023: Biennial Meeting, Conference for Food Protection, Houston, TX, http://www.foodprotect.org

May 8–11, 2023: Food Safety Summit, produced by *Food Safety Magazine*, Rosemont, IL, https://www.food-safety.com/food-safety-summit

July 16–19, 2023: IAFP 2023 Annual Meeting, International Association for Food Protection (IAFP), Toronto, ON, https://www.foodprotection.org/annualmeeting

Preparedness

April 24–27, 2023: Preparedness Summit, hosted by the National Association of County and City Health Officials, Atlanta, GA, https://www.preparednesssummit.org

May 21–27, 2023: Environmental Health Training in Emergency Response Operations, Center for Domestic Preparedness, Federal Emergency Management Agency, Anniston, AL, https://cdp.dhs.gov/training/course/PER-309

Did You Know?

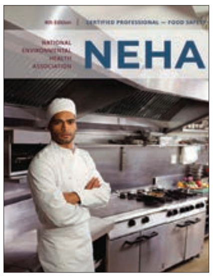
Earth Day is April 22. Celebrated first in 1970, Earth Day mobilizes approximately 1 billion individuals for action every year across over 190 countries. For the first time in history, the organizers are continuing the important theme of “Invest in Our Planet” for a second year. Learn more at www.earthday.org.

RESOURCE CORNER

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

CP-FS Study Guide (4th Edition)

National Environmental Health Association (2022)

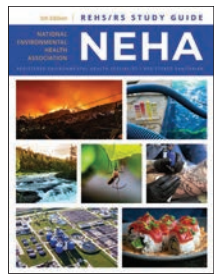


The National Environmental Health Association (NEHA) has released an updated edition of the *Certified Professional–Food Safety (CP-FS) Study Guide*. The fourth edition of the study guide has been updated to the current FDA *Food Code* and includes information and requirements from the Food Safety Modernization Act. It was developed by retail professionals to help prepare candidates for the NEHA CP-FS credential exam with in-depth content, an examination blueprint, practice test, and many helpful appendices. The study guide is the go-to resource for students of food safety and food safety professionals in both regulatory agencies and industry. Chapters in the new edition include causes and prevention of foodborne illness, HACCP plans, cleaning and sanitizing, facility and plan review, pest control, inspections, foodborne illness outbreaks, sampling food for laboratory analysis, food defense, responding to food emergencies, and legal aspects of food safety. Also now available as an e-book!

358 pages, spiral-bound paperback
Member: $199/Nonmember: $229

REHS/RS Study Guide (5th Edition)

National Environmental Health Association (2021)



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

261 pages, spiral-bound paperback
Member: $165/Nonmember: $199

Management and Supervisory Practices for Environmental Professionals: Basic Principles, Volume I (4th Edition)

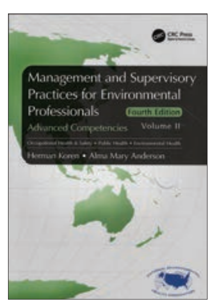
Herman Koren and Alma Mary Anderson (2021)

The fourth edition of this bestseller provides up-to-date information for newly promoted or management-aspiring professionals and engineers in the fields of environmental health, occupational health and safety, water and wastewater treatment, public health, and other environmental professions. The book is also an excellent resource for students interested in learning management skills prior to entering the workforce. Through nine sets of tools, the first volume explains the basic principles supervisors need to understand the structure of their organization, what leadership is, how to effectively plan and budget, how to manage other people, and best practices for achieving success in a management position.

258 pages, paperback
Member: $49/Nonmember: $56

Management and Supervisory Practices for Environmental Professionals: Advanced Competencies, Volume II (4th Edition)

Herman Koren and Alma Mary Anderson (2021)



The fourth edition of this bestseller provides up-to-date information for newly promoted or management-aspiring professionals and engineers in the fields of environmental health, occupational health and safety, water and wastewater treatment, public health, and other environmental professions. The book is also an excellent resource for students interested in learning management skills prior to entering the workforce. The second volume explains the advanced principles that supervisors need to understand the art of communications and resolving communications problems, as well as the supervisor or manager's role in teaching, counseling, and managing employee performance, health, and safety.

276 pages, paperback
Member: $49/Nonmember: $56

SPECIAL LISTING

The National Environmental Health Association (NEHA) Board of Directors includes 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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Term expires 2023.

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Term expires 2025.

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NEHA NEWS

New Policy Statement Approved to Support the Profession

In January 2023, the Board of Directors of the National Environmental Health Association (NEHA) approved an update policy statement on the Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential. Environmental health programs carried out by REHS/RS credentialed individuals, as well as other credentialed personnel, serve to prevent illness, injury, and death. Credentialed personnel within these programs work to improve the health and quality of life of people living in their communities. Their services prevent adverse health outcomes and help communities prepare for, respond to, and recover from disease outbreaks and disasters.

NEHA supports the credentialing of the environmental health workforce, in particular people who earn the REHS/RS credential. This credential is recognized in many states and the District of Columbia. Additionally, some jurisdictions have local environmental health credential programs that are required for the practice of environmental health.

A credentialed environmental health workforce is essential to meet the demands required of federal, state, local, tribal, and territorial environmental health agencies. As such, NEHA supports the following:

- Health is the basis of prosperity in every community.
- Safe food, safe drinking water, clean air, safe sewage disposal, emergency response, and healthy living and workplace environments are basic necessities for communities.
- Assuring health equity and a healthy living environment requires a workforce of well trained and technically competent environmental health specialists and sanitarians who are credentialed.
- Environmental health agencies and industry partners should strive to attract and retain credentialed and trained environmental health professionals to provide capacity and quality in their environmental health programs.

The policy statement was drafted by the NEHA Credentialing Committee and NEHA staff. The policy will sunset in January 2026. Visit www.neha.org/policy to view the full statement, as well as other policy statements on body art, climate change, food safety, preparedness, vector control, water quality, and more.

NEHA Staff Profiles

As part of tradition, we feature new staff members in the *Journal* around the time of their 1-year anniversary. These profiles give you an opportunity to get to know our 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 three NEHA staff members. Contact information for all NEHA staff can be found on pages 44 and 45.

Joetta DeFrancesco

I joined the NEHA Entrepreneurial Zone team in April 2022 as the Retail Program Standards coordinator working on the NEHA-FDA Retail Flexible Funding Model (RFFM) Grant Program. Coming from a state regulatory agency, I was excited to begin work as the importance of this grant program and the impact of the funds are well understood.

My role here involves supporting grantees to aid in the successful completion of their grant work. This support can be anything from reviewing grant reports to developing guidance to aiding jurisdictions in meeting the Voluntary National Retail Food Regulatory Program Standards or reaching out to our stakeholders to share information. It is a job I not only enjoy but also get the pleasure of working with a remarkable group of professionals to help improve food safety nationwide.

My background includes 14 years with a state regulatory agency, most recently running retail quality assurance and training with a team that was responsible for all aspects of the training and certification process for all new inspection staff. Prior to working for the state, I spent over 20 years working in both restaurant and private club food service operations. Additionally, I have taught as an adjunct instructor for both business and hospitality courses.

When not working for NEHA you can find me gardening, spending time with friends and family, taking my camper on adventures, or enjoying countless other hobbies.

Adrienne Gothard

After I received my undergraduate degree in nutrition and dietetics from the University of Northern Colorado, I began my professional career as a clinical dietitian in an acute care hospital. During my 10 years at the hospital, I wore many hats while providing nutritional care to patients in clinical and food services. I greatly enjoyed being able to care for patients and serve as a leader in the nutrition department. I realized, however, that I wanted to be part of preventing disease, not just treating it.

This realization led me to begin graduate studies in public health. I started my journey with NEHA as an intern while I was finishing up my master of public health from the University of Nebraska Medical Center. From the moment I started, I knew that NEHA was an organization where I could really see myself thriving and making a difference. I was hired full time in April 2022 to assume the role of internship coordinator for the National Environmental Public Health Internship Program. I love getting to work with students who are passionate about environmental health and connecting them with opportunities that help them grow. Through their passion and experiences, I get to learn more about the world of environmental health.

I am a Colorado native and I love the life that I have built for myself here with the help of my husky named Finn. My favorite things to do are travel, go boating or camping with friends, and play any type of game—especially volleyball and yard games. My ideal day includes the company of friends or family, good food, and a small dose of friendly competition!

Elizabeth Grenier

I am a senior project coordinator at NEHA. I primarily support our events but also assist with other projects. I oversee and coordinate all of the planning and logistics for our Retail Program Standards Symposium (RPSS). I work closely with all of the teams that are involved, including content and education, marketing, and the NEHA-FDA RFFM Grant Program leadership. My job is to ensure nothing is overlooked so that we produce a seamless and thorough event. I also provide support to our Annual Educational Conference & Exhibition. I handle all presenter and moderator logistics and communications, as well as provide any additional assistance to overall conference planning and on-site support. Additionally, I assist with other NEHA-sponsored meetings and events, as needed. Lastly, I support the NEHA-FDA RFFM Grant Program in various capacities.

I am passionate about planning events and all of the logistical aspects that are involved in producing an event. I love that my efforts lead to an experiential product that provides a space and purpose for others. Additionally, I really enjoy that every event is different, held in a new location, produced with diverse elements, and with different needs and new challenges. So each day is exciting and unique. I look forward to planning more events—possibly larger or more complex—to further engage our audience.

I graduated from California Polytechnic State University, Pomona, with my bachelor's of science in international business and marketing management. I have had a diverse professional experience, which I think has prepared me for the role I am currently in. I have worked in hotel hospitality in various capacities, which has given me a great deal of understanding of hotel operations, contracts, and food and beverage—all integral elements for events. I have also worked at the university level, which has provided a wealth of knowledge in the world of grants, grant cycles, and reporting. The NEHA-FDA RFFM Grant Program is a federally-funded program that supplements the RPSS. Producing an event within the parameters of a grant brings on a whole new set of challenges that must be understood before you can start planning.

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Additionally, I have worked with various organizations planning meetings and events—everything from corporate, promotional, charitable, and social events. I have a diverse background that is based in events and have had the opportunity to find processes that work well when producing an event.

Outside of my professional career, I enjoy traveling, dancing, live music, trying new foods, spending time with my family, and my cats.

Recognize Excellence With a NEHA Award

We know that we do not join the environmental health profession to get rich. We can, however, honor the good work of our colleagues by recognizing and celebrating them with an environmental health award from NEHA. Please consider nominating a colleague for their work to protect and support your communities. Awards will be presented at the NEHA 2023 Annual Educational Conference & Exhibition in New Orleans, Louisiana, on July 31–August 3.

While awards may not have monetary value to the awardee, they acknowledge the contribution to the success of your organization and the profession, which also boosts morale and motivation. More information about the awards and the nomination and application processes can be found at www.neha.org/awards.

- **Walter S. Mangold Award**: The Mangold Award is our most prestigious honor and recognizes an individual for exceptional contributions to the advancement of the environmental health profession. The deadline for nominations is May 15.
- **Joe Beck Educational Contribution Award**: The Beck Award recognizes an individual or team for an educational contribution designed for the advancement of environmental health professionals through instruction or development of an educational or training tool. The deadline to submit an application is May 15.
- **Dr. Bailus Walker, Jr. Diversity and Inclusion Awareness Award**: The Diversity Award honors an individual or group that has made significant achievements in the development or enhancement of a more culturally diverse, inclusive, and competent environment. The deadline to submit an application is May 15.
- **Walter F. Snyder Award**: The Snyder Award honors an individual for outstanding accomplishments in environmental and public health protection. The award is presented in partnership with NSF. The nomination deadline is May 1.

American Indian and Alaska Native Resources

NEHA has compiled an online resource webpage of tool kits and guides that can be used to help support American Indian and Alaska Native environmental health agencies. The following is a list of funding opportunities, educational resources, and programmatic support provided on the webpage at www.neha.org/ai-an-toolkits.

- **Tribal Lead Guidebook**: From the U.S. Environmental Protection Agency (U.S. EPA), this guidebook provides tribal communities an educational tool to discuss potential lead exposure and promote in-home activities that parents, grandparents, childcare providers, and others can do to reduce childhood lead exposure.
- **Disaster Response Tool Kit**: From the Federal Emergency Management Agency, the Tribal Mitigation Planning Handbook is a tool for tribal governments to use in developing a mitigation plan that meets the requirements of Title 44. It focuses on practical approaches for how tribal governments can build mitigation plans that reduce long-term risk from natural hazards.
- **Community Health Assessment for Public Health Accreditation Guide and Tool Kit**: From the Inter-Tribal Council of Arizona, this resource provides support for tribal leaders, health professionals, and community members in the planning and implementation of community health accreditations.
- **American Indian and Alaska Native Environmental Health Recognition Awards**: From NEHA, these awards are an opportunity for leaders in tribal environmental health to showcase the important work they do to protect the health of their communities.
- **Resource Guide for American Indians and Alaska Natives**: From the U.S. Department of Agriculture (USDA), this resource guide provides a summary of USDA programs available to tribal leaders and residents, 1994 land-grant colleges and universities, businesses, and nongovernmental organizations.
- **Tribal Environmental Health Research**: From the U.S. EPA, this resource discusses outcomes and results of tribal environmental health research from U.S. EPA-funded grants over the past decade. This research has yielded data, tools, products, methods, and knowledge that can help better define and reduce the health risks of tribal populations, protect natural resources essential to cultural and spiritual practices, and encourage ecological knowledge and tribal practices of protecting and preserving the Earth for future generations.
- **Guidebook for Developing Tribal Water Quality Standards**: From the National Tribal Water Council, this guidebook focuses on the fundamental element of any water quality management program—water quality standards.
- **Strengthening Environmental Health Programs and Services in Your Tribal Community**: From the Division of Environmental Health Services within the Indian Health Service, this tool kit can assist tribal communities in developing and implementing environmental health programs. The goal of the tool kit is to provide a set of resources to assess and strengthen environmental health programs and services to support a comprehensive, integrated approach to environmental health. The second goal is to clearly identify and support operational standards for a governmental environmental health system.
- **Tribal Green Building Tool Kit**: From the U.S. EPA, this tool kit is designed to help tribal officials, community members, planners, developers, and architects develop and adopt building codes to support green building practices.