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Volume 82, No. 1 July/August 2019

Published by the National Environmental Health Association

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ABOUT THE COVER

Pesticide residue in honey is becoming a growing concern because of the potential human health effects and negative impacts on beehives. Urban beehives can be subject to increased pesticide use from spraying of commercial, park, and residential locations. This month's cover article, "Pesticide Contamination in Central Kentucky Urban Honey: A Pilot Study," tested honey and beeswax honeycomb samples for pyrethroid pesticides, organochlorine pesticides, and heavy metals. The study found that 72% of honey samples tested exhibited levels of pesticides exceeding U.S. Environmental Protection Agency tolerable daily intake levels. Of the samples tested for lead, 56% exceeded daily intake limits. These results indicate the need for regular monitoring programs to assess the potential risk to consumer health.

See page 8.

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NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION

Journal of Environmental Health
(ISSN 0022-0892)

Published monthly (except bimonthly in January/February and July/August) by the National Environmental Health Association, 720 S. Colorado Blvd., Suite 1000-N, Denver, CO 80246-1926. Phone: (303) 756-9090; Fax: (303) 691-9490; Internet: www.neha.org. E-mail: kruby@neha.org. Volume 82, Number 1. Yearly subscription rates in U.S.: $150 (electronic), $160 (print), and $185 (electronic and print). Yearly international subscription rates: $150 (electronic), $200 (print), and $225 (electronic and print). Single copies: $15, if available. Reprint and advertising rates available at www.neha.org/JEH. CPM Sales Agreement Number 40045946.

Full text of this journal is available from ProQuest Information and Learning, (800) 521-0600, ext. 3781; (734) 973-7007; or www.proquest.com. The *Journal of Environmental Health* is indexed by Current Awareness in Biological Sciences, EBSCO, and Applied Science & Technology Index. It is abstracted by Wilson Applied Science & Technology Abstracts and EMBASE/Excerpta Medica.

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Periodicals postage paid at Denver, Colorado, and additional mailing offices. POSTMASTER: Send address changes to *Journal of Environmental Health*, 720 S. Colorado Blvd., Suite 1000-N, Denver, CO 80246-1926.

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PRESIDENT'S MESSAGE

Priscilla Oliver, PhD

Introducing NEHA's New President

Greetings from my Audubon Forest neighborhood in Atlanta, Georgia. Atlanta is the home of the "dream" for a better humanity and is known as the International City! Living here since 1978 has had a powerful impact on my work and values.

I am so honored, privileged, and thankful to serve as president of the National Environmental Health Association (NEHA). Having joined NEHA at my first Annual Educational Conference (AEC) & Exhibition in Orlando in 1993, I did not envision becoming its president. I have entertained so many leaders in the past telling me of their plans to become president. I listened and encouraged so many to follow that dream and many have succeeded. At my first AEC in 1993, Art Bloom told me he wanted to be president and recruited me to help him. I passed out Bloom pencils and he became president of NEHA. Retired Colonel Anthony Aiken, retired Colonel Dr. Welford Roberts, and Roy Kroeger expressed interest to me of becoming president. They each ran and won. It appeared to be my role to help obtain good leadership for NEHA. With my leadership training, I gladly accepted that role for years. Over the years, however, I realized it was my time to serve.

Having grown up in Opelika, a small town in Alabama, my grandmother, grandfather, mother, and father put me on the path of becoming an environmentalist. We were outdoors people—gardening, fishing, and taking care of people, animals, the yard, the home, and the surrounding lands. I fell in love with biology under Ms. Price, one of my high school teachers, and decided on biology as an undergraduate major at the University of Alabama. During the 1970s there was limited education in environmental health in Alabama. Not much there has changed even today and there is still much need for change in many states.

*One NEHA: **Blue**, **Green**, and **Gold**.*

Thinking back on my undergraduate years, my 2-hour course on ecology was intriguing. I still have visions of our teacher, Dr. Rogers, and the classroom lectures. Later in my career I had the privilege of taking a group of students on a field trip to the University of Georgia's Institute of Ecology to interview Dr. Eugene Odum, the father of modern ecology and coauthor of *Fundamentals of Ecology*, which was the text for my ecology class. Dr. Odum was close to 90 years old at the time and it was so exciting for us to meet and talk with him.

As scientific knowledge of the connection between environment and health expanded, so has my interest been enhanced. I've learned so much during my almost 46 years of service with the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Congress, U.S. Environmental Protection Agency, U.S. Department of Health and Human Services, and the Morehouse School of Medicine. Having attended graduate school for two degrees (a Master of Public Administration and a doctorate) at Georgia State University, I learned more about education, health, public administration, nonprofit management, and medicine.

Volunteering to serve has also been a part of my training. Since 2001, I have volunteered time supporting the following NEHA technical sections: emerging diseases/vector control/zoonotic diseases, environmental health in schools, hazardous materials and toxic substances, and institutional environmental health. I was a member of the *Journal of Environmental Health's* Technical Editorial Advisory Board for more than 12 years and a peer reviewer for more than 15 years. I helped to create the National Council on Diversity in Environmental Health with Professor Joe Beck, Dr. Carolyn Harvey, and other Eastern Kentucky University officials, as well as representatives from various federal, state, local, and industrial organizations. In 1995, the Physician and Undergraduate Student Educational Partnerships Foundation, Inc. was founded to mentor students and increase the number of minority and diverse physicians and dentists.

These experiences have shaped me into the person I am. I am a retired federal employee (life scientist) and an adjunct faculty member with the Department of Community Health and Preventive Medicine at the Morehouse School of Medicine. Thus, I have come up through the NEHA ranks, taught, conducted research, conducted inspections, implemented policy, witnessed the making of the laws, and administered programs in environmental health.

I am known as a caring, loyal, and dedicated scholar, professor, scientist, and administrator. I am devoted to family, church, community, education, sorority, and NEHA. It has been a privilege to serve on NEHA's board of directors and to now serve as its president. Since joining NEHA, I have grown and remained active in the organization. It is my goal to keep growing, help individuals expand, and support NEHA in becoming greater. I want to utilize my skills, talents, education, and abilities to serve the profession and environmental health professionals of today and the future. It is important for each of us plan and leave footprints for others to follow.

I support and want to further the concept of One NEHA—an organization in which we all work together to connect, to recruit new and diverse members and partners, and to share our ideas across the country and beyond. Your help is solicited in fostering One NEHA and making the organization a better association for the advancement of the professional and the profession. Please help me to be a great president and to make NEHA greater. The lines of communication should be enhanced. NEHA is our association. Please join us. Let us hear from you and see you in action.

I have been consistent and faithful in my environmental health commitments and work ethic for over 45 years. I want us to bring to NEHA a variety of meaningful and relevant leadership experiences, qualifications, and skills. I'm proposing a simple platform for NEHA's future—a more visible NEHA that is **Blue**, **Green**, and **Gold**: Limitless as the sky, sustainable with going green, and resourceful in people and additional funding.

The focus is on advancing all people and NEHA, as well as resources and funding. Stronger partnership connections among professionals—older and younger, students and retirees, urban and rural, industry and government, nonprofit and academia—are needed and will be the future emphasis for success for the environmental health profession. We need to communicate, collaborate, and connect to make us one. Technology and social media outlets are here to help facilitate our continuing connections and progress. Remember, this organization is ours: One NEHA.

Priscilla

President@neha.org

Did You Know?

NEHA's 83rd Annual Educational Conference & Exhibition is this month, July 9–12! We look forward to seeing everyone in Nashville for an event that will be packed with educational, networking, and professional growth opportunities. Want to attend but haven't registered? Visit www.neha.org/aec.

SUPPORT THE NEHA ENDOWMENT FOUNDATION

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

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

Thank you.

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Pesticide Contamination in Central Kentucky Urban Honey: A Pilot Study

Mary Sheldon, MPH
Clint Pinion, Jr., DrPH, RS
James Klyza, PhD, CIH
Eastern Kentucky University

Anne Marie Zimeri, PhD
University of Georgia, Athens

Abstract **Pesticide residues in honey are becoming a growing concern because of both potential human health effects and negative impacts on beehives. Urban beehives from city apiaries can be subject to increased pesticide use from spraying of commercial, park, and residential locations. We tested honey and beeswax collected from urban hives in Central Kentucky for pyrethroid pesticide residues, organochlorine pesticides, and heavy metals. Although our results showed no detectable levels of pyrethroid pesticides, organochlorine pesticides such as DDT and endosulfan were present, both of which have persisted in the environment since being banned in 1972 (DDT) and 2010 (endosulfan). We found that 72% of honey samples tested in this study exhibited levels of pesticides exceeding U.S. Environmental Protection Agency tolerable daily intake levels. We also tested honey and honeycombs for toxic heavy metals. We found lead levels up to 5 ppm in these samples. Results indicate the need for regular monitoring programs to assess the potential risk to consumer health—along with bee health—while also giving information on the pesticide treatments that have been used in areas surrounding the hives.**

Introduction

Honey has increased in popularity among shoppers at chain and local marketplaces. The increased popularity has led to small-scale urban beekeeping becoming an attractive practice, coinciding with the local food movement and concern over the decreasing honeybee population (Peters, 2012). Concerning to the producers of honey, and ultimately the end market, are the potential contaminants that can result in a toxic hive product or hive collapse. During foraging, honeybees are exposed to pollutants deposited on plants and from systemic pesticides. Most honeybees and their food are contaminated by spray applications that bees fly through or by residual pesticide left on foliage or floral parts (especially pollen).

Honeybees can bring these pollutants into their hive via collected nectar or pollutants that attach to the pollen-collecting hairs on their body; the aforementioned modes of pollutant transport yields the possibility of pesticide contamination in honey and other bee products, including the honeycomb (Mussen & Brandi, 2010). Pesticide contamination could weaken the beneficial properties of honey and, if present in hazardous amounts, pose a threat to human health (Peters, 2012).

Assessment of environmental diffusion of pesticides can be accomplished via matrix analyses of hive products, such as beeswax or honey (Chauzat et al., 2006). Monitoring pesticide residues in honey is also critical for assessing potential risk to consumer health and health of the hive, and can provide information on the pesticide treatments that have been used in areas surrounding hives (Peters, 2012). Researchers have used bees and bee products as biomonitoring agents for environmental contamination (Badiou-Bénéteau et al., 2013; Bargańska, Ślebioda, & Namieśnik, 2016; Chauzat et al., 2011; de Oliveira, Queiroz, da Luz, Porto, & Rath, 2016; Malhat, Haggag, Loutfy, Osman, & Ahmed, 2015; Pérez et al., 2016), to assess heavy metal environmental contamination (Giglio et al., 2017; Matin, Kargar, & Buyukisik, 2016), and to analytically document chemicals used in agricultural settings (Irungu et al., 2016; Niell et al., 2015). Monitoring research suggests that urban bees are exposed to even higher levels of pesticides than rural bees. Approved pesticide-use levels often are much higher for home and garden use than the levels permitted in commercial agriculture (Peters, 2012).

Pesticide Applications

The rising fear of potential diseases transmitted via mosquito bites has sparked increased mosquito abatement through commercial pesticide application, homeowner pesticide application, and public health programming.

Pyrethroids are an extensively used class of insecticides with acute toxicity to insects governed by toxicological actions upon the central nervous system. Humans are less sensitive to pyrethroids than are insects, due to a combination of faster metabolic disposal, higher body temperature, and an inherently lower sensitivity of the similar human ion channel target sites. These features led to pyrethroids becoming the major pesticide class for agricultural and public health applications (Ray & Fry, 2006). As an insecticide with both repellent and killing functions, pyrethroids are the mainstay of current mosquito management. Insecticide use in the U.S. accounted for 40% of total world use by volume in 2006, and at least 9% or 70 million pounds of these insecticides were applied in urban settings (Zhu et al., 2016).

Due to extensive use of pesticides on food, escalated commercial pesticide use, and easy unsupervised access to pesticides by the general public, the public likely is facing higher risks from pesticide exposure than currently acknowledged. Unfortunately, the Food and Drug Administration has no regulations or definition for honey, so approximately 70% of the honey on U.S. grocery store shelves is adulterated. Adulterated honey can contain cheaper sweeteners, illegally trafficked honey, and/or chemicals. U.S. honey companies can dilute honey with other sweeteners to save money. Some companies receive imported honey, which can come from countries with negligent environmental safety regulations (The Honeybee Conservancy, 2017).

The best way to avoid adulterated honey is to buy local honey from a source that you can trust such as from farmers markets, co-ops, or local apiaries. The Kentucky State Beekeepers Association (2018) launched the Kentucky Certified Honey Program in summer 2018 as a new marketing program. This certification signifies that the producers' beehives are being managed within the state, the bees have collected nectar and pollen within the area immediately surrounding their beehives, and the honey is processed and bottled in Kentucky.

Organochlorine Pesticides and Heavy Metals

Organochlorine pesticides are chlorinated hydrocarbons used extensively from the 1940s through the 1960s in agriculture and mosquito control. These compounds are lipophilic pesticides known for their high toxicity, slow degradation, and bioaccumulation in lipid-rich tissue such as body fat. As a result, most living organisms now contain organochlorine residues, with the highest concentrations generally occurring in carnivorous species. These chemicals belong to the class of persistent organic pollutants, with high persistence in the environment through large reservoirs that remain in soils, sediments, and other environmental compartments (Huang et al., 2018).

Among environmental contaminants found on honeybees and in bee products, the most commonly studied are heavy metals. Honeybees are good biological indicators of anthropogenic pollution because they can indicate the chemical damage of their environment through high bee mortality and the residues present on their bodies or in beehive products. Honeybees sample most environmental sectors (i.e., soil, vegetation, water, air) through foraging (Abrol, 2013).

Ecosystem pollution from chemicals and heavy metals have greatly accelerated during the last few decades due to mining, smelting, manufacturing, use of agricultural fertilizers, pesticides, municipal wastes, traffic emissions, industrial emissions, and industrial chemicals (Bogdanov, 2006). The primary characteristic that distinguishes heavy metals from other pollutants, such as pesticides, is their introduction into an area and their environmental outcome. Pesticides are scattered both in time and space and deteriorate by means of various environmental factors over differing periods of time. Heavy metals are discharged in a continuous manner by various natural and human sources to continuously enter the physical and biological cycles (Porrini et al., 2003).

The main sources for contamination of honey with heavy metals result from placing hives near urban areas with heavy car traffic or near industrialized areas, or from storing honey in objects or containers made of materials that are unsuitable (Ciobanu & R dulescu, 2016). A number of variables have to be considered when using bees, or beehive products such as honey, to monitor heavy metals in the environment: the weather (rain and wind can reduce air pollution or transfer heavy metals to other environmental areas); the season (the nectar flow, which is usually more prominent in spring than in summer and autumn, could dilute the pollutant); and the botanical origin of the honey (flowers with an open morphology are more vulnerable to pollutants) (Porrini et al., 2003).

Pesticides and Heavy Metal Health Issues

Several studies have cited the human health hazards concerning honey contamination by pesticides (Al-Waili, Salom, Al-Ghamdi, & Ansari, 2012; Amendola, Pelosi, & Dommarco, 2011; Celli & Maccagnani, 2003; Chauzat et al., 2006; Chen, Tao, McLean, & Lu, 2014; Chiesa et al., 2016; Frazier, Mullin, Frazier, & Ashcraft, 2008; Long & Krupke, 2016; Mukherjee, 2009; Porrini et al., 2003; Sanchez-Bayo & Goka, 2014). The research done by Mahmoudi and coauthors (2016) found that floral sources can create a significant influence on honey safety and contamination. Rissato and coauthors (2007) showed that honey could contain a low level of contamination from pesticide residues with a much higher concentration of pesticide used for controlling dengue mosquitos. Mullin and coauthors (2010) conducted the most extensive North American survey of pesticide residues in managed honeybee colonies to date in 23 states and 1 Canadian province during the 2007–2008 growing season. Pyrethroids were the dominant class of insecticides detected in all samples. A study done by Stahl (2002) indicated that all pesticides are associated with some risk of harm to human health and the environment.

This pilot study examined two research questions:

1. Are residues from pyrethroid pesticide present in urban honeybee hive products (i.e., honey, honeycombs, and beeswax)?
2. Are organochlorine pesticides and heavy metals present in urban honeybee hive products (i.e., honey, honeycombs, and beeswax)?

Materials and Methods

To determine if pyrethroid pesticide residues were present in urban honeybee hive products, a total of 20 1-lb honey samples were collected from beekeepers located in urban areas (i.e., cities or towns) in Central Kentucky. This pilot study included cities or towns within McLean, Hardin, Bullitt, Jefferson, Nelson, Shelby, Oldham, Franklin, Woodford, Fayette, Madison, and Menifee counties. Inclusion criteria were urban beekeepers or amateur beekeepers who maintained hives within 4 miles of their residence or 4 miles from a park, campground, or recreational area. Exclusion criteria included commercial beekeepers or those beekeepers who lived in rural areas that would not be involved in mosquito abatement spraying.

Each 1-lb honey sample was placed in a 1-lb BPA-free plastic jar and then shipped to the U.S. Department of Agriculture (USDA) Agricultural Marketing Service's National Science Laboratories in Gastonia, North Carolina, which was contracted to perform pesticide analysis for the presence of d-phenothrin, prallethrin, and piperonyl butoxide. The National Science Laboratories performed a pesticide residue analysis (method AOAC OMA 2007.01) referred to as QuEChERS, which stands for Quick-Easy-Cheap-Effective-Rugged-Safe. The honeybee product method uses the QuEChERS approach with a cleanup step to help overcome the added complexities and interferences associated with residue testing of honeybee products.

Sample extracts were analyzed for pesticide residues by gas chromatography (GC) and/or liquid chromatography (LC) using mass selective detection systems. Using both LC with tandem mass spectrometry (LC/MS/MS) and GC approaches allow for a faster, more complete picture of pesticide residues. The use of tandem mass spectrometry also permits identification of the target pesticides through the selection of specific multiple reaction monitoring (MRM) transitions for each compound.

Organochlorine Residues

To determine if organochlorine pesticide residues and heavy metals were present in urban honeybee hive products, 10–50 mL beeswax honeycomb samples and 8–50 mL honey samples were collected during the months of May–December 2017 for pesticide residue analysis. In brief, 10 g of sample material was mixed with acetonitrile and agitated. Additions of sodium chloride, magnesium sulfate, and buffering salts were used for phase separation and pH adjustment. Intensive agitation and spinning in a centrifuge produced a raw extract. Using dispersive solid phase extraction cleanup (d-SPE) to remove water and undesired co-extractives produced the final extract that was analyzed by GC/LC techniques.

Wax honeycomb analysis consisted of adding 15 mL methanol to each tube and sonicating for 1 hr, then centrifuging at 2,000 rpm for 20 min. Tubes were then frozen at -20 °C for 2 hr. The supernatant methanol was passed through cellulose extraction thimbles to collect the filtered separated solvent. A second extraction was performed with the extracts transferred to evaporation tubes and placed in a 75 °C water bath. Once the extracts were nearly dry, they were moved to 1 mL volumetric tubes and brought to volume with methanol. The analysis was done by both LC/MS/MS and GC approaches.

We looked for the following pesticides: alpha-cyclohexane, 1,2,3,4; beta-cyclohexane, 1,2,3,4; gamma-cyclohexane, 1,2,3,4; delta-cyclohexane, 1,2,3,4; heptachlor; 1,4:5,8-dimethanonaphthale; epoxyheptachlor; endosulfan I; p,p'-dichlorodiphenyldichloroethylene (p,p'-DDE); dieldrin; endrin; p,p'-DDD; endosulfan II; endrin aldehyde; p,p'-DDD+DDT; endosulfan sulfate; and methoxychlor.

Metal Residues

Honey was prepared prior to the digestion procedure by placement in a desiccator under vacuum until dry. Once dry, the samples were ground using a mortar and put through a 2 mm sieve. We placed 0.2 g of solid sample into a preweighed digestion vessel, then added 5 mL of trace metal grade nitric acid and left the sample at room temperature overnight. We then closed and tightened the digestion vessels using a specialized wrench. Next we placed the vessels in the microwave for two consecutive cycles: once at power level 3 for 30 min, then at power level 2 for 30 min.

Once cooled, we opened the vessels and added 20 mL of deionized water. Then the vessels were shaken. We recorded the full vessel weight and collected sample aliquots in centrifuge tubes. Prior to inductively coupled plasma mass spectrometry (ICP/MS) analysis, we diluted the samples 1:10. Note: the dilution factor was calculated by subtracting the weight of the empty vessel before analysis from that of the loaded vessel at the end, then dividing by the mass of the samples used. Using mass instead of volume for this calculation increases the accuracy of the results. The results of the ICP/MS analysis were multiplied by this calculated dilution factor as well as by the 1:10 dilution factor.

Results

We tested a total of 20 raw unfiltered honey samples from urban hives for Duet pesticide containing d-phenothrin, prallethrin, and piperonyl butoxide by the USDA National Science Laboratories using GC/LC analysis. The report of analytical test results showed that samples were below the detectable limit for d-phenothrin, prallethrin, and piperonyl butoxide.

As seen in Table 1, we tested a total of 6 honeycomb samples and 12 honey samples by GC/MS for organochlorine pesticides and 72% exceeded one or more U.S. Environmental Protection Agency (U.S. EPA) tolerable daily intake (TDI) values. Results are based on U.S. EPA (2018) noncarcinogen TDI values:

- 1,4:5,8-dimethanonaphthale (CAS 309002): U.S. EPA limits daily oral intake to 0.00003 (mg/kg/d); honey samples FA2 and JE1 exceeded daily oral intake.
- Heptachlor (CAS 76448): U.S. EPA limits daily oral intake to 0.0005 (mg/kg/d); honey sample MA1 exceeded daily oral intake.
- Dieldrin (CAS 60571): U.S. EPA limits daily oral intake to 0.00005 (mg/kg/d); honey samples NI1 and PO1 exceeded daily oral intake.
- p,p'-DDD+DDT (CAS 50293): U.S. EPA limits daily oral intake to 0.0005 (mg/kg/d); honeycomb samples BU1 and JE1 and honey samples CS1, FA1, FA3, LR1, MA1, NI1, and RO1 exceeded daily oral intake.
- Endrin (CAS 72208): U.S. EPA limits daily oral intake to 0.0003 (mg/kg/d); honey samples FA2 and FA3 exceeded daily oral intake.
- Endrin aldehyde (CAS 72208): U.S. EPA limits daily oral intake to 0.0004 (mg/kg/d); honey samples FA3 and PO1 exceeded daily oral intake.
- Methoxychlor (CAS 72435): U.S. EPA limits daily oral intake to 0.005 (mg/kg/d); honey samples FA2 and MA1 and honeycomb samples JE1 and LM1 exceeded daily oral intake.

Additionally, we analyzed these honey and honeycomb samples for heavy metal content.

TABLE 1

Organochlorine Pesticide Testing Analysis Results

Sample	Target Compounds						
	Heptachlor (ppb)	1,4:5,8-Dimeth-ano-naphthale (ppb)	Dieldrin (ppb)	Endrin (ppb)	p,p'-DDD+DDT (ppb)	Endrin Aldehyde (ppb)	Methoxychlor (ppb)
BL1 (C)	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BU1 (C)	BDL	BDL	BDL	BDL	**225.72**	BDL	BDL
CS1 (H)	BDL	BDL	BDL	BDL	**28.31**	BDL	BDL
FA1 (H)	BDL	BDL	BDL	BDL	**145.02**	BDL	BDL
FA2 (H)	BDL	**0.72**	BDL	**56.12**	BDL	BDL	**38.97**
FA2 (C)	BDL	BDL	BDL	BDL	BDL	BDL	BDL
FA3 (H)	BDL	BDL	BDL	**158.86**	**137.28**	**5.56**	BDL
FA4 (H)	BDL	BDL	BDL	BDL	BDL	BDL	BDL
JE1 (H)	BDL	**0.34**	BDL	BDL	BDL	BDL	BDL
JE1 (C)	BDL	BDL	BDL	BDL	**294.07**	BDL	**622.02**
LM1 (C)	BDL	BDL	BDL	BDL	BDL	BDL	**158.10**
LR1 (H)	BDL	BDL	BDL	BDL	**55.33**	BDL	BDL
MA1 (H)	**2.50**	BDL	BDL	BDL	**207.43**	BDL	**516.31**
NI1 (H)	BDL	BDL	**638.60**	BDL	**26.75**	BDL	BDL
PO1 (H)	BDL	BDL	**98.96**	BDL	BDL	**29.69**	BDL
RO1 (H)	BDL	BDL	BDL	BDL	**29.61**	BDL	BDL
SH1 (H)	BDL	BDL	BDL	BDL	BDL	BDL	BDL
SH2 (C)	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Tolerable daily intake (TDI)							
TDI (mg/kg/day)	0.0005	0.00003	0.00005	0.0003	0.0005	0.0004	0.005

BDL = below detection limit; C = honeycomb sample, H = honey sample.
Note. Bolded numbers indicate that results exceed TDI.

Some lead contamination was apparent, but results were below the tolerable upper intake level (UL) guidelines (6 µg/day) set by U.S. EPA, which is the maximum usual daily intake level at which no risk of adverse health effects is expected for most individuals in a specific group based on stage of life.

As seen in Table 2, 56% of the 18 samples tested for lead exceeded the World Health Organization/Food and Agriculture Organization (WHO/FAO) limit of 50 ppb, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) provisional tolerable weekly intake of 0.025 mg/kg/bw, and the California Proposition 65 Safe Drinking Water and Toxic Enforcement Act of 1986 acceptable intake level of 0.0005 mg/day.

Discussion

The detection of pesticide residues in honey is essential for determining that human exposure to contaminants through dietary intake does not exceed acceptable levels. With the local honey market strong and demand for honey on the rise (especially for locally produced honey and specialty honey), the bioaccumulation and short-term environmental uptake of insecticides can cause not only mass poisoning of bees but also a health threat to humans as pesticides are transferred to consumable bee products, affecting their quality and properties.

Honey typically is extracted by means of a centrifugal honey extractor, which makes it achievable to remove the honey without causing damage to the honeycomb. Empty honeycombs are replaced back into the hive for the bees to refill. Bees are attracted to older honeycombs because these combs are rich in the scent of bees, honeybee pheromones, beeswax, pollen, and honey. Unfortunately, though, old honeycombs can be a source of health problems for bees and contamination of bee products. Beeswax readily retains chemical contaminants such as miticides to control parasitic mites as well as fungal and bacterial spores inside the hive. Beeswax also retains agricultural or urban insecticides and pesticides. Beekeepers generally are taught to reuse honeycombs to reduce the workload on their bees and to facilitate honey production. There is a need for education, especially for

TABLE **2**

Heavy Metal Testing Analysis Results

Sample	Lead (ppm)	Exceeds Daily Intake Limits*
BL1 (C)	1.297	Yes
BU1 (C)	0.070	Yes
CS1 (H)	BDL	No
FA1 (H)	BDL	No
FA2 (H)	BDL	No
FA2 (C)	BDL	No
FA3 (H)	BDL	No
FA4 (H)	3.240	Yes
JE1 (H)	BDL	No
JE1 (C)	0.230	Yes
LM1 (C)	0.127	Yes
LR1 (H)	0.176	Yes
MA1 (H)	BDL	No
NI1 (H)	5.653	Yes
PO1 (H)	BDL	No
RO1 (H)	0.192	Yes
SH1 (H)	1.104	Yes
SH2 (C)	0.210	Yes

BDL = below detection limit; C =honeycomb sample; H = honey sample.
*WHO/FAO = 50 ppb; JECFA PTWI = 0.025 mg/kg/bw; California Proposition 65 = 0.0005 mg/day.

amateur apiarists, on the practice of replacing old honeycombs to reduce the risk of bee product contamination.

Risk assessment of the impact of pesticides on human health differs in the periods and levels of exposure, the types of pesticides used (regarding toxicity and persistence), and the environmental characteristics of the areas where pesticides are applied. Risk assessments, however, fail to look at chemical mixtures, synergistic effects, myriad health endpoints (such as endocrine disruption), disproportionate effects to vulnerable population groups, and regular noncompliance with product label directions. These inadequacies contribute to severe limitations in defining real-world poisoning as captured by epidemiologic studies.

This study begins to establish a baseline of exposure from honey and honeybee products from one state's urban hives. Upon further examination of different regions, policy makers can be better informed about any necessary regulatory reactions to this unregulated industry. In addition, informed apiarists can protect their honeybees and hives by locating them away from areas contaminated by the pesticides and metals.

Conclusion

The overall goal of this research was to protect consumer health by addressing the need for regular monitoring programs for pesticide residues and heavy metal contaminants in honey and consumable bee products. Regional studies show that the statistically significant results concerning p,p'-DDD+DDT contamination in Kentucky is on the high end of the continuum and warrants further investigation to see if there are areas of higher concentrations that might pose risks to consumers.

Limitations of this study included the small sampling size and a short time period in which the sampling was conducted. With further research and analysis during an extended time period, a more comprehensive determination of contaminants and residues in honey and other bee products can help to assess the potential risk to consumer health. Pesticide treatments that have been used in areas surrounding the hives can also be evaluated, thereby offering a more realistic picture of possible health risks to consumers and honeybees.

Acknowledgement: This work was supported by a University-Funded Major Project Award from Eastern Kentucky University. The funders had no role in study design, data collection, analysis, decision to publish, or preparation of the manuscript.

Corresponding Author: Clint Pinion, Jr., Assistant Professor, Department of Environmental Health Science, College of Health Science, Eastern Kentucky University, 521 Lancaster Avenue, Dizney 220, Richmond, KY 40475. E-mail: clint.pinion@eku.edu.

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Compliance With Mandated Testing for Lead in Drinking Water in School Districts in New Jersey

Marianne Sullivan, MPH, DrPH
Marcos Lopez
William Paterson University of New Jersey

Abstract **Preventing lead exposure from all sources is critical for children's optimal health and development. The crisis in Flint, Michigan, drew attention to the role of drinking water in lead exposure. School drinking water might pose significant risks due to aging infrastructure and the particular conditions of water use in schools. In 2016, New Jersey mandated that school districts test all drinking water outlets for lead and specified procedures that districts must follow. This study assessed compliance with this mandate. Districts were required to report results on their websites, so we used district websites as the unit of analysis to assess compliance with testing and reporting procedures and to identify schools that had reported maximum concentrations of lead in water. Most districts complied with the mandate to test their drinking water (90%) and the majority complied with online reporting requirements to some extent (87%). Most districts (79%) had one or more outlets in their district that exceeded the U.S. Environmental Protection Agency's action level of 15 ppb. Mandated testing for lead in drinking water in schools is an important policy that can prevent childhood lead exposure. New Jersey should consider lowering the action level at which lead in drinking water should be remediated.**

Introduction

Despite dramatic improvements, childhood lead exposure is an ongoing problem in the U.S. An estimated 0.5% of children had blood lead levels (BLLs) exceeding the reference level of 5 µg/dL in 2013–2014, the level at which the Centers for Disease Control and Prevention recommends public health intervention should begin (Tsoi, Cheung, Cheung, & Cheung, 2016). Low-level lead exposure in childhood is associated with developmental effects such as problems with behavior and attention and decrements in IQ (National Toxicology Program, 2012; U.S. Environmental Protection Agency [U.S. EPA], 2013). As no level of lead exposure is thought to be safe for children, there is widespread agreement in the public health community that preventing lead exposure is critical for children's optimal health and development (Centers for Disease Control and Prevention [CDC], 2012).

In the U.S., efforts to prevent lead exposure in children have focused primarily on lead exposure in and around the home due to lead in house dust and in the soil from deteriorating lead paint (CDC, 2004). Though some public health experts have argued that drinking water is an important source of childhood lead exposure, there has not been coordinated state and federal action to address this issue (Renner, 2010). The U.S. Environmental Protection Agency (U.S. EPA) estimates that exposure to lead in drinking water could account for as much as one fifth of a person's total lead exposure (U.S. EPA, 2018). There is a growing understanding from a prevention perspective that it is important to control and minimize all sources of lead exposure in a child's environment, including from drinking water (Levallois, Barn, Valcke, Gauvin, & Kosatsky, 2018).

Lead in drinking water recently has become a significant national issue as a result of the crisis in Flint, Michigan. In 2014 and 2015, growing resident complaints, independent water testing by researchers at Virginia Tech, and media attention brought the Flint lead crisis into public view. Many households in Flint were found to have lead in water above U.S. EPA's action level. An epidemiologic study comparing children's blood lead levels before and after the city changed its source of drinking water attributed increases in elevated blood lead levels among children in certain Flint neighborhoods to contaminated drinking water (Hanna-Attisha, LaChance, Sadler, & Champney Schnepp, 2016). The Flint crisis heightened awareness among professionals and the public that lead in drinking water might be a more widespread problem in the U.S. than previously acknowledged due to aging infrastructure and a history of using lead in solder, pipes, service lines, and fixtures.

Lead in Water Standards

In 1991, U.S. EPA set the action level for lead in drinking water at 15 ppb and required drinking water providers to take action to reduce lead in water if 10% of their tap water samples exceed this level. U.S. EPA's nonenforceable maximum contaminant level goal for lead is 0 ppb, in recognition of lead's toxicity and the public health imperative to prevent any lead exposure, particularly among infants, children, and pregnant women (U.S. EPA, 2018).

After water leaves the water treatment facility, lead enters drinking water typically from lead service lines, lead-containing solder, or through lead-containing fixtures such as faucets or bubblers. Water that is corrosive is particularly of concern, as corrosive water can contribute to more leaching of lead from pipes or fixtures (U.S. EPA, 2018).

School drinking water has been identified as an important point of exposure to lead for U.S. children because many schools in the U.S. contain aging infrastructure such as pipes with lead solder and lead-containing bubblers, water fountains, or faucets. Additionally, because schools typically are in use for only 8–10 hours per day and not on weekends or during holidays, there are long periods of time in which water sits in the pipes, which can increase the migration of lead into drinking water (Lambrinidou, Triantafyllidou, & Edwards, 2010).

Lambrinidou and coauthors (2010) noted that the problem of lead in school drinking water has suffered from "systemic neglect," as U.S. EPA regulation has been minimal. Currently there are no federal requirements to test for lead in school drinking water unless the school "operate(s) their own public water system" (e.g., schools that use well water). In this instance, schools must follow the testing and remediation requirements of the Lead and Copper Rule (LCR), a federal regulation that requires periodic lead testing; however, the testing is not comprehensive and there is no requirement under the LCR to test all outlets where exposure could occur (U.S. EPA, 2017). According to the U.S. EPA (2017), approximately 8,000 schools and child cares in the U.S. are routinely required to test drinking water under the LCR; however, the vast majority of schools (598,000 schools and child cares) are not required to do so.

Childhood Lead Exposure in New Jersey

New Jersey requires blood lead testing for all children at 12 and 24 months of age. In 2015–2016, 26.8% of all New Jersey children <6 years were tested, and of those, 2.7% had BLLs of ≥5 µg/dL (4,824 children). A total of 881 children <6 years were identified as having BLLs of ≥10 µg/dL. The data indicate that childhood lead exposure is an important ongoing issue in the state (New Jersey Department of Health, 2016).

In New Jersey in 2016, likely due to heightened awareness of the issue because of the lead water crisis in Flint, Michigan, several high-profile cases of lead in school drinking water were reported in the press. One such case was the Newark Public School District: lead in excess of 15 ppb had been found in some drinking water outlets in district schools dating back to 2010. In 2016 the district was said to be taking steps to test all outlets and to publicly report results (McGeehan, 2016). Other districts also began to test and report on lead levels in their drinking water and some elevated results were reported.

Responding to public concerns, in May 2016 Governor Chris Christie ordered the New Jersey Department of Education to ensure that all New Jersey public school districts test for lead in all drinking water outlets in all district schools within 1 year and that the results be publicly posted for parents and students to view. Additionally, parents would have to be notified if lead in water at their child's school exceeded 15 ppb (Santora, 2016).

In July 2016 the New Jersey Department of Education, in consultation with the New Jersey Department of Environmental Protection, released the regulation corresponding to the Governor's Order, which provided detailed procedures for districts to follow when testing water for lead. The regulation specified that districts must develop a plumbing survey at all schools and sample all drinking water outlets in all schools and facilities within 1 year of promulgation, although extensions for another year were possible. Other requirements included

- samples must be first draw, the water must sit in pipes for 8–48 hr prior to testing, and signs must be posted to indicate not to use water for 8 hr prior to testing;
- aerators must not be removed and the samples must be "collected in pre-cleaned high-density polyethylene (HDPE) 250 milliliter (mL) wide-mouth, single-use rigid sample containers that are properly labeled;"
- analysis must be done by a certified laboratory according to the requirements of the federal Safe Drinking Water Act;
- quality control and chain of custody procedures must be followed;
- results must be posted on the district's website and if exceedances are found, districts must notify parents and employees in writing of "measures taken to immediately end use of each drinking water outlet" in excess of 15 ppb; and
- districts must retest drinking water every 6 years (New Jersey Administrative Code, 2016).

Notably, as of July 2018, New Jersey is one of eight states to require lead testing in the state's schools (U.S. Government Accountability Office [GAO], 2018).

Purpose

This study examined New Jersey school district compliance with New Jersey Department of Education regulations testing water for lead in 2016–2017 in New Jersey schools. We assessed whether districts tested their water, publicly reported their data, and followed the state's guidelines for testing, reporting, and communication of results to parents and the school community.

Methods

The New Jersey Department of Education regulations for testing water are directed at school districts and require that results be reported on district websites, so we used school districts as the unit of analysis and assessed what a parent, student, and/or community member would see if they were to search online for their district's data testing water for lead. The New Jersey State Department of Education maintains a publicly accessible database of all school districts in the state that includes district name, location, and website address for 599 districts. We used this database to identify our sample, which consisted of 581 school districts that were operational at the time of our study.

We visited all 581 school district websites and searched for lead test results. If no results were found, we performed a Google search that included the district name and the phrase "lead in water testing." We assessed all 581 school districts on three primary outcomes: compliance with testing, reporting, and maximum lead concentration. In addition, we selected a subset of schools to investigate compliance in more detail using a simple random sample of every fifth district in the database (n = 120). The database is organized alphabetically and we did not detect any periodicity in the database.

For the subsample, data were collected on

- adherence to sampling and testing requirements,
- accessibility of results on websites,
- parent/community notification and explanation of results, and
- communication of corrective course of action taken for test results over U.S. EPA's action level (15 ppb) for lead in water.

Each school website was assessed for the variables of interest between October 2016–January 2018. If a district did not have data on their website prior to July 2017 (the last date for compliance), we rechecked the district to see if data had been posted between September 2017–January 2018.

Results

Of the 581 operational school districts in New Jersey during our study period, we found that the large majority of New Jersey School Districts (520, 90%) tested their water either immediately prior to or within the 1-year period stipulated by the state (July 2016–July 2017). We found that some New Jersey school districts carried out extensive water testing prior to the issuance of the state law. If the testing was extensive (not simply in compliance with U.S. EPA's LCR), we included the district as complying with the state's rules. For the approximately 10% of districts for which we did not find results reported on the Internet, we were unable to determine if they did test their water but did not comply with the web-based reporting requirements, or if their results were taken off of their website after posting and not accessible to us.

We were able to find some form of test results posted online, as required, for the majority of districts that tested (87%), which could either include laboratory results, a summary of results, or a letter to parents explaining the test results—or all three. For a small number of districts (n = 14), we found evidence somewhere on their website (e.g., minutes of a school board meeting) that the district had tested their water in compliance with state law, but we were unable to find their results online—this finding accounts for the discrepancy between the number of districts that we report tested their water and the number for which we found online results.

TABLE **1**

Maximum Reported Concentration Distribution of Lead in Drinking Water in New Jersey School Districts

Maximum Lead Concentration (ppb)	#	%
<15	103	21.2
15.00–44.99	122	25.1
45.00–99.99	92	18.9
100.00–999.99	130	26.7
>1,000	39	8.0
Total	486	

Note. Of the 581 districts in the study, we could not find maximum concentrations for 95. Out of the 95, there were 61 for which we could not find any results to indicate if they tested their water and 34 tested their water but we could not find the maximum concentration report online for their district.

The majority of school districts in New Jersey that reported results had one or more outlets in their district equaling or exceeding the U.S. EPA's action level for lead in drinking water. Of the 486 districts that provided enough information online to identify maximum lead levels in school water, 383 (79%) reported that at least one drinking water outlet in the district had a lead concentration that equaled or exceeded U.S. EPA's 15 ppb action level.

Additionally, more than one half of all reporting districts (261, 54%) had at least one maximum lead concentration in school drinking water outlets of ≥45 ppb, triple the U.S. EPA's action level; 39 districts reported maximum lead concentrations of ≥1,000 ppb. Table 1 shows the distribution of maximum lead concentrations reported.

The maximum lead value detected among all of the school districts was 23,980 ppb in a bubbler in the girl's locker room in the Hanover Park Regional High School District. The fountain was removed so that exposure to this extremely high source of lead was corrected. This concentration of lead in water is nearly 5 times the level that is considered hazardous waste (Roy, 2015). Additionally, five other New Jersey school districts reported maximum concentrations of lead in water that would qualify as hazardous waste (5,000 ppb or higher).

Results From Subsample

Compliance With Testing and Communication of Results

For the randomly selected subsample (n = 120) we assessed compliance with New Jersey's testing regulations in more detail. Compared with the entire sample, we found a similar percentage of the subsample had tested their water (84%) and a similar percentage had some form of results online (84%). We also assessed whether test results were easy to find online. Results were judged to be easy to find if they could be accessed within two clicks from the homepage (60% were judged to be easy to find; 40% were judged to be difficult). We observed that districts put results in many different places online. While many result reports were linked to district home pages, results were also often found on buildings/grounds, parent information, or district news pages. Often it was necessary to do a Google search to find results, as they were not readily locatable on district websites.

Of the subsample schools for which we found some report of test results online (n = 101), 73% provided actual laboratory results on the district's website as required and 68% provided a qualitative description of the results, either in addition to or in lieu of the laboratory results. We found that 61% of districts provided a risk communication letter to parents on the website, following a template that covered the purpose, methods, results, and health risks of lead. This communication was required only of schools with lead concentrations in water above the U.S. EPA's action level.

Compliance With Sampling and Testing Procedures

The New Jersey Department of Education regulation specified that first-draw samples were required from all drinking water outlets. We assessed whether the districts reported using first-draw samples by looking for this information either in the report of laboratory results, in the qualitative summary, or in the letter to parents. Of the 101 subsample districts with results online, 59% reported using first-draw samples; however, 39% of districts in the subsample did not state the type of sample they used and one district did not use first-draw samples.

Districts were also supposed to ensure that water sat for between 8–48 hr prior to sampling. Few districts, however, reported compliance with this testing requirement when reporting out their findings—in fact, only 25% affirmatively stated following this requirement. Similarly, other testing requirements were not thoroughly reported on district websites, including posting signs not to use outlets prior to testing (only 7% reported posting signs), the use of HDPE 250 mL bottles (only 20% reported using them), and not removing aerators prior to testing (none of the districts included this information in the reports of testing). Additionally, 62% of districts in the subsample that reported results said they used a certified laboratory. The majority (81%) of district results indicated that testing had been done in compliance with the Safe Drinking Water Act.

Lead in Water Findings and Remediation

We found that 95% of the districts in the subsample for which results were available reported finding any lead in their water. In 76% of districts with results, there was at least one outlet that exceeded the U.S. EPA action level for lead in drinking water. Of those exceeding 15 ppb, we determined that at least 63% had excessive lead in at least one fixture that a child drinks from or could possibly drink from (e.g., water fountains, bubblers, or classroom sinks). This finding was difficult to evaluate, however, because not all laboratory reports provided descriptions of the outlets tested: some were identified only numerically, so this percentage likely is an underestimation.

We found that 81% of districts with lead >15 ppb provided information on their plans to remediate drinking water outlets. Schools were required to end the use of drinking water outlets exceeding 15 ppb.

Discussion

The majority of school districts in New Jersey complied with state Department of Education requirements to fully test all drinking water outlets in all schools within their districts during the 365-day period from 2016–2017. Lead was detected in at least one drinking water outlet in the majority of districts in New Jersey and the majority also found lead in excess of the U.S. EPA action level in at least one outlet. Extremely high levels of lead in drinking water were found in some schools. The results argue for the importance of requiring comprehensive lead testing and remediation in schools.

We noted the majority of schools complied with key testing requirements such as testing within the year, first-draw sampling, use of certified laboratories, and conducting analysis according to Safe Drinking Water Act requirements. Other testing requirements, although they might have been followed (such as posting signage and not removing aerators), were not adequately reported. This reporting gap should be addressed in subsequent rounds of testing and reporting as they are key aspects of ensuring accurate results.

Some of the most significant problems we noted were with public reporting of results. Some district results were difficult to find online or were incomplete (e.g., missing laboratory reports). Additionally, the location of reports on district websites varied. Although many districts had a link from the district home page to the results, others did not, making it difficult to find results. If results were not on the district home page, common page locations were buildings/grounds/facilities, district news/notices, or mandated information. Additionally, some districts posted testing results on the district home page, while others posted results on individual school websites within the district.

For future rounds of testing, the state should require standardization of website reporting. We recommend requiring a link in an obvious location on district and individual school home pages. The link should go directly to a letter that explains the health effects of lead, how lead gets into water, the water testing process, and results of the testing. This information should be at an eighth-grade reading level and translated into appropriate languages. Laboratory results should also be accessible through this link.

While most districts provided a letter explaining results to parents along with actual laboratory results, some districts posted only laboratory results, with no explanation of the testing or the results. Particularly unhelpful were the few districts that reported their results as >15 ppb or <15 ppb without providing the actual laboratory results or concentrations of the lead found in the water testing. Only districts where lead in drinking water exceeded 15 ppb were required to provide risk communication letters to parents; this action should be required of all schools regardless of the lead concentrations found, because laboratory results can be difficult for lay people to read and interpret.

Beyond district website reporting, New Jersey should develop electronic reporting requirements that result in a statewide database in which progress toward lowering lead concentrations in school drinking water can be monitored and assessed. New Jersey Future, a nonprofit organization, made a similar recommendation in their preliminary analysis of New Jersey's testing data (New Jersey Future, 2017).

Notably, New Jersey's law for lead testing in school drinking water does not include requirements for addressing health concerns associated with elevated concentrations of lead in drinking water. The school district with the highest concentration of lead in drinking water in this study advised parents in a letter reporting the results to talk to their healthcare providers if they had concerns about their child's exposure. Maryland's lead testing law requires school districts to report elevated samples to the state department of health (Maryland Department of the Environment, 2017). This requirement is one that New Jersey should consider. The New Jersey Department of Health could then determine what type of follow up might be needed, as well as how to implement that follow up.

While the majority of school districts that found lead >15 ppb in their schools' drinking water reported that they planned to take out of service and/or remediate those drinking water outlets, the state should monitor remediation efforts, ensure that lead concentrations have been reduced under the U.S. EPA action level, and develop a set of best practices for all New Jersey school districts.

According to the U.S. Government Accountability Office, eight states (including the District of Columbia) have implemented lead testing requirements for school drinking water. In most of these states, including New Jersey, the law is limited to public schools and in some cases, charter schools. New Jersey also requires private schools that have contracts with public districts to serve special education students to comply with the lead testing requirements. Maryland is currently the only state to require all private schools to test their drinking water (GAO, 2018).

The testing and reporting requirements for school districts vary by state with New Jersey's law being one of the most stringent and potentially health protective. New Jersey required that all drinking water outlets in every school be testing within the first year after passing the law. In contrast, California's law recommends the sampling of 1–5 drinking water outlets per school by July 2019. The New Jersey law also has provisions for resampling every 6 years while the California law does not. Other states have shorter intervals for retesting, such as Maryland (every 3 years) and Minnesota (every 5 years) (GAO, 2018). New Jersey requires that districts take outlets that are above the U.S. EPA action level offline and communicate remediation plans to parents. In contrast, the Minnesota law only covers testing of school drinking water and not remediation (Minnesota Department of Health, 2019).

New Jersey also reimburses school districts for the cost of testing, while other states expect districts to shoulder the entire cost (GAO, 2018). In light of its strict requirements for testing and remediation, New Jersey's law can be a model for other states considering similar legislation.

Limitations

We assessed compliance by looking for and examining test results and communications with parents on district websites, which was the only format in which the data were available. As such, we might have underestimated compliance with the law due to this approach. Furthermore, test results might have been posted and then removed, leading us to have not counted them. It is also possible that we did not find some test results because they were difficult to find on district websites in some cases. Finally, we might have undercounted compliance with testing requirements if the information was not included in laboratory test results or letters to parents.

Conclusion

Although few states mandate testing of drinking water outlets in schools, the experience in New Jersey demonstrates that such a requirement is an important public health strategy for protecting children from the harmful effects of lead. If New Jersey had not mandated testing of all drinking water outlets in each district in the state, hundreds of drinking water outlets in New Jersey schools would not have been identified as harmful exposure points for lead—and action would not have been taken to end use or remediate these outlets.

New Jersey's regulation is a good first step toward protecting children's health from lead exposure in drinking water in schools. Of note, almost all districts that reported results found lead in drinking water at detectable levels. This information, combined with the recognition that the current U.S. EPA action level of 15 ppb was not set as a health-based standard (Jonas, 2015), New Jersey should consider lowering its action level at which drinking water outlets should be remediated. Because there is no safe level of lead exposure, the American Academy of Pediatrics (2016) recommends that "state and local governments should take steps to ensure that water fountains in schools do not exceed water lead concentrations of 1 ppb." Parks and coauthors (2018) argue, however, that "meeting this goal with current plumbing and fixtures will be challenging because current 'lead-free' standards did not anticipate targets this low." Therefore, even schools with new plumbing and fixtures would be required to use lead filters to meet this standard (Roy & Edwards, 2019).

Finally, in the absence of strong U.S. EPA leadership at a national level, states are left to determine how and if they will ensure that drinking water in schools does not exceed action levels for lead. New Jersey should study the implementation of its mandated lead-in-water testing program, along with the outcomes of its remediation, in order to provide best practice recommendations that would be useful to other states.

Corresponding Author: Marianne Sullivan, Associate Professor, Public Health, William Paterson University, 300 Pompton Road, Wayne, NJ 07470.
E-mail: sullivanm19@wpunj.edu.

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INTERNATIONAL PERSPECTIVES

Acute to Chronic Malnutrition: How Significant Water, Sanitation, and Hygiene Factors Change With Health Outcomes and Geographies in the Western Highlands of Guatemala

Lee E. Voth-Gaeddert, MS, PhD, EIT
Daniel B. Oerther, MS, PhD, PE, BCEE, CEng, FAAN
Missouri University of Science and Technology

Abstract **Adequate and appropriate water, sanitation, and hygiene (WaSH) infrastructure is important for reducing pathogen exposures in developing communities. To improve the ability of field practitioners in optimizing WaSH infrastructure within communities, models can provide insight into the complex interactions among WaSH infrastructure, health outcomes, and geographies. This study investigated the significant correlations between WaSH infrastructure variables and three different health outcomes (diarrhea, environmental enteric dysfunction, and stunting) over five geographic regions within Guatemala. Exploratory structural equation modeling was used to build WaSH models from U.S. Agency for International Development (USAID) 2012 Food for Peace Survey data (*n* = 2,103). The models were then tested using USAID 2013 Western Highlands Integrated Program survey data collected from the same regions (*n* = 4,633). Our results support that significant WaSH infrastructure variables vary widely over health outcome and geographic region. Improved sanitation had the highest prevalence of significance among all models. The floor transmission route for pathogens was identified as significant across all geographies for child stunting. Additionally, commonalities in potential pathogen transmission routes were identified among environmentally similar geographies. Practitioners and policy makers must account for the specific geography and health outcome to identify which set of WaSH infrastructure interventions are most appropriate at the correct scale.**

Introduction

Adequate coverage of water, sanitation, and hygiene (WaSH) infrastructure in Central America has been reported to be low in comparison with overall Latin American averages (Uytewaal, 2016). Previous research, however, has reported on the positive significance of WaSH interventions for the health of communities in these regions (Fewtrell et al., 2005; Moll, McElroy, Sabogal, Corrales, & Gelting, 2007). A primary objective for WaSH infrastructure in developing countries is to create barriers to transmission of bacterial contaminants from one person or animal to another person. These transmission pathways previously have been summarized as the five Fs: fingers, fluids, floors, foods, and flies (Centers for Disease Control and Prevention [CDC], 2013; Wagner, Lanoix, & World Health Organization [WHO], 1958).

Due to the variety of pathogen species, the differing severities of exposure, repeated exposures, and the impact on intestinal integrity of children, understanding of the relationships between WaSH infrastructure barriers and health outcomes is limited (Waddington, Snilstveit, White, & Fewtrell, 2009). Additionally, effectiveness of WaSH infrastructure on improving health outcomes has been shown to be geographically dependent because moving from one community or region to another can alter coverage rates, environmental realities, or cultural interactions (Botting et al., 2010).

The U.S. Agency for International Development (USAID) consistently collects household WaSH infrastructure data that include water sources, water treatment techniques, types of sanitation facilities, presence of soap at hand washing stations, and floor type or animal pen infrastructure. Furthermore, USAID collects specific child health data including child stunting, child wasting, child body mass index, and diarrheal occurrences (U.S. Agency for International Development [USAID], n.d.). Child stunting (or wasting) is defined as a child with a height-for-age (or weight-for-height) ratio 2 standard deviations below the World Health Organization (WHO) growth mean and is often used as a chronic (or acute) health indicator (WHO, 2010). Presence of diarrhea often is used as an acute measure of health and is defined by WHO as three or more loose stools in 24 hr (WHO, 2019). With regional WaSH infrastructure data coupled with health data,

TABLE **1**

Environmental Characteristics for Each Department

Department	Elevation (m)	Mean Temperature (C)	Annual Rainfall (mm)
Huehuetenango	2,000–2,700	17.9–20.9	2,700
Quetzaltenango	2,100–2,500	9.5–14.2	1,300
Quiché	1,600–1,850	13.0–18.0	1,500
San Marcos	2,400–2,600	10.0–16.0	1,450
Totonicapán	2,100–2,500	6.5–13.1	800–1,200

TABLE **2**

Variables, Explanation, and Scale Used in the Structural Equation Models

Variable	Explanation	Scale
Diarrhea	Has the child had a bout of diarrhea within the past 2 weeks?	0 = yes 1 = no
Environmental enteric dysfunction (EED)	Latent (reflective) variable that was created from the manifestations of diarrhea, height-for-age *z*-score (ZHAZ), body mass index *z*-score (ZBMI), and weight-for-height *z*-score (ZWHZ)	ZHAZ, ZBMI, and ZWHZ given in standard deviations
ZHAZ	Measure of height-for-age of child and standardized based on World Health Organization growth charts	Given in standard deviations
WaterSource	What water source is used by the household?	1 = in-house system connection 2 = outside-house system connection 3 = public tap 4 = private pump 5 = public pump 6 = river, lake, open water 7 = rainwater 8 = pickup truck tank
WaterTreat	Does the household treat its water in any way?	0 = yes 1 = no
HygSoap	Was soap observed at the hand washing station?	0 = yes 1 = no
SanitType	What type of sanitation facility is used by the household?	1 = in-house system connection 2 = in-house septic connection 3 = latrine 4 = open latrine/hole 5 = no sanitation facility
AnimalPen	Does the family have an animal pen that has walls?	0 = yes 1 = no

it is possible to assess trends over geographies and health outcomes to help identify significant infrastructure-based interventions that are likely to have the best return on investment for improving child health.

To assess differences in significant correlations between WaSH infrastructure and child health outcomes over both geography and type of health outcome in the Western Highlands of Guatemala, we assessed two datasets from USAID. We built structural equation models and tested them for five geographic regions and three types of health outcomes. We discuss the implications of these findings for governmental and nongovernmental organizations at international and local levels.

Methods

Data and Location

We assessed data from the USAID 2012 Food for Peace Baseline Survey (ICF International, 2014) and USAID 2013 Western Highlands Integrative Program Baseline Survey (Taylor, 2014) for five departments (states) including Huehuetenango, San Marcos, Quiché, Totonicapán, and Quetzaltenango. We describe the data collection methods elsewhere—but briefly, a clustered randomized survey was administered verbally to mothers in their local dialect while anthropometric measurements of the children were taken following the WHO protocol. Data were de-identified and provided to researchers for analysis upon approval by USAID. Table 1 reports environmental statistics on each department including mean elevation, mean temperatures, and mean rainfall. All five departments are in a set of mountain ranges collectively known as the Western Highlands. Commonalities among the population included 1) farming as the primary livelihood and 2) the level of socioeconomic status with over 51% of the population living below the poverty line (Prado Córdova, Wunder, Smith-Hall, & Börner, 2013; USAID, 2012). A majority of the population self-identified as a specific Mayan ethnicity, including Ixil, Quiché, Mam, and Popti, with each using their own distinct language (ICF International, 2014).

Data Preparation

Table 2 shows the variables we selected to be analyzed in the models along with the associated questions and scales we used. Diarrhea and ZHAZ (height-for-age *z*-score) were selected as acute and chronic measures of health, respectively, while the latent variable EED (environmental enteric dysfunction)—a combination of ZHAZ, ZBMI (body-mass index *z*-score), ZWHZ (weight-for-height *z*-score), and diarrhea—was created to represent medium-term measures of health. Additionally, each WaSH infrastructure variable was linked with the five-F transmission pathway in which it provided a barrier (CDC, 2013; Julian, 2016; Prüss, Kay, Fewtrell, & Bartram, 2002; Wagner et al., 1958).

Improved water source and water treatment infrastructure were associated with barriers of transmission via the fluid and food pathways. Having soap for hand washing was associated with barriers for the finger and food transmission pathways. An improved sanitation facility was associated with barriers for transmission for the floor and fly pathways. Finally, both having an animal pen and an improved household floor were associated with barriers for the floor transmission pathway. The 2013 dataset did not collect information on animal pens; therefore, type of flooring was selected as the substitute for the 2013 models (Berkman, Lescano, Gilman, Lopez, & Black, 2002; Zambrano, Levy, Menezes, & Freeman, 2014).

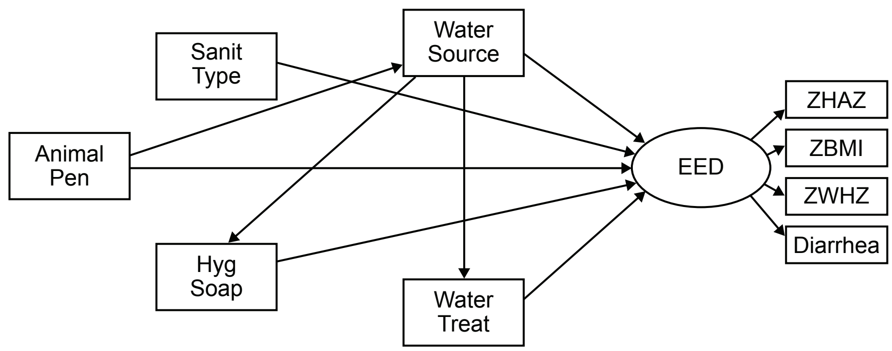
Statistical Techniques

Three structural equation models (SEMs) were built and tested for five geographic regions and each model included five WaSH infrastructure variables (WaterSource, WaterTreat, SanitType, HygSoap, and AnimalPen/FloorType) regressed on by a health variable (diarrhea, EED, or ZHAZ). SEM is a statistical modeling technique that combines path analysis and factor analysis to analyze multiple hypotheses simultaneously. Figure 1 depicts the basic graphical representation of the SEM where arrows are hypotheses, rectangles are observable variables, and ovals are latent variables. A latent variable (shown here as EED) is hypothesized to be an underlying factor that influences a set of indicator variables (shown here as ZHAZ, ZBMI, ZWHZ, and diarrhea).

As this factor is estimated, path analysis is used to compute and analyze the difference in the data-driven and hypothesized covariance matrices. These covariance matrices include all observable and latent variables. If the data show good fit to the model based on four fit statistics (chi-square $p > .05$, root mean square error of approximation <0.08, confirmatory factor index >0.90, Tucker–Lewis index >0.90), the individual parameter estimates can be analyzed (read like regression parameter estimates). We used an exploratory SEM approach to build the models from the 2012 data and a confirmatory approach to test the validity of each model using the 2013 data. We encourage further reading on the general application of SEM (Grace, 2006) and on the application of SEM to environmental health, child diarrhea (Voth-Gaeddert, Cudney, & Oerther, 2018; Voth-Gaeddert, Divelbiss, & Oerther, 2015a, 2015b), and child stunting (Voth-Gaeddert, Stoker, Torres, & Oerther, 2018). We used the lavaan package in R 3.3.2 for the analysis.

FIGURE **1**

Hypothesized Water, Sanitation, and Hygiene Infrastructure Structural Equation Model for EED



Note. Arrows are hypothesized causality, rectangles are observable variables, and ovals are latent variables.

TABLE **3**

Descriptive Statistics for the U.S. Agency for International Development (USAID) 2012 and 2013 Datasets

Descriptor	USAID 2012 Dataset	USAID 2013 Dataset
Sample size	2,103	4,633
Boys (%)	52	51
Girls (%)	48	49
Diarrhea prevalence (%)	39	33
Child height-for-age (*SD*)	-2.47	-2.44

Finally, using previously reported transmission pathways associated with individual WaSH infrastructure barriers (discussed previously), subsets of the five Fs were reported for each geography and health outcome based on the set of 2012 SEMs. Additionally, we report both changes in diarrheal occurrences and ZHAZ between the 2012 and 2013 datasets alongside the changes in WaSH infrastructure-based transmission pathways.

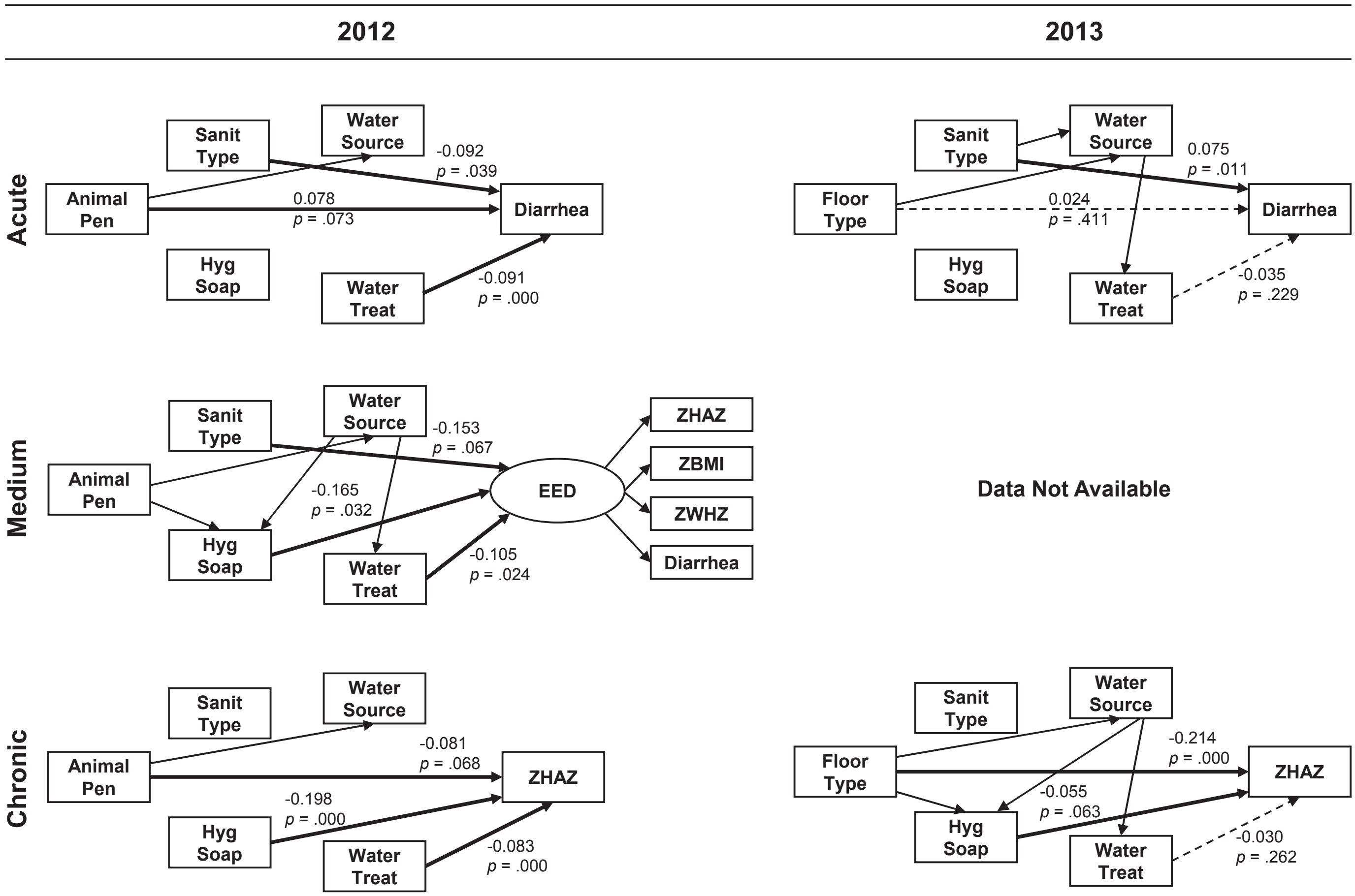
Results

Descriptive Results of Data

Table 3 presents descriptive statistics for each dataset. The 2012 data included $n = 2{,}103$ children in the analysis (52% males, 48% females). Diarrheal prevalence within the past 2 weeks was 39% and the mean ZHAZ level was -2.47 standard deviations. The 2013 data included $n = 4{,}633$ children in the analysis (51% males, 49% females). Diarrheal prevalence within the past 2 weeks was 33% and the mean ZHAZ level was -2.44 standard deviations. Data were grouped according to geographic proximity of each municipality, which resulted in three separate departments, Huehuetenango, San Marcos, and Quiché, and two subdivided departments, Northern Totonicapán and Quetzaltenango–Southern Totonicapán. According to the data, the diarrheal prevalence improved in every group from 2012–2013, while child stunting became worse in every group except San Marcos over the same time period. The 2013 sample size for Huehuetenango, San Marcos, and Quiché was more than double the 2012 dataset, while Northern Totonicapán and Quetzaltenango–Southern Totonicapán retained similar sample sizes.

FIGURE 2

The Five Structural Equation Models for the Department of San Marcos



Note. Outcome variables include acute (diarrhea), medium (EED latent variable), and chronic (ZHAZ). 2012 denotes models built from the U.S. Agency for International Development (USAID) 2012 dataset and 2013 are the results of the test of the 2012 models with the USAID 2013 dataset.

Normal lines signify a significant correlation between two variables where neither is the primary outcome variable. Bolded lines signify a significant correlation between two variables where one variable is the primary outcome. Dashed lines signify an insignificant correlation between two variables, however, that correlation is still important to the overall model.

2012 Model Results

Figure 2 displays the graphical results (as an example) of the set of models we built based on the 2012 data and that we tested using the 2013 data for San Marcos. In Table 4 we present results for all groups on the significant WaSH infrastructure variables (at a 10% level) identified by the 2012 models for diarrhea (acute), EED (medium), and ZHAZ (chronic) health outcomes. We also report standardized parameter estimates to provide a rank order for variables. The Huehuetenango models had no significant WaSH infrastructure variables correlated with diarrhea (acute); however, in both EED (medium) and ZHAZ (chronic) models we found improved types of sanitation (SanitType) were negatively correlated with negative health outcomes.

Furthermore, for the ZHAZ model, improved types of water sources (WaterSource) and having soap at the hand washing station (HygSoap) were also negatively correlated with negative health outcomes. For the San Marcos models, improved types of water treatment (WaterTreat) were negatively correlated with negative health outcomes in all models, improved types of sanitation were negatively correlated with diarrhea and lower EED, and having an animal pen (AnimalPen) was positively correlated with diarrhea but negatively correlated with lower ZHAZ.

Additionally, having soap was negatively correlated with negative outcomes in EED and ZHAZ. The Quiché models had improved types of water sources (positively correlated) and improved types of water treatment (negatively) correlated only with diarrhea. For the Northern Totonicapán models, improved types of sanitation were negatively correlated with negative health outcomes in all models and having an animal pen was negatively correlated with lower ZHAZ. And lastly, the Quetzaltenango–Southern Totonicapán models had improved types of water sources negatively correlated with diarrhea, having an animal pen positively correlated with higher EED, and improved sanitation negatively correlated with lower ZHAZ.

2013 Model Results

In Figure 2, the 2013 row displays the SEMs graphically for San Marcos. Data were not available for computing the EED models. Furthermore, the AnimalPen variable was not available in the 2013 dataset and therefore was replaced with FloorType. The results of the confirmation analysis suggested a nested 2013 model (submodel) inside the 2012 models. In Table 5 we report the changes necessary to obtain a well-fitting submodel. For each model, we made minimal adjustments to attain fit of the 2013 data to the 2012 models according to the tests of model fit as discussed in Methods.

Over the 2012–2013 period, the diarrheal prevalence among children in all departments decreased (range: -1.8% to -14.5%). Only Huehuetenango (-8.1%) had a variable become significant in 2013 (improved type of water source), which was not significant in the 2012 diarrhea model but was important to overall 2012 model fit. All other 2013 models either remained the same or lost significant variables (i.e., became submodels of the 2012 models). Over the 2012–2013 period, ZHAZ became worse for all departments (*SD* = -0.01 to -0.18) except for San Marcos (*SD* = 0.22). All 2013 models except San Marcos gained additional significant variables that previously had been insignificant in the 2012 models but important to overall 2012 model fit (improved floor type was most common).

TABLE **4**

Summarized Results of the 2012 Models for Health Outcomes and Geographic Groups

Region	Acute	Medium	Chronic
Huehuetenango	None	SanitType (-0.220)	WaterSource (-0.152) SanitType (-0.148) HygSoap (-0.118)
Quetzaltenango and Southern Totonicapán	WaterSource (-0.091)	AnimalPen (0.145)	SanitType (-0.085)
Quiché	WaterSource (0.211) WaterTreat (-0.111)	None	None
San Marcos	SanitType (-0.092) WaterTreat (-0.091) AnimalPen (0.078)	HygSoap (-0.165) SanitType (-0.153) WaterTreat (-0.105)	HygSoap (-0.198) WaterTreat (-0.083) AnimalPen (-0.081)
Northern Totonicapán	SanitType (-0.108)	SanitType (-0.228)	AnimalPen (-0.140) SanitType (-0.101)

Note. Acute outcome was diarrhea, medium was EED, and chronic was ZHAZ. Values are significant parameter estimates ($p < .05$).

TABLE **5**

Results of Necessary Adjustments to Fit the U.S. Agency for International Development 2013 Dataset to the 2012 Models

Regions	Acute	Medium	Chronic
Huehuetenango	WaterSource (-0.056; $p = .032$)	NA	FloorType (-0.207; $p = .000$)
Quetzaltenango and Southern Totonicapán	–	NA	FloorType (-0.188; $p = .001$) HygSoap (-0.137; $p = .001$)
Quiché	**WaterTreat**	NA	WaterSource (0.177; $p = .000$) FloorType (-0.156; $p = .000$)
San Marcos	**FloorType** **WaterTreat**	NA	**WaterTreat**
Northern Totonicapán	–	NA	HygSoap (-0.124; $p = .036$)

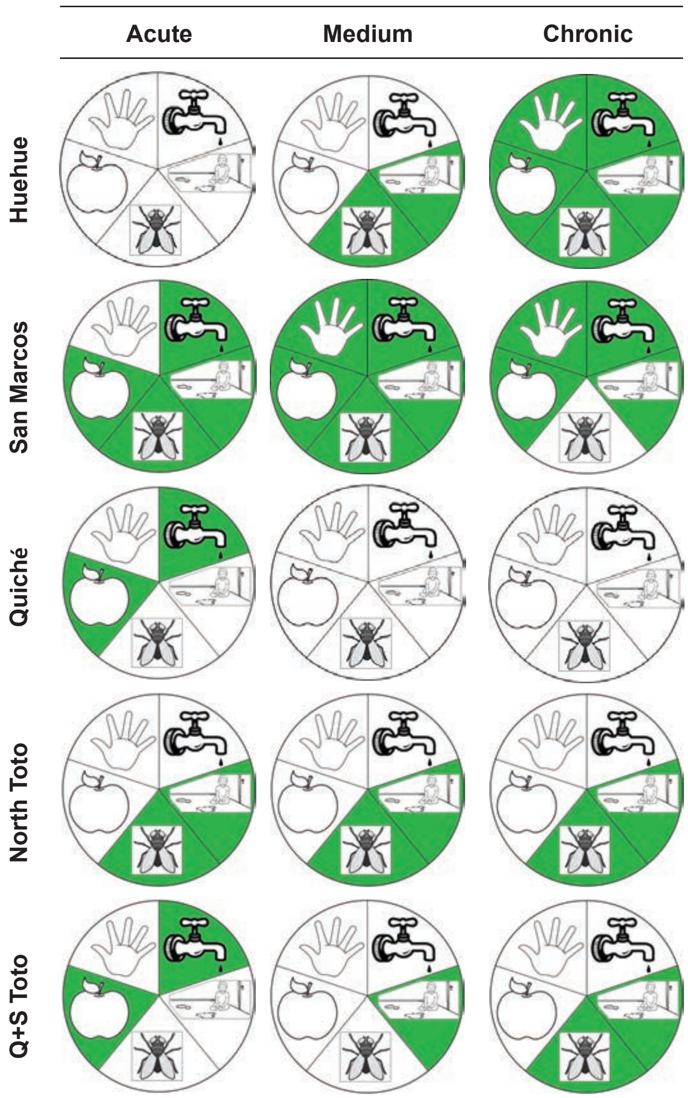
NA = data not available.
Note. Bolded names are variables that became insignificant in 2013.

Transmission Pathways

Figure 3 displays which potential pathogen transmission pathways were important for each geographical region and health outcome based on the significant WaSH infrastructure variables identified in the 2012 SEMs. The most common transmission pathway across all geographic groups and health outcomes was floors in the chronic health model column. Models for Huehuetenango and San Marcos displayed similarities among potentially associated transmission pathways, while models for Northern Totonicapán and Quetzaltenango–Southern Totonicapán displayed similar characteristics. The similarities in transmission pathways regionally appeared to be more pronounced in the medium and chronic health indictors (EED and ZHAZ): the fly and floor pathways were important for the Totonicapán–Quetzaltenango region, while the finger, fluid, floor, and food pathways were all significant for the Huehuetenango–San Marcos region. In the acute health indicator column (diarrhea models), San Marcos and Northern Totonicapán displayed a trend in the fly and floor pathways, while models for San Marcos, Quiché, and Quetzaltenango–Southern Totonicapán had similarities in

FIGURE **3**

Summary of the Potential Transmission Pathways Associated With the 2012 Structural Equation Models



Huehue = Huehuetenango; North Toto = Northern Totonicapán; Q+S. Toto = Quetzaltenango and Southern Totonicapán.
Note. Green denotes a potential significant pathway. Pathways (from top right and moving clockwise): water faucet is the fluid pathway, the ground is the floor pathway, the fly is the fly pathway, the apple is the food pathway, and the hand is the finger pathway.

the fluid and food pathways that potentially contributed to diarrheal issues.

For 2013, the diarrheal prevalence in Quiché, Totonicapán, and Quetzaltenango improved, while the potential transmission pathways remained the same. Child stunting, however, became slightly worse for the same groups, while according to the 2013 ZHAZ models, multiple transmission pathways might have become significant: most commonly, the finger and food pathways. In Huehuetenango, the opposite trend was present: as the diarrheal prevalence dropped, the type of water source became significant and therefore the fluid and food pathways were potentially contributing transmission routes. Furthermore, ZHAZ stayed constant and the potential transmission pathways also remained the same, even though the WaSH variable of type of flooring became significant. Finally, within the ZHAZ models, all geographic groups had type of sanitation or type of flooring as significant, suggesting the floor pathway was common among all groups.

Discussion

Models and Pathways: 2012 and 2013

For the 2012 SEMs, each geographical group displayed a unique set of significant WaSH infrastructure variables that also changed for each health outcome. Overall, type of sanitation was the most common significant WaSH variable, being significant in 8 of 15 models; this finding supports previous research (Al-Mazrou, Khan, Aziz, & Farid, 1995; Berkman et al., 2002; Exum et al., 2016; Zambrano et al., 2014). Having soap at the hand washing station was correlated with medium and/or chronic health outcomes in Huehuetenango and San Marcos (3 of 4 models), while improved water sources were important for acute outcomes in Totonicapán and Quetzaltenango.

A common variable across all health outcomes for San Marcos was the type of water treatment and in Northern Totonicapán the type of sanitation was common across all health outcomes. For the transmission pathways of the five Fs linked to WaSH infrastructure, important pathways (shown in green in Figure 3) could signify that there was 1) a high number or a longer sustained level of pathogens transmitted via this particular pathway that made the associated WaSH barrier significant or 2) a wide enough distribution of exposure levels for a given pathway and barrier effectiveness to be correlated with a health outcome.

For the 2013 models, the nesting effect within the 2012 models might have been due to one of several factors. First, the use of datasets from the same region suggests consistent and potentially reliable trends but the trends vary slightly because of realities on the ground. Second, the overall 2013 dataset doubled in sample size for the regional groups of Huehuetenango, San Marcos, and Quiché, increasing the probability of detecting smaller differences. More variables, however, became insignificant for these three models. Finally, the substitution of FloorType for AnimalPen could have caused slight discrepancies between models: bringing the variable closer to the house (i.e., where a child spends more time) potentially increases the importance of the variable.

Comparing geographic groups, San Marcos was unique for two reasons: 1) both diarrheal prevalence and the mean ZHAZ improved and 2) three total WaSH infrastructure variables became insignificant. Among the other models, the type of floor became significant for three of the four child stunting models; this finding supports previous work in this region (Voth-Gaeddert, Stoker, Cornell, & Oerther, 2018). In Totonicapán and Quetzaltenango, an increase in the presence of soap was correlated with an increase in ZHAZ, or households improved the actual usage of the soap at the hand washing station.

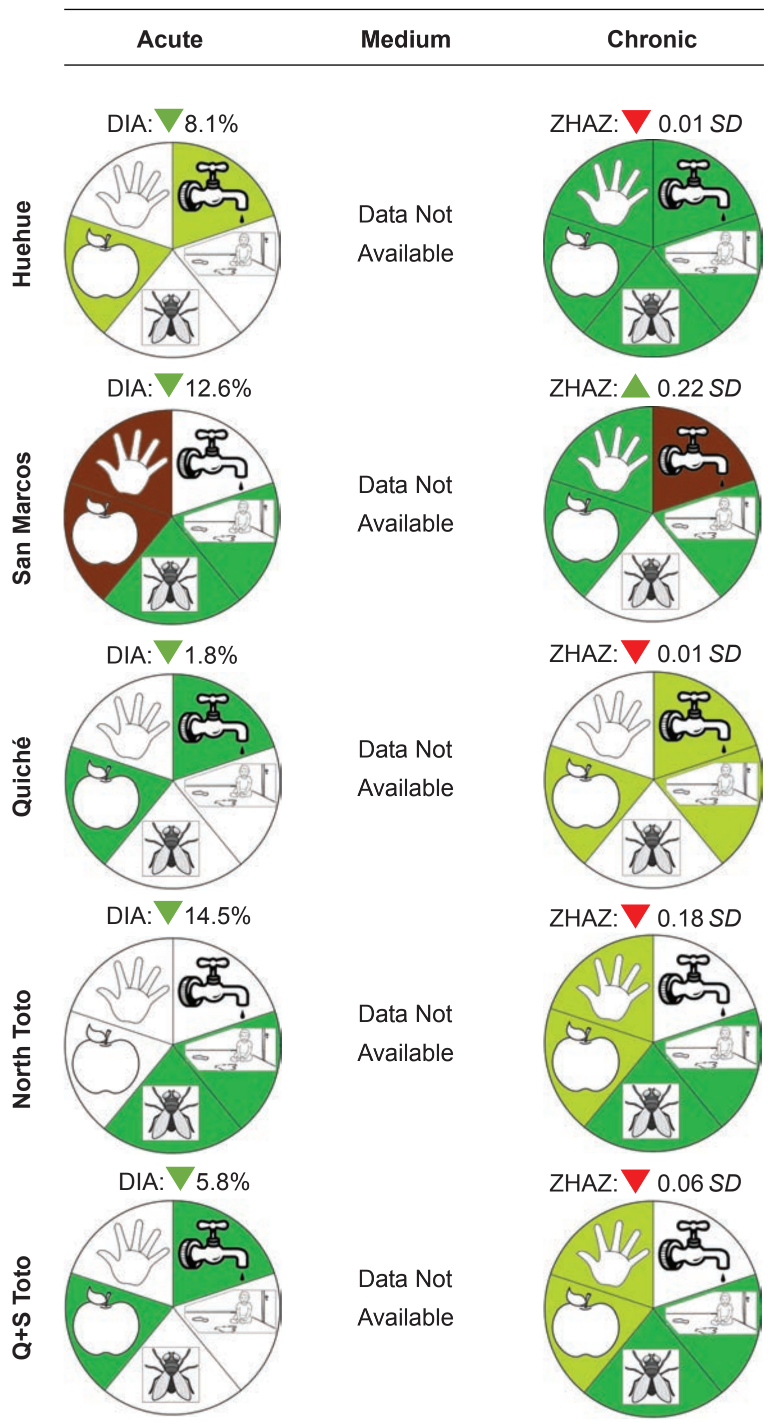
Implications for Organizations

The primary outcome from this work suggests that for any intervention, whether local or national, a multibarrier component should be considered. Specific interpretation of these results by policy makers and practitioners should depend on the spatial scale: either the department level or smaller or the regional level or larger. At a department level or smaller, the outcomes should be used as a baseline or initial estimate of priority needs for WaSH infrastructure. An inclusive, community-based needs assessment should be conducted, however, to adapt these departmental findings to the local context. Oerther and coauthors (2019) discuss a set of methods for initiating inclusive projects at the community- or multi-community-level to have a positive, sustainable impact. Furthermore, there is a clear distinction between factors that affect acute and chronic health outcomes. While previous research has demonstrated a significant association between diarrhea (acute) and ZHAZ (chronic) (Voth-Gaeddert, Al-Jabery, Olbricht, Wunsch, & Oerther, 2019; Voth-Gaeddert & Cornell, 2016), local organizations must prioritize which outcome is most important to the community and adjust accordingly.

At a regional level or larger, these outcomes should be validated with additional data (when available) and used as an ini-

FIGURE 4

Summary of the Potential Transmission Pathways Associated With 2013 Structural Equation Models



DIA = diarrhea; Huehue = Huehuetenango; North Toto = Northern Totonicapán; Q+S. Toto = Quetzaltenango and Southern Totonicapán.

Note. Green denotes significant 2013 pathways confirmed by 2012 models. Light green are new pathways identified in 2013. Brown (only in San Marcos) are significant pathways from 2012 that became insignificant.

tial estimate of resource allocation across departments. It is imperative, however, to adjust these allocated resources as additional data are obtained from assessments of the intervention. For example, the data suggest improved flooring as an important contributing factor to both diarrhea and child stunting. Therefore, if investment is allocated to aiding households to improve flooring, whether by government intervention, policy adjustments, or private sector models (see EarthEnable example at www.earthenable.org), then improved flooring eventually should become insignificant and resources can be reallocated to another set of transmission pathway barriers. Finally, our data were limited to presence of WaSH infrastructure only, but it is imperative to understand adherence and sustainability of interventions in the community-led design phase. Further reading on this topic is encouraged (Ashoka, 2019; IDEO, 2019; Ramalingam, 2014).

Conclusion

In this study, we assessed two datasets covering five departments of the Western Highlands of Guatemala by building and testing descriptive models of WaSH infrastructure variables and different health outcomes. Results showed a nested relationship between 2012 models and 2013 models. Furthermore, the floor transmission pathway for pathogens was identified as potentially common across all geographic regions for child stunting and was supported by previous work in the Western Highlands. For policy makers and practitioners at the local level, attention should be given to the correlations between WaSH variables and varying health outcomes within specific geographic groups; policy makers and practitioners at the regional or national level should be concerned with similarities across geographies in the same health outcome. It is only by understanding trends across geographies and health outcomes of interest that change will be possible on a national scale within Guatemala.

Acknowledgement: This work would not have been possible without the contribution from Alene Seiler-Martinez.

Corresponding Author: Lee E. Voth-Gaeddert, Research Fellow, Missouri University of Science and Technology, 1401 North Pine Street, Rolla, MO 65409. E-mail: lv6w3@mst.edu.

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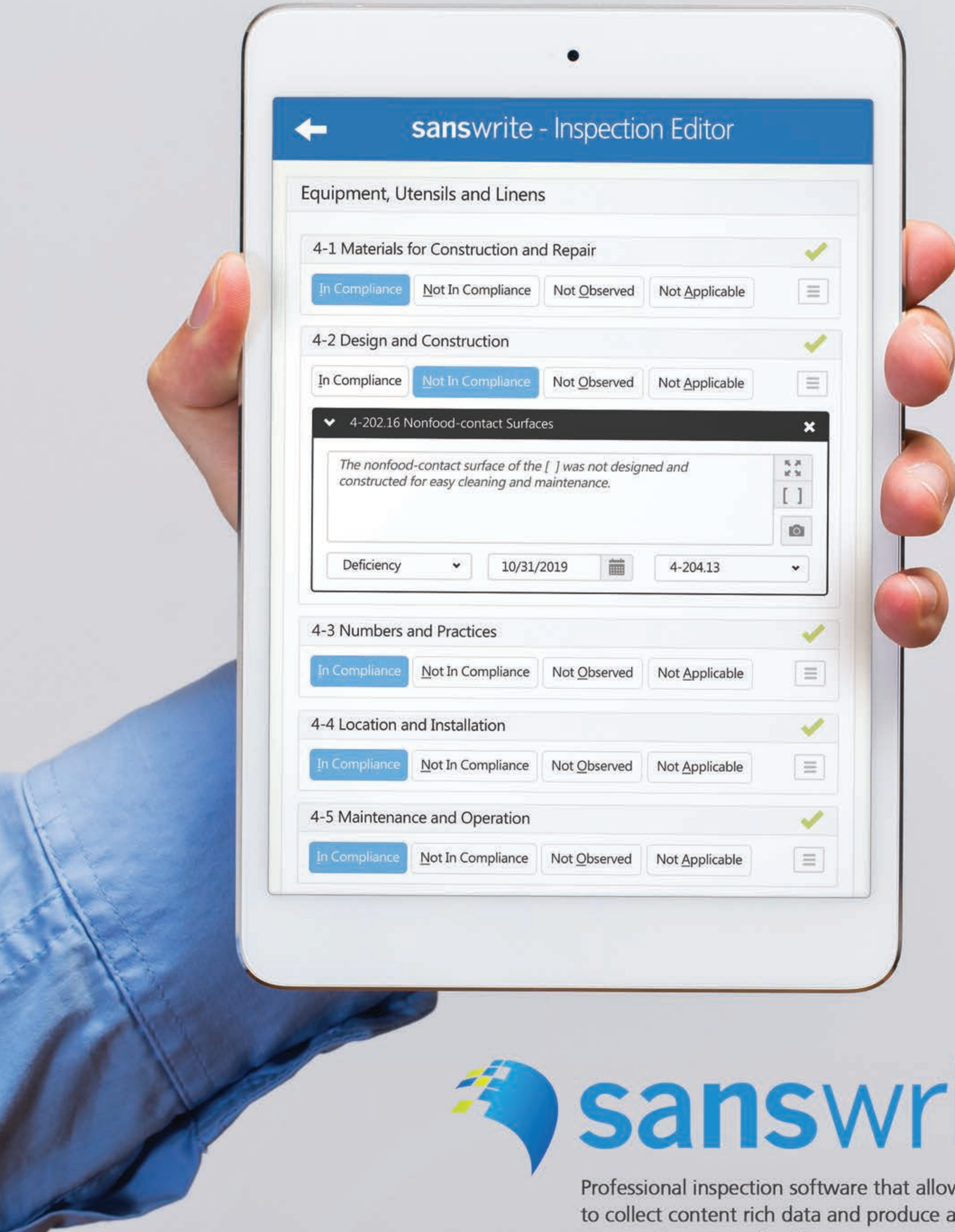
sanswrite - Inspection Editor
Equipment, Utensils and Linens
4-1 Materials for Construction and Repair
In Compliance
Not In Compliance
Not Observed
Not Applicable
4-2 Design and Construction
In Compliance
Not In Compliance
Not Observed
Not Applicable
4-202.16 Nonfood-contact Surfaces
The nonfood-contact surface of the [ ] was not designed and constructed for easy cleaning and maintenance.
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Deficiency
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4-204.13
4-3 Numbers and Practices
In Compliance
Not In Compliance
Not Observed
Not Applicable
4-4 Location and Installation
In Compliance
Not In Compliance
Not Observed
Not Applicable
4-5 Maintenance and Operation
In Compliance
Not In Compliance
Not Observed
Not Applicable

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES

Insights Into the National Institute for Occupational Safety and Health's Emergency Preparedness and Response Program

Kerton R. Victory, MSc, PhD, REHS
Jill Shugart, MSPH, REHS
Sherry Burrer, MPH-VPH, DVM, DACVPM
Chad H. Dowell, MS, CIH
Lisa J. Delaney, MS, CIH
National Institute for Occupational Safety and Health

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

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

Kerton Victory is an environmental health specialist and emergency coordinator with the National Institute for Occupational Safety and Health's (NIOSH) Emergency Preparedness and Response Office (EPRO). Jill Shugart is a senior environmental health specialist and the Emergency Responder Health Monitoring and Surveillance coordinator with NIOSH EPRO. Sherry Burrer is a senior epidemiologist and emergency coordinator with NIOSH EPRO. Chad Dowell is the NIOSH deputy associate director for emergency preparedness and response. Lisa Delaney is the NIOSH associate director for emergency preparedness and response.

Introduction

Emergency response and recovery workers might be exposed to multiple hazardous conditions and stressful work environments when responding to a public health emergency. Previous emergency events have demonstrated that significant gaps and deficiencies in responder health and safety continue to exist (Michaels & Howard 2012, Newman, 2012). Ensuring the health and safety of emergency response and recovery workers who might be exposed to hazardous conditions and stressful work environments when responding to a public health emergency should remain a top priority (Kitt et al., 2011). The National Response Framework contains a Worker Safety and Health Annex detailing responsibilities for safety and health during major emergencies, including roles for the National Institute for Occupational Safety and Health (NIOSH) such as exposure assessment and personal protective equipment determination.

The NIOSH Emergency Preparedness and Response (EPR) Program was created in 2002 following the events of 9/11, which included attacks on the World Trade Center and Pentagon, and the anthrax letter terrorist attacks. The goal of the NIOSH EPR Program is to coordinate emergency preparedness and response within NIOSH and improve NIOSH's ability to respond to future emergencies and disasters. The NIOSH EPR Program protects the health and safety of emergency response and recovery workers through the advancement of research and collaborations to prevent diseases, injuries, and fatalities in anticipation of and during responses to natural and human-induced disasters and novel emergent events.

The NIOSH EPR Program participates in response planning at the local, state, national, and international levels to ensure the timely identification of health hazards associated with emergency responses and implementation of adequate protection measures; support the Centers for Disease Control and Prevention's (CDC) emergency response efforts; and use the Disaster Science Responder Research Program to identify research needs to protect emergency response and recovery workers while identifying solutions to rapidly support research during emergencies. Training for emergency response and recovery workers is an integral part of the NIOSH EPR Program. This column highlights the NIOSH EPR Program training opportunities and activities.

TABLE **1**

Number of Public Health Professionals Who Completed the ERHMS and Responder Health and Safety Training Modules for EHTER and PHRCP Courses, 2015–2018

Year	ERHMS	EHTER	PHRCP	Total
2015	255	19	–	274
2016	255	85	61	401
2017	225	70	83	378
2018	210	72	59	341
Total	945	246	203	1,394

ERHMS = Emergency Responder Health Monitoring and Surveillance; EHTER = Environmental Health Training in Emergency Response; PHRCP = Public Health Readiness Certificate Program.

FIGURE **1**

Overview of the Emergency Responder Health Monitoring and Surveillance Info Manager software tool developed by the National Institute for Occupational Safety and Health's Emergency Preparedness and Response Program

Training Opportunities and Activities

The NIOSH EPR Program has trained over 1,000 public health professionals and emergency responders through its Emergency Responder Health Monitoring and Surveillance (ERHMS) training courses from 2015–2018 (Table 1). ERHMS is a health monitoring and surveillance framework that includes recommendations and tools specific to protect emergency responders during all phases of a response—predeployment, deployment, and postdeployment (Shugart, 2017). The goals of ERHMS are to prevent short- and long-term illness and injury in emergency responders and to ensure workers can respond safely and effectively to future emergencies. ERHMS principles are scalable to both small and large events, including federal-, state-, local-, tribal-, and territorial-level responses (Figure 1).

In addition to ERHMS, the NIOSH EPR Program also created a responder health and safety training module for CDC's Environmental Health Training in Emergency Response and Public Health Readiness Certificate Program courses. These courses are offered to CDC staff, as well as to other federal, state, and local health agencies, and have trained over 450 public health professionals from 2015–2018 (Table 1). The responder safety and health training module highlights the importance of critical personnel, equipment, training, and other resources needed to ensure that all workers are protected from all hazards during a public health emergency. While space is limited to attend these in-person trainings, anyone wishing to attend this course can contact CDC's School of Preparedness and Emergency Response.

The NIOSH EPR Program also developed a number of free courses that are offered on NIOSH's website. Recognizing that many response and recovery workers are required to work long hours during responses, NIOSH developed the Interim NIOSH Training for Emergency Responders: Reducing Risks Associated With Long Work Hours to describe personal strategies to promote good sleep and other safe work practices during a public health emergency. Additionally, the NIOSH EPR Program developed the Anthrax: Instructor Training in 2014. The training is a collec-

Photo 1. The National Institute for Occupational Safety and Health's (NIOSH) Emergency Preparedness and Response Program staff demonstrate how to sample for Bacillus anthracis *spores. Photo courtesy of NIOSH.*

Quick Links

- National Institute for Occupational Safety and Health's (NIOSH) Emergency Preparedness and Response Program: www.cdc.gov/niosh/programs/epr/default.html
- Emergency Responder Health Monitoring and Surveillance: www.cdc.gov/niosh/erhms/default.html
- Interim NIOSH Training for Emergency Responders: Reducing Risks Associated With Long Work Hours: www.cdc.gov/niosh/emres/longhourstraining
- Anthrax: Instructor Training: www.cdc.gov/niosh/topics/anthrax/training.html

tion of train-the-trainer resources including a slide presentation, videos, and handouts to teach responders how to collect, decontaminate, and ship samples. Sampling procedures taught in the training follow CDC's recommended gold-standard surface sampling procedures for *Bacillus anthracis* spores (Photo 1).

Through course feedback and program evaluation, the NIOSH EPR Program continues to refine and update its trainings and preparedness activities for the next generation of public health professionals and emergency responders. The program also actively works with other federal agencies such as the Federal Emergency Management Agency, as well as state and local health agencies and other stakeholders, to integrate key components of responder health and safety into new and existing trainings and provide technical assistance to these agencies. More information about the NIOSH EPR Program can be found on its website (see Quick Links).

Corresponding Author: Kerton R. Victory, Environmental Health Specialist, Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health, 1600 Clifton Road, MS E-20, Atlanta, GA 30329. E-mail: kvictory@cdc.gov.

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EH CALENDAR

UPCOMING NEHA CONFERENCES

July 9–12, 2019: NEHA 2019 Annual Educational Conference & Exhibition, Nashville, TN. For more information, visit www.neha.org/aec.

July 13–16, 2020: NEHA 2020 Annual Educational Conference & Exhibition, New York, NY.

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

NEHA AFFILIATE AND REGIONAL LISTINGS

Alabama

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

California

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

Colorado

September 17–20, 2019: Annual Education Conference, hosted by the Colorado Environmental Health Association, Keystone, CO. For more information, visit www.cehaweb.com.

Florida

July 30–August 2, 2019: Annual Education Meeting, hosted by the Florida Environmental Health Association, Howey in the Hills, FL. For more information, visit www.feha.org/events.

Illinois

September 16–17, 2019: South Chapter Annual Educational Conference, hosted by the South Chapter of the Illinois Environmental Health Association, Marion, IL. For more information, visit www.iehaonline.org.

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

Indiana

September 23–25, 2019: Fall Educational Conference, hosted by the Indiana Environmental Health Association, South Bend, IN. For more information, visit www.iehaind.org/Conference.

Kentucky

July 24–26, 2019: 2019 Interstate Environmental Health Seminar, hosted by Eastern Kentucky University Department of Environmental Health Science, Richmond, KY. For more information, visit www.ehsky.org.

Montana

September 17–18, 2019: 2019 MPHA/MEHA Conference, hosted by the Montana Public Health and Environmental Health Associations, Bozeman, MT. For more information, visit www.mehaweb.org.

Nebraska

September 25–26, 2019: NEHA Region 4 Fall Conference, hosted by the Nebraska Environmental Health Association, Omaha, NE. For more information, visit www.nebraskaneha.com/region4conference.html.

North Carolina

September 25–27, 2019: Fall Educational Conference, hosted by the North Carolina Public Health Association, Greensboro, NC. For more information, visit https://ncpha.memberclicks.net.

Texas

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

Utah

August 18–21, 2019: Fall Conference, hosted by the Utah Environmental Health Association, Salt Lake City, UT. For more information, visit www.ueha.org/events/html.

Wisconsin

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

TOPICAL LISTING

Recreational Water

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

Water Quality

September 11–13, 2019: *Legionella* Conference 2019, presented by NSF International and the National Environmental Health Association, Los Angeles, CA. For more information, visit www.legionellaconference.org.

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JEH QUIZ

FEATURED ARTICLE QUIZ #1

Compliance With Mandated Testing for Lead in Drinking Water in School Districts in New Jersey

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

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JEH Quiz #5 Answers

March 2019

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

➔ Quiz deadline: October 1, 2019

1. In 2013–2014, an estimated __ of children had blood lead levels (BLLs) exceeding the reference level of 5 µg/dL, the level at which the Centers for Disease Control and Prevention recommends public health intervention should begin.
   a. 0.5%
   b. 1.0%
   c. 2.5%
   d. 5.0%
2. Low-level lead exposure in childhood is associated with developmental effects such as
   a. decrements in IQ.
   b. problems with behavior.
   c. problems with attention.
   d. all the above.
   e. none of the above.
3. The U.S. Environmental Protection Agency (U.S. EPA) estimates that exposure to lead in drinking water could account for as much as __ of a person's total lead exposure.
   a. one fifth
   b. one fourth
   c. one third
   d. one half
4. In 1991, U.S. EPA set the action level for lead in drinking water at
   a. 5 ppb.
   b. 10 ppb.
   c. 15 ppb.
   d. 20 ppb.
5. As of July 2018, New Jersey is one of __ states to require lead testing in the state's schools.
   a. 8
   b. 10
   c. 16
   d. 25
6. In 2015–2016, __ of all New Jersey children <6 years were tested for BLLs, and of those, __ had BLLs of ≥5 µg/dL.
   a. 2.7%; 26.8%
   b. 26.8%; 2.7%
   c. 38.6%; 26.8%
   d. 38.6%; 2.7%
7. The New Jersey Department of Education regulations for testing water for lead specify that districts must develop a plumbing survey at all schools and sample all drinking water outlets in all schools and facilities within 1 year of promulgation.
   a. True.
   b. False.
8. Of the 581 operational school districts in New Jersey during the study period, __ of school districts tested their water either immediately prior to or within the 1-year period stipulated by the state.
   a. 54%
   b. 79%
   c. 87%
   d. 90%
9. Study researchers were able to find some form of test results posted online for __ of the districts that tested their water.
   a. 54%
   b. 79%
   c. 87%
   d. 90%
10. More than __ of all reporting districts had at least one maximum lead concentration in school drinking water outlets of ≥45 ppb.
    a. one fifth
    b. one fourth
    c. one third
    d. one half
11. The maximum lead value detected among all of the school districts was nearly __ times the concentration level of lead in water that is considered hazardous waste.
    a. 2
    b. 3
    c. 5
    d. 8
12. The study found that __ of districts in the subsample with lead >15 ppb provided information on their plans to remediate drinking water outlets.
    a. 61%
    b. 71%
    c. 81%
    d. 91%

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Certified Professional–Food Safety Manual (3rd Edition)

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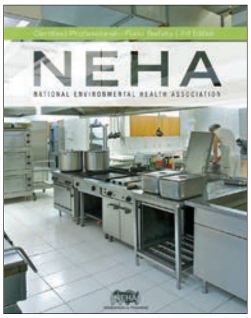

The Certified Professional–Food Safety (CP-FS) credential is well respected throughout the environmental health and food safety field. This manual has been developed by experts from across the various food safety disciplines to help candidates prepare for NEHA's CP-FS exam. This book contains science-based,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

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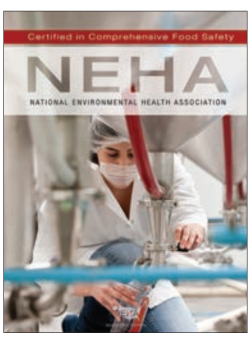

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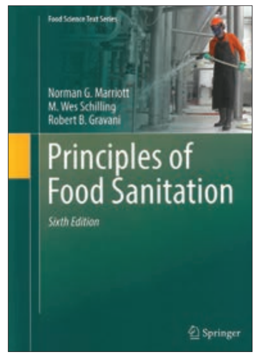

Now in its 6th edition, this highly acclaimed textbook provides sanitation information needed to ensure hygienic practices and safe food for food industry professionals and students. It addresses the principles related to contamination, cleaning compounds, sanitizers, and cleaning equipment. It also presents specific directions for applying these concepts to attain hygienic conditions in food processing or preparation operations. The new edition includes updated chapters on the fundamentals of food sanitation, as well as new information on contamination sources and hygiene, HACCP, waste handling disposal, biosecurity, allergens, quality assurance, pest control, and sanitation management principles. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety credential exams.

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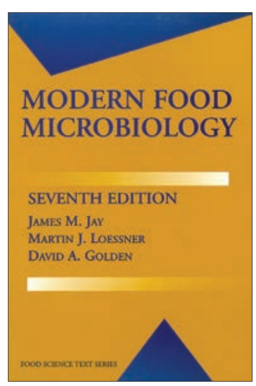
James M. Jay, Martin J. Loessner, and David A. Golden (2005)



This text explores the fundamental elements affecting the presence, activity, and control of microorganisms in food. It includes an overview of microorganisms in food and what allows them to grow; specific microorganisms in fresh, fermented, and processed meats, poultry, seafood, dairy products, fruits, vegetables, and other products; methods for finding and measuring microorganisms and their products in foods; methods for preserving foods; food safety and quality controls; and foodborne diseases. Other section topics include biosensors, biocontrol, bottled water, *Enterobacter sakazakii*, food sanitizers, milk, probiotics, proteobacteria, quorum sensing, and sigma factors. Study reference for NEHA's Certified Professional–Food Safety credential exam.

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Code	Corresponding Author/Title	Volume/Issue	Keyword 1	Keyword 2	Keyword 3	Keyword 4	Keyword 5
1	**Elizabeth Ablah, MPH, PhD, et al.** Need for Transparency and Ongoing Communication After Residents With Contaminated Water Wells Are Connected to City Water	81.3 Oct 2018 Pages: 26–31	Drinking Water	Hazardous Materials/Toxic Substances	Public Health/ Safety	Water Pollution Control/Water Quality	
2	**Steve Bennett, PhD, et al.** Estimation of the Prevalence of Undocumented and Abandoned Rural Private Wells in McDonough County, Illinois	81.5 Dec 2018 Pages: 26–33	Drinking Water	Land Use Planning/ Design	Public Health/ Safety	Water Pollution Control/Water Quality	
3	**Karen M. Butler, DNP, RN, et al.** Access to Free Home Test Kits for Radon and Secondhand Smoke to Reduce Environmental Risks for Lung Cancer	81.3 Oct 2018 Pages: E1–E6	Ambient Air	Environmental Justice	Indoor Air	Radiation/ Radon	Risk Assessment
4	**Linh Anh Cat, MS, et al.** Crossing the Line: Human Disease and Climate Change Across Borders	81.8 April 2019 Pages: 14–22	Emerging Pathogens	International	Management/ Policy	Meteorology/ Weather/ Climate	Microbiology
5	**Laura A. Cooley, MPHTM, MD, et al.** Legionnaires' Disease at a Hotel in Missouri, 2015: The Importance of Environmental Health Expertise in Understanding Water Systems	81.7 March 2019 Pages: 8–13	Emerging Pathogens	Epidemiology	Pools/Spas	Public Health/ Safety	Water Pollution Control/Water Quality
6	**Caroline Cox, MS, et al.** Reduction in the Lead Content of Candy and Purses in California Following Successful Litigation	81.7 March 2019 Pages: 28–31	Hazardous Materials/Toxic Substances	Lead	Legal	Public Health/ Safety	
7	**Kevin R. Cromar, PhD, et al.** Evaluation of the Air Quality Index as a Risk Communication Tool	81.6 Jan/Feb 2019 Pages: 8–15	Ambient Air	Epidemiology	Public Health/ Safety		
8	**Larry W. Figgs, MPH, PhD, REHS/RS, et al.** Rapid Environmental Health Response to High Venous Blood Lead Concentrations in a Child Less Than 6 Years Old: A Local Health Department Perspective	81.1 July/Aug 2018 Pages: 22–28	Children's Environmental Health	Hazardous Materials/Toxic Substances	Lead	Risk Assessment	
9	**Chelsea Fizer, MS, et al.** Barriers to Managing Private Wells and Septic Systems in Underserved Communities: Mental Models of Homeowner Decision Making	81.5 Dec 2018 Pages: 8–15	Drinking Water	Environmental Justice	Management/ Policy	Wastewater	Water Pollution Control/Water Quality
10	**Amy L. Freeland, PhD, et al.** Facilitators and Barriers to Conducting Environmental Assessments for Food Establishment Outbreaks, National Environmental Assessment Reporting System, 2014–2016	81.8 April 2019 Pages: 24–28	Food	Workforce Development			
11	**Justin A. Gerding, DHA, REHS, et al.** Uncovering Environmental Health: An Initial Assessment of the Profession's Health Department Workforce and Practice	81.10 June 2019 Pages: 24–33	Workforce Development				
12	**Shawn L. Gerstenberger, PhD, et al.** Landlord–Tenant Hotline Study: Characterizing Environmental Hazards in Renter-Occupied Units in Clark County, Nevada	81.3 Oct 2018 Pages: 8–15	Children's Environmental Health	Environmental Justice	Hazardous Materials/Toxic Substances	Indoor Air	Public Health/ Safety

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13	**N.C. Gupta et al.** Firework-Induced Particulate and Heavy Metal Emissions During the Diwali Festival in Delhi, India	81.4 Nov 2018 Pages: E1–E8	Ambient Air	Hazardous Materials/Toxic Substances	International	Meteorology/ Weather/ Climate	
14	**Leila Heidari, MPH, et al.** Characterizing the Roles and Skill Gaps of the Environmental Health Workforce in State and Local Health Departments	81.6 Jan/Feb 2019 Pages: 22–31	Workforce Development				
15	**EunSol Her, MS, et al.** Does a Water Flow Timer Improve Food Handler Hand Washing Practices in Food Service Establishments? The Effects of Passive and Indirect Interventions	81.8 April 2019 Pages: 8–13	Education/ Training	Food	Institutions and Schools	Public Health/ Safety	Technology
16	**Tiffany J. Huang, MPH, MA, et al.** Navigating Degrees of Collaboration: A Proposed Framework for Identifying and Implementing Health in All Policies	81.4 Nov 2018 Pages: 22–28	Land Use Planning/ Design	Management/ Policy			
17	**Guang Jin, ScD, PE, et al.** Food Donation and Food Safety: Challenges, Current Practices, and the Road Ahead	81.10 June 2019 Pages: 16–21	Food	Public Health/ Safety			
18	**Guang Jin, ScD, PE, et al.** Phosphorus Recovery From Surface Waters: Protecting Public Health and Closing the Nutrient Cycle	81.2 Sept 2018 Pages: 16–22	Drinking Water	Sustainability	Technology	Water Pollution Control/Water Quality	
19	**Branko Kolaric, MD, PhD, et al.** Detecting Styrene With Spectral Fluorescence Signature Analysis	81.9 May 2019 Pages: 24–30	Drinking Water	Food	Hazardous Materials/Toxic Substances	Technology	Water Pollution Control/Water Quality
20	**Raymond Lam, MSc, CPHI(C), et al.** Beyond Zoonosis: The Mental Health Impacts of Rat Exposure on Impoverished Urban Neighborhoods	81.4 Nov 2018 Pages: 8–12	Community Nuisances/ Safety	International	Public Health/ Safety	Vector Control	
21	**Kathryn Lane, MA, MPH, et al.** Death From Unintentional Nonfire Related Carbon Monoxide Poisoning in New York City During the Cold Season, 2005–2013	81.9 May 2019 Pages: 16–22	Disaster/ Emergency Response	Hazardous Materials/Toxic Substances	Indoor Air	Occupational Health/Safety	Public Health/ Safety
22	**Jing Ma, PhD, et al.** Restaurant Manager Perceptions of the Food and Drug Administration's Newest Recommended Food Facility Inspection Format: Training and Words Matter	81.10 June 2019 Pages: 8–14	Education/ Training	Food			
23	**Lisa R. Maness, MS, PhD, MT (ASCP, AMT)** The Effect of Hurricanes on Pathogenic Diseases	81.6 Jan/Feb 2019 Pages: 16–20	Disaster/ Emergency Response	Emerging Pathogens	Indoor Air	Microbiology	Water Pollution Control/Water Quality
24	**Federica Manzoni, MD, et al.** Is Air Pollution a Risk Factor for Sleep-Disordered Breathing in Children? A Study in the Province of Varese, Italy	81.5 Dec 2018 Pages: E1–E7	Ambient Air	Children's Environmental Health	International	Risk Assessment	
25	**Oriol Marquet, PhD, et al.** Worksite Built Environment and Objectively Measured Physical Activity While at Work: An Analysis Using Perceived and Objective Walkability and Greenness	81.7 March 2019 Pages: 20–26	Environmental Justice	Land Use Planning/ Design	Occupational Health/Safety	Public Health/ Safety	

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29	**Lauren T. Orkis, MPH, CIC, et al.** Cooling Tower Maintenance Practices and *Legionella* Prevalence, Allegheny County, Pennsylvania, 2016	81.5 Dec 2018 Pages: 16–24	Emerging Pathogens	Epidemiology	Public Health/ Safety	Water Pollution Control/Water Quality	
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32	**Aditya Stanam, MPH, PhD, et al.** Exposure to Computer Work and Prevalence of Musculoskeletal Symptoms Among University Employees: A Cross-Sectional Study	81.7 March 2019 Pages: 14–19	Epidemiology	Institutions and Schools	Occupational Health/Safety	Technology	
33	**Ramona Stone, MPH, PhD, et al.** Male–Female Differences in the Prevalence of Non-Hodgkin Lymphoma and Residential Proximity to Superfund Sites in Kentucky	81.3 Oct 2018 Pages: 16–24	Environmental Justice	Epidemiology	Hazardous Materials/Toxic Substances	Public Health/ Safety	Risk Assessment
34	**Rebecca Sunenshine, MD, et al.** Community-Wide Recreational Water-Associated Outbreak of Cryptosporidiosis and Control Strategies—Maricopa County, Arizona, 2016	81.4 Nov 2018 Pages: 14–21	Emerging Pathogens	Epidemiology	Pools/Spas	Recreational Environmental Health	
35	**Greg S. Whiteley, MSc, PhD, DAICD, et al.** Improving the Reliability of Adenosine Triphosphate (ATP) Testing in Surveillance of Food Premises: A Pilot Study	81.1 July/Aug 2018 Pages: E1–E8	Food	International	Technology		
36	**Ronald D. Williams, Jr., PhD, CHES, et al.** Continued Reduction of Particulate Matter in Bars Six Months After Adoption of a Smoke-Free Ordinance	81.1 July/Aug 2018 Pages: 8–15	Indoor Air	Management/ Policy	Public Health/ Safety		

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liefalbertson@gmail.com

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graciela.garcia@ventura.org

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bmetcalf@tchd.org

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jfletcher@moheganmail.com

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latoya.backus@gmail.com

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jessica.badour@agr.georgia.gov

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sjurries@phd2.idaho.gov

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jxiong@marionhealth.org

Iowa—Maria Sieck, Pottawattamie County Division of Public Health, Council Bluffs, IA.
maria.sieck@pottcounty-ia.gov

Jamaica—Rowan Stephens, St. Catherine, Jamaica.
info@japhi.org.jm

Kansas—Robert Torres, Pratt County Environmental Services, Pratt, KS.
rtorres@prattcounty.org

Kentucky—Gene Thomas, WEDCO District Health Dept., Cynthiana, KY.
williame.thomas@ky.gov

Massachusetts—Robin Williams, REHS/RS, Framingham Dept. of Public Health, Marlborough, MA.
robinliz2008@gmail.com

Michigan—Greg Braun, Jackson County Health Dept.
gbraun@meha.net

Minnesota—Caleb Johnson, Planner Principal, Minnesota Dept. of Health, St. Paul, MN.
caleb.johnson@state.mn.us

Missouri—Brandy Sheehan, Hillsboro, MO.
brandy.sheehan@jeffcohealth.org

Montana—Dustin Schreiner.

National Capital Area—Kristen Pybus, MPA, REHS/RS, CP-FS, Fairfax County Health Dept., VA.
NCAEHA.President@gmail.com

Nebraska—Sue Dempsey, MS, CPH, Administrator, Nebraska Dept. of Health and Human Services, Lincoln, NE.
sue.dempsey@nebraska.gov

Nevada—Anna Vickrey.
avickrey@agri.nv.gov

New Jersey—Lynette Medeiros, Hoboken Health Dept., Hoboken, NJ.
president@njeha.org

New Mexico—Bart Faris, City of Albuquerque Environmental Health Dept., Albuquerque, NM.
bfaris@cabq.gov

North Carolina—Nicole Thomas.
nthomas@moorecountync.gov

North Dakota—Grant Larson, Fargo Cass Public Health, Fargo, ND.
glarson@cityoffargo.com

Northern New England Environmental Health Association—Brian Lockard, Health Officer, Town of Salem Health Dept., Salem, NH.
blockard@ci.salem.nh.us

Ohio—Carrie Yeager, RS, Warren County Combined Health District, Lebanon, OH.
cyeager@wcchd.com

Oregon—Sarah Puls, Lane County Environmental Health, Eugene, OR.
sarah.puls@co.lane.or.us

Past President —Adam London, MPA, RS, Health Officer, Kent County Health Department, Grand Rapids, MI.
adamelondon@gmail.com

Rhode Island—Dottie LeBeau, CP-FS, Food Safety Consultant and Educator,

Dottie LeBeau Group, Hope, RI.
deejaylebeau@verizon.net

South Carolina—Melissa Tyler, Environmental Health Manager II, SCDHEC, Cope, SC.
tylermb@dhec.sc.gov

Tennessee—Kimberly Davidson, Chattanooga, TN.
kimberly.davidson@tn.gov

Texas—Leisha Kidd-Brooks.

Uniformed Services—MAJ Sean Beeman, MPH, REHS, CPH, Colorado Springs, CO.
sean.p.beeman.mil@mail.mil

Utah—Nancy Davis, Salt Lake County, NV.
ndavis@slco.org

Virginia—Sandy Stoneman, Food Safety Extension Agent, Virginia Cooperative Extension, Wytheville, VA.
sandra.stoneman@virginiaeha.org

Washington—Tom Kunesh, Bellingham, WA.
tkunesh@co.whatcom.wa.us

West Virginia—David Whittaker.
david.g.whittaker@wv.gov

Wisconsin—Mitchell Lohr, Dept. of Agriculture, Trade, and Consumer Protection, Sauk City, WI.
mitchell.lohr@wisconsin.gov

Wyoming—Stephanie Styvar, State of Wyoming Dept. of Agriculture, Riverton, WY.
stephanie.styvar@wyo.gov

Technical Advisors

Air Quality—David Gilkey, PhD, Montana Tech University.
dgilkey@mtech.edu

Aquatic Health/Recreational Health—Tracynda Davis, MPH, Davis Strategic Consulting, LLC.
tracynda@yahoo.com

Aquatic Health/Recreational Health—CDR Jasen Kunz, MPH, REHS, USPHS, CDC/NCEH.
izk0@cdc.gov

Cannabis—Cindy Rice, MSPH, RS, CP-FS, CEHT, Eastern Food Safety.
cindy@easternfoodsafety.com

Children's Environmental Health—Cynthia McOliver, MPH, PhD, U.S EPA.
mcoliver.cynthia@epa.gov

Climate Change—Richard Valentine, Salt Lake County Health Dept.
rvalentine@slco.org

Drinking Water—Craig Gilbertson, Minnesota Dept. of Health.
craig.gilbertson@state.mn.us

Emergency Preparedness and Response—Marcy Barnett, MA, MS, REHS, California Dept. of Public Health, Center for Environmental Health.
marcy.barnett@cdph.ca.gov

Emergency Preparedness and Response—Martin A. Kalis, CDC.
mkalis@cdc.gov

Emerging General Environmental Health—Tara Gurge, Needham Health Dept.
tgurge@needhamma.gov

Food (including Safety and Defense)—Eric Bradley, MPH, REHS, CP-FS, DAAS, Scott County Health Dept.
eric.bradley@scottcountyiowa.com

Food (including Safety and Defense)—John Marcello, CP-FS, REHS, FDA.
john.marcello@fda.hhs.gov

Food and Emergencies—Michele DiMaggio, REHS, Contra Costa Environmental Health.
mdimaggi69@gmail.com

General Environmental Health—Timothy Murphy, PhD, REHS/RS, DAAS, The University of Findlay.
murphy@findlay.edu

Global Environmental Health—Crispin Pierce, PhD, University of Wisconsin–Eau Claire.
piercech@uwec.edu

Global Environmental Health—Sylvanus Thompson, PhD, CPHI(C), Toronto Public Health.
sthomps@toronto.ca

Government Representative—Timothy Callahan, Georgia Dept. of Public Health.
tim.callahan@dph.ga.gov

Industry—Nicole Grisham, University of Colorado.
nicole.grisham@colorado.edu

Information and Technology—Darryl Booth, MPA, Accela.
dbooth@accela.com

Injury Prevention—Alan Dellapenna, RS, North Carolina Division of Public Health.
alan.dellapenna@dhhs.nc.gov

Institutions—Robert W. Powitz, MPH, PhD, RS, CP-FS, R.W. Powitz & Associates, PC.
powitz@sanitarian.com

Land Use Planning and Design/Built Environment—Kari Sasportas, MSW, MPH, REHS/RS, Town of Lexington.
ksasportas@lexingtonma.gov

Land Use Planning and Design/Built Environments—Robert Washam, MPH, RS.
b_washam@hotmail.com

Leadership—Robert Custard, REHS, CP-FS, Environmental Health Leadership Partners, LLC.
bobcustard@comcast.net

Onsite Wastewater—Sara Simmonds, MPA, REHS, Kent County Health Dept.
sara.simmonds@kentcountymi.gov

Premise Plumbing—Andrew Pappas, MPH, Indiana State Dept. of Health.
APappas@isdh.IN.gov

Radiation/Radon—Robert Uhrik, South Brunswick Township Health Dept.
ruhrik@sbtnj.net

Uniformed Services—Welford Roberts, MS, PhD, RS, REHS, DAAS, Edaptive Computing, Inc.
welford@erols.com

Vector Control/Zoonotic Diseases—Mark Beavers, MS, PhD, Rollins, Inc.
gbeavers@rollins.com

Vector Control/Zoonotic Diseases—Christine Vanover, MPH, REHS, CDC NCEH/ATSDR.
npi8@cdc.gov

Vector Control/Zoonotic Diseases—Tyler Zerwekh, MPH, DrPH, REHS, Shelby County Health Dept.
tyler.zerwekh@shelbycountytn.gov

Water Quality—Maureen Pepper, Idaho Dept. of Environmental Quality.
maureen.pepper@deq.idaho.gov

Women's Issues—Michéle Samarya-Timm, MA, HO, MCHES, REHS, DLAAS, Somerset County Dept. of Health.
samaryatimm@co.somerset.nj.us

NEHA Staff: (303) 756-9090

Seth Arends, Graphic Designer, NEHA Entrepreneurial Zone (EZ), ext. 318, sarends@neha.org

Jonna Ashley, Association Membership Manager, ext. 336, jashley@neha.org

Rance Baker, Director, NEHA EZ, ext. 306, rbaker@neha.org

Trisha Bramwell, Sales and Training Support, NEHA EZ, ext. 340, tbramwell@neha.org

Natalie Brown, Project Coordinator, Program and Partnership Development (PPD), nbrown@neha.org

Kaylan Celestin, Public Health Associate, ext. 320, kcelestin@neha.org

Renee Clark, Accounting Manager, ext. 343, rclark@neha.org

Lindsi Darnell, Executive Assistant, ext. 347, ldarnell@neha.org

Natasha DeJarnett, Research Coordinator, PPD, ndejarnett@neha.org

Kristie Denbrock, Chief Learning Officer, ext. 313, kdenbrock@neha.org

Roseann DeVito, Project Manager, ext. 333, rdevito@neha.org

Joyce Dieterly, Evaluation Coordinator, PPD, ext. 335, jdieterly@neha.org

David Dyjack, Executive Director, ext. 301, ddyjack@neha.org

Santiago Ezcurra, Media Production Specialist, NEHA EZ, ext. 342, sezcurra@neha.org

Soni Fink, Sales Manager, ext. 314, sfink@neha.org

Brian Hess, Program and Operations Manager, PPD, ext. 345, bhess@neha.org

Sarah Hoover, Credentialing Manager, ext. 328, shoover@neha.org

Arwa Hurley, Website and Digital Media Manager, ext. 327, ahurley@neha.org

Ayana Jones, Project Coordinator, PPD, ajones@neha.org

Kim Koenig, Instructional Designer, EZ, ext. 315, kkoenig@neha.org

Elizabeth Landeen, Associate Director, PPD, elandeen@neha.org

Angelica Ledezma, AEC Manager, ext. 302, aledezma@neha.org

Matt Lieber, Database Administrator, ext. 325, mlieber@ne ha.org

Bobby Medina, Credentialing Dept. Customer Service Coordinator, ext. 310, bmedina@neha.org

Marissa Mills, Human Resources Manager, ext. 304, mmills@neha.org

Alexus Nally, Member Services Representative, ext. 300, atnally@neha.org

Eileen Neison, Credentialing Specialist, ext. 339, eneison@neha.org

Carol Newlin, Credentialing Specialist, ext. 337, cnewlin@neha.org

Christine Ortiz Gumina, Project Coordinator, PPD, cortizgumina@neha.org

Barry Porter, Financial Coordinator, ext. 308, bporter@neha.org

Kristen Ruby-Cisneros, Managing Editor, *Journal of Environmental Health*, ext. 341, kruby@neha.org

Allison Schneider, CDC Public Health Associate, PPD, ext. 307, aschneider@neha.org

Robert Stefanski, Marketing and Communications Manager, ext. 344, rstefanski@neha.org

Reem Tariq, Project Coordinator, PPD, ext. 319, rtariq@neha.org

Christl Tate, Training Logistics Manager, NEHA EZ, ext. 305, ctate@neha.org

Sharon Unkart, Associate Director, NEHA EZ, ext. 317, sdunkart@neha.org

Gail Vail, Director, Finance, ext. 309, gvail@neha.org

Sandra Whitehead, Director, PPD, swhitehead@neha.org

Nicholas "Cole" Wilson, Administrative Support Specialist, EZ, ext. 311, nwilson@neha.org

Joanne Zurcher, Director, Government Affairs, jzurcher@neha.org

A Tribute

to Our Peer Reviewers, 2018–2019

The *Journal of Environmental Health* thanks and honors the individuals listed below whose contributions as peer reviewers are paramount to the *Journal's* efforts to advance, educate, and promote the science and profession of environmental health. We sincerely appreciate their hard work, devotion to the environmental health profession, and willingness to share their wealth of knowledge and expertise.

Becky Nancy Achieng Aloo, MSc
Eldoret, Kenya

Anna Aragon, PhD, CHES, CSP, REHS/RS
Colorado Springs, CO

Sushrut Arora, MVSc, PhD
Houston, TX

Gholamreza Asadollahfardi, MS, PhD
Tehran, Iran

Erik Balster, MPH, REHS, RS
Mason, OH

David Banaszynski, REHS, CP-FS
Hoffman Estates, IL

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Tallahassee, FL

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Lebanon, OH

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Oviedo, FL

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Ironton, OH

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Davenport, IL

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Alexandria, VA

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College Station, TX

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Lubbock, TX

Jiangang Chen, PhD
Knoxville, TN

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Las Vegas, NV

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Cincinnati, OH

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CDR Miguel Cruz, MPH
Atlanta, GA

Paulomi Das, MSc, PhD
Kalyani, India

Tracynda Davis, MPH
Middleton, WI

Royal DeLegge, PhD, LEHS, RS
Murray, UT

James D. Dingman, MS, REHS, DLAAS
Plano, TX

Maria Alzira Primenta Dinis, PhD
Porto, Portugal

Zachary Ehrlich, MS, REHS
West Orange, NJ

Robert Emery, DrPH, CHP, CIH, CSP, RBP, CHMM, CPP, ARM
Houston, TX

Richard T. Enander, PhD
Providence, RI

Major Jason Finley, MS, DAAS, REHS, RS, CHMM
Louisville, KY

Thomas R. Gonzales, MPH, REHS
Colorado Springs, CO

Patrick Goodman, PhD
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Harry E. Grenawitzke, Jr., MPH, RS, DAAS
Monroe, MI

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Gainesville, FL

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Daikwon Han, PhD
College Station, TX

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Maywood, IL

F. Charles Hart, PhD, CIH, CSP, RS
Athens, OH

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St. Petersburg, FL

Timothy N. Hatch, MPH, REHS
Montgomery, AL

Michelle Homan, PhD
Erie, PA

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Lytle, TX

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Athens, OH

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Cumberland, MD

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Little Rock, AR

Adam Kramer, MPH, ScD, RS, CFS
Atlanta, GA

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Columbus, OH

Sharron LaFollette, PhD
Springfield, IL

John Lange, REHS/RS
Pittsburgh, PA

Madeleine LaRue
Chapel Hill, NC

Grace Lasker, PhD, CN
Kirkland, WA

Scott T. LeRoy, MPH, MS, REHS/RS
Denton, MD

Courtney D. Lewis, MS
Midland, TX

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Ann Arbor, MI

Zhanbei Liang, PhD
Ada, OK

Chuck Lichon, MPH, RS
Linwood, MI

Xuyang Liu, PhD
St. Louis, MO

Ting Lu, PhD
Cincinnati, OH

Yuan Lu, PhD
Houston, TX

Ming Luo, PhD
Rensselaer, NY

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Madison, WI

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Fairfax, VA

Ephraim Massawe, PhD
Hammond, LA

Ruth McDermott-Levy, MPH, PhD, RN
Villanova, PA

Edward Mc Keown, MS, PhD
Gulfport, MS

Stuart Mitchell, MPH, PhD, BCE
West Des Moines, IA

G. Poyya Moli, PhD
Pudacherry, India

Michele M. Monti, MS, MPH
Atlanta, GA

Vinayak K. Nahar, MS, MD
Oxford, MS

John Naut, CP-FS
Lehi, UT

Asia Neelam, MSc
Karachi, Pakistan

Priscilla Oliver, PhD
Atlanta, GA

CDR Stephen M. Perrine, MS, REHS/RS, CP-FS
Washington, DC

Eric Pessell, REHS
Delton, MI

David S. Peterson, MBA, MPA, RS, DAAS
Edmonds, WA

Robert W. Powitz, MPH, PhD, RS, DLAAS
Old Saybrook, CT

Reginald Quansah, PhD
Oulu, Finland

Amy Roberts, RN
Kansas City, MO

CDR Luis O. Rodriguez, MS, REHS/RS, CP-FS
Plantation, FL

Paul Rosile, MPH, PhD, RS
Richmond, KY

Jeff Rubin, PhD, CEM, NREMT-B
Tigard, OR

Ken Runkle, DPA, LEHP, REHS
Springfield, IL

Ben Ryan, MPH
Queensland, Australia

Ratul Saha, MSc, MS, PhD
New Brunswick, NJ

Michéle Samarya-Timm, MA, HO, MCHES, REHS, DAAS
Franklin Park, NJ

Fatih Sekercioglu, MSc, MBA, CIPHI(C)
London, Canada

CAPT Sarath Seneviratne, MS, CIH, CSP, CBSP, CHMM, RBT, CET, REHS, DAAS
Bethesda, MD

Behzad Shahmoradi, PhD
Sanandaj, Iran

Derek G. Shendell, MPH, DEnv
Piscataway, NJ

Samendra Sherchan, PhD
New Orleans, LA

Kevin Sherman, PhD, PE, DWRE
Crampbellsburg, KY

Jo Anna M. Shimek, MS, PhD, CIH, CSP
Bloomington, IN

Ivy Shiue, MSc, PhD
Newcastle upon Tyne, England

Zia Siddiqi, PhD, BCE
Snellville, GA

Satheesh Sivasubramani, PhD
Galveston, TX

David A. Sterling, PhD, CIH
Fort Worth, TX

John A. Steward, MPH, REHS
Atlanta, GA

Roman Tandlich, PhD
Grahamstown, South Africa

M.L. Tanner, HHS
Swansea, SC

Sylvanus Thompson, PhD, CPHI(C)
Toronto, Canada

Rong Wang, PhD
New Haven, CT

Yi Wang, PhD
Indianapolis, IN

Chris J. Wiant, MPH, PhD
Denver, CO

Felix I. Zemel, MCP, MPH, CEHT, HHS, REHS/RS, CPO
Needham, MA

Tyler Zerwekh, MPH, DrPH, REHS
Austin, TX

Tao Zhan, PhD
Elk Grove, CA

Kai Zhang, MS, PhD
Buffalo, NY

Yougui Zheng, PhD
Houston, TX

Zheng Zhou, MS, PhD
Minneapolis, MN

NEHA NEWS

NEHA's Third Annual Hill Day

By Joanne Zurcher (jzurcher@neha.org)

On May 1, 2019, the National Environmental Health Association's (NEHA) board of directors traveled to Washington, DC, to visit Capitol Hill to advocate for NEHA members everywhere. They spent the day talking to senators, representatives, and their staff in over 50 offices from both political parties to ensure that the environmental health profession is at the table when it comes to major policy decisions. "This year's Hill Day was at once rewarding and impactful in that we had very specific pieces of preparedness and workforce legislation to advocate for during our conversations with elected officials," said NEHA Executive Director Dr. David Dyjack. "These efforts will bring over time recognition and resources to our members and the profession at large."

The major focus of the event was to share with staff from the highest level of influencers why we work as environmental health professionals and the importance of a credentialed profession to protect the public's health and safety. NEHA board members discussed the importance of having national guidelines so that every state has a credentialed environmental health workforce. "Organized visits to Capitol Hill are great leadership training experiences for all involved. Leaders need this continual training on the pressing issues to keep NEHA viable," stated NEHA President Dr. Priscilla Oliver.

NEHA board members and staff also asked members of Congress for their support of the Environmental Health Workforce Act of 2019 (HR 2262 and S 1137), which was introduce by Representative Brenda Lawrence (D-Michigan) in the U.S. House of Representatives and Senator Debbie Stabenow (D-Michigan) in the U.S. Senate. These two pieces of legislation will ensure that the 22 states that currently do not require a credentials for those that do environmental health work will have to start credentialing their environmental health workforce. Many staffers on both sides of the political aisle expressed deep interest in learning more about the legislation and promised to discuss it with their elected officials. "Hill Day provided a meaningful in person conversation with our national legislators while we serve as environmental public health ambassadors," reflected NEHA Region 8 Vice-President James Speckhart.

Another topic of discussion was the importance of funding the Centers for Disease Control and Prevention's National Center for Environmental Health/Agency for Toxic Substances and Disease Registry (NCEH/ATSDR). NCEH/ATSDR is a critical partner with NEHA in developing national environmental health programs. NEHA board members and staff relayed stories regarding the importance of NCEH/ATSDR's work and how that work helps in every aspect of public health and improves environmental health throughout the country. NEHA's Government Affairs program is committed to educating influencers in Washington, DC, on the importance of funding NCEH/ATSDR at the highest levels for fiscal year 2019 and beyond. As stated by NEHA President-Elect Sandra Long, "Hill Day is a wonderful opportunity to meet with our legislators and provide education on environmental health issues."

Finally, this year is critical for the Pandemic and All-Hazards Preparedness Act. The original law was created to improve the nation's public health and medical preparedness and response capabilities for emergencies, whether deliberate, accidental, or

NEHA's board of directors convene at the U.S. Capitol Building before a very successful Third Annual Hill Day meeting with senators, representatives, and their staff from over 50 offices. From left to right: Jacqueline Reszetar, Adam London, Kim Carlton, David Dyjack, Lynne Madison, Roy Kroeger, Priscilla Oliver, Tim Hatch, Sandra Long, Matthew Reighter, Vince Radke, Tom Vyles, Larry Ramdin, and James Speckhart. Photo courtesy of David Dyjack.

Before heading out for a day full of meetings, NEHA's board of directors prepared and strategized. Photo courtesy of Kristie Denbrock.

NEHA board members and staff meet with Representative Nita Lowey's (D-New York) staff to discuss environmental health funding. Photo courtesy of David Dyjack.

natural. Unfortunately, the law has already sunset. The U.S. House of Representatives has already passed the reauthorization of the law; however, the U.S. Senate has not and needs to pass it in an expedient manner. A bipartisan group of senators are working diligently to pass the reauthorization, which includes language regarding environmental health. Board members demonstrated NEHA's support of this bill by explaining to congressional staff that environmental health professionals are second responders in a crisis, describing their own experiences during different crisis situations. NEHA's Government Affairs program has requested the U.S. Senate pass the reauthorization as soon as possible. (*Editor's note:* As of press, the bill has passed both houses of Congress and has headed to the president for approval.)

For me, it was great to see the comradery among veteran and new board members with the shared goal of telling senators, representatives, and their staff why they are passionate about environmental health. NEHA Region 2 Vice-President Jacqueline Reszetar, who is serving her first term on NEHA's board, commented, "Hill Day was a priceless opportunity. The lobbying experience should be an educational requirement for all levels of environmental health professionals."

NEHA board members and staff thank Representative Brenda Lawrence (D-Michigan) [center] for her leadership and support of the Environmental Health Workforce Act of 2019. Photo courtesy of David Dyjack.

As we put this important day to bed for another year, I am grateful for the support of our board and staff who took time to participate in the Third Annual Hill Day. NEHA's Government Affairs program looks forward to next year's event and in the meantime, will continue to provide a voice for the environmental health profession in Washington, DC.

Did You Know?

Early bird registration for the *Legionella* Conference 2019, hosted by NSF International and NEHA, ends **July 19.** The conference will be held September 11–13 in Los Angeles, California. The conference will focus on emerging issues related to building water systems and will bring professionals together to work toward solutions. To register or learn more, visit www.legionellaconference.org.

NEHA NEWS

NEHA Receives ecoAmerica Climate Leadership Award

The National Environmental Health Association (NEHA) was honored to be one of nine recipients of the Climate Leadership Award (https://ecoamerica.org/nine-organizations-receive-climate-leadership-awards-at-acls19/) presented by ecoAmerica at the American Climate Leadership Summit 2019 in Washington, DC, May 1–2. The other honorees included the African Methodist Episcopal Zion Church–Western Episcopal District, Alliance of Nurses for Healthy Environments, American Public Health Association, Christian Church (Disciples of Christ), Climate Resolve, Physicians for Social Responsibility, United Church of Christ, and a multi-stakeholder effort with Salt Lake City, Park City, Summit County, Utah Climate Action Network, and Utah Clean Energy.

The award recognizes NEHA's commitment to work towards 100% clean energy by 2030, which was formalized in a declaration issued by NEHA in November 2018. The declaration is included below and can be viewed online at https://neha.org/sites/default/files/publications/position-papers/NEHA-Clean-Energy-By-2030-Declaration_0.pdf.

NEHA is grateful to ecoAmerica for the award and recognition.

NEHA Declaration on 100% Clean Energy by 2030

The National Environmental Health Association (NEHA) recognizes climate change as a worldwide environmental health challenge that detrimentally affects the health and safety of individuals and communities. Climate change alters our environmental health—the quality of air, food, and water in the communities where we live, work, and play. Environmental health professionals improve and protect the public's health and create and sustain healthy communities. Our responsibility is to build the capacity of environmental health professionals to address the health effects of climate change. We define climate change as any significant change in climate trends and measures lasting for an extended period of time, such as changes in temperature, precipitation, or wind patterns. Climate change poses an increased risk in changing sea levels, water temperatures, and water chemistry; coastal flooding and erosion; the expansion of the range of disease vectors; the geographic spread of tropical diseases to new areas; and prolonged droughts with associated effects on crops, water resources, and wildfires.

We are compelled to act because carbon pollution is warming our planet and profoundly affecting the U.S. and the world. According to the National Oceanic and Atmospheric Administration, the surface temperature of the earth has risen at a rate of approximately 0.17 °C per decade since 1970. Increasing temperatures pose the greatest threat to the environment and human health due to impaired air quality and heat-related illnesses in vulnerable populations. The human, environmental, and economic costs of increasing droughts, floods, wildfires, extreme weather, and rising sea levels can be measured in lost lives, higher food prices, poorer health, and billions of dollars in disaster relief. Human activity contributes to these threats and humans can solve this challenge. We have an obligation to act today on climate change and build a sustainable future for our children. We can choose clean energy and use it efficiently. U.S. leadership can help the world meet these challenges with innovative solutions. We must start with mitigating our own climate impact.

Therefore, NEHA is committed to work towards 100% clean energy use by 2030. We will employ administrative, educational, engineering, and fiscal measures to meet this goal. These measures will:

Demonstrate Leadership: Environmental health professionals are influencers in their local communities and professional networks. They have a solemn responsibility to engage with federal, state, and local influencers to report on the needs of the communities they serve and to be the voice of their communities on all environmental health concerns.

Create a Positive Energy Future: Climate change solutions need to promote abundant clean energy, avoid costly carbon pollution, and provide choices in affordable energy. Solutions will help Americans save money by making homes, buildings, and transportation more energy efficient (e.g., to incorporate green space and other technologies into the built environment to help reduce urban heat island effects).

Improve People's Health: Solutions need to clean the air, improve land and water quality, and provide healthy food choices. They need to combat the devastating health effects of climate change and reduce mortality, injury, and illness associated with increased pulmonary diseases, extreme weather events, and increased vector populations.

Build Shared and Sustainable Prosperity: Climate solutions need to create American jobs and a sustainable economy that supports better lives and livelihoods today and for generations to come. They need to also ensure a just transition for communities negatively affected by America's shift to cleaner fuels.

Prepare for Harmful Effects: As we begin to reverse the climate crisis, restore the natural environment, and build a better future, we must protect families, communities, and livelihoods from the harmful effects we are already experiencing from climate change.

Involve All Americans: All of us must have a say in decisions that affect our lives. Special efforts should be made to include youth and vulnerable communities in crafting solutions and setting policy.

continued from page 54

FIGURE **1**

Years of Experience of National Environmental Health Association (NEHA) Credential Holders

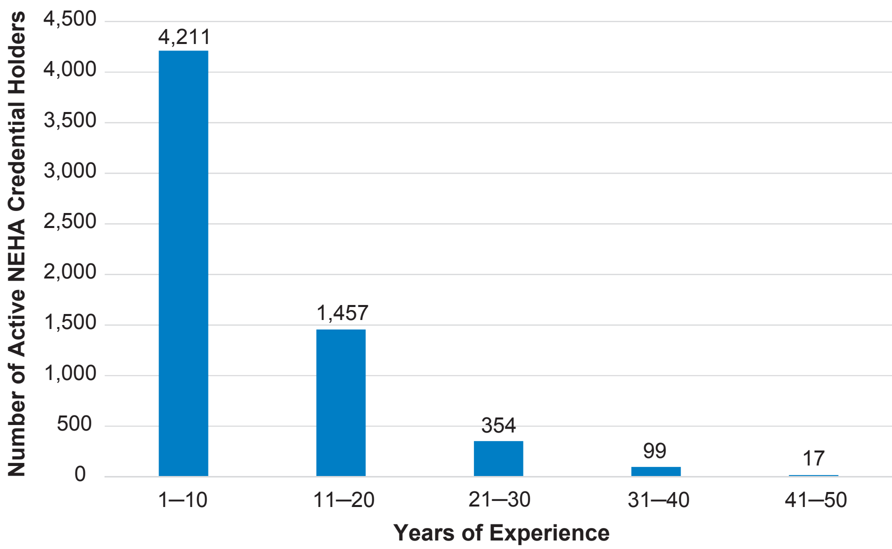

TABLE **1**

Countries/Territories With Active National Environmental Health Association Credential Holders

Country/Territory
Bermuda
Canada
Guam
Jamaica
Saudi Arabia
United Kingdom
United States

sional sites and social media avenues, which allows us to promote our professional brand to large audiences in a matter of minutes. I envision NEHA credential holders instantly accessing their credential via digital badges and receiving real time data on the status of their credential and continuing education, and then sharing that information with employers, peers, and potential customers in a timely and easy fashion. New applicants would be able to submit and monitor their application status through their MyNEHA account at any time.

Technology will certainly come into play as we expand into markets outside the U.S. In our Credentialing Department, we are seeing an uptick in international applicants from all over the world. Fortunately, our computer-based testing partner operates globally in the Americas, Asia-Pacific, Europe, the Middle East and Africa (https://home.pearsonvue.com/About-Pearson-VUE/Company-information/Locations.aspx). There is more to be done than merely offering locations for exams. While it is a privilege to receive international interest and recognition, the responsibility and opportunity is upon us to deliver valuable and relevant credentialing support that answers the charge of this year's Annual Educational Conference & Exhibition: "Local Voices. Universal Language." As we enhance our prestigious credentials with the ease and convenience of digital technology, we will consider the gaps that exist in the international arena, namely language and education differences, in order to welcome, engage, and support those interested in environmental health no matter where their local community resides on the map.

By embracing technological advances that add value, transparency, and portability to its current pool of credential holders and credential applicants, NEHA's Credentialing Department will be poised to manage and support the swell of credentialing needs that will come about from the bills currently in the U.S. House of Representatives and U.S. Senate, advocating for national legislation of a credentialed environmental health workforce (National Environmental Health Association, 2019). To varying degrees, NEHA works with states that currently have credential programs in place and we look forward to growing, engaging, and supporting this national expansion to any extent possible.

Capitalizing on these opportunities takes infrastructure and a positive, willing attitude. At NEHA, we possess the attitude and are working on infrastructure that welcomes technology and increases our capacity to provide support and value to credential holders. We are also looking into what you, as credential holders, want to see from us as a return on your investment—your investment in yourself, your profession, and the populations you keep safe—by means of surveys and focus groups. I welcome your thoughts and ideas on what NEHA can do to support, engage, and grow outstanding environmental health professionals. Please send any questions and comments to shoover@neha.org.

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David Dyjack, DrPH, CIH

The Hallmark of Competence

On May 1, 2019, the National Environmental Health Association's (NEHA) board of directors spent a full 10 hours educating elected officials in Washington, DC, in an effort to support credentialing, in general, and the Environmental Health Workforce Act, in particular. In the U.S. House of Representative, the Environmental Health Workforce Act (HR 2262) was introduced by Representative Brenda Lawrence (D-Michigan). The U.S. Senate's companion bill (S 1137) was introduced by Senator Debbie Stabenow (D-Michigan). These pieces of legislation reinforce the critical role credentialed professionals play in protecting and promoting the health, safety, and security of Americans, their families, and their communities.

In that spirit, I've asked Sarah Hoover, NEHA's credentialing manager, to share her insight into the state our credentialing operation. Sarah and her credentialing department team—Eileen Neison, Carol Newlin, and Bobby Medina—are a valuable customer-oriented resource who collectively manage and maintain the globally recognized NEHA credentialing enterprise.

Dave

ddyjack@neha.org
Twitter: @DTDyjack

Credentialing Outlook

Sarah Hoover, MPH, PMP

> ***Earning a credential is investing in yourself.***

I earned my first credential in 2012. It was based in clinical research and required hours of studying select parts of the Food and Drug Administration's *Code of Federal Regulations*. I sat for my exam on a muggy, midwestern Saturday morning and waited in agony for the results. I passed—and I was hooked. Since then, I have earned an advanced academic degree and two professional credentials. My mantra was and is, "Earning a credential is investing in yourself."

Apparently, others share this sentiment. In 2015, the U.S. Bureau of Labor Statistics added new questions to their Current Population Survey to begin to understand who holds professional licenses/credentials and how those individuals perform in the labor force (U.S. Bureau of Labor Statistics, 2016). With these newly added questions, 25.5% of the employed civilian survey population (N = 37,930) indicated that they held a professional license or certification. When controlling for level of highest education attained, these respondents earned 11% more per week than their noncredentialed counterparts (U.S. Bureau of Labor Statistics, 2018).

Individuals certainly see a benefit in becoming credentialed in their field of expertise and the professions they belong to benefit as well. It can be the case, such as with environmental health, that the health and safety of the human population benefits as credentialing ensures that population health and safety are in the hands of competent professionals who have demonstrated the knowledge and expertise to perform at a high standard. So, I ask myself, in this win-win-win environment, what is NEHA's role in supporting, engaging, and growing credentialed environmental health professionals?

NEHA is a unique organization that offers membership, instruction, education, publications, certificates, and credentials to individuals interested in and passionate about our planet and the vitality of the people living in it. There are currently six different credentials available from NEHA that are as broad as touching all aspects of environmental health and safety and as niched as focusing on investigative foodborne outbreaks and third-party food facility auditing. Across these six different credentials, there are roughly 6,000 individuals actively holding a NEHA credential at any given time. Altogether, this population of credential holders possess up to 50 years of credentialed experience and span 7 countries (Figure 1, Table 1). With a rich resource of perspectives from professionals with a variety of environmental health roles, years of experience, and localities, NEHA will continue to learn from its credential holders how to support, engage, and grow the large community of those entrusted with the safety and health of the population.

Three obvious opportunities that jump out at me include technologically savvy credentialing, the international expansion of NEHA credentials, and priming the stage to support the Environmental Health Workforce Act of 2019. Our world is digital—most of our communication delivery is performed through the keyboards of our smartphones and tablets. These devices allow instant interfacing with profes-

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