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airbnb venues

Assessing Potential Public Health Concerns

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ABOUT THE COVER

Airbnb is the world's leading platform for peer-to-peer (P2P) short-term housing rentals. Airbnbs are typically used as an alternative to a stay in a hotel or other traditional hospitality offerings. This month's cover article, "Assessing Potential Public Health Concerns in Airbnb Venues in Four Canadian Cities," examined the prevalence of important amenities relevant to public health such as smoke alarms, carbon monoxide detectors, fire extinguishers, and first aid kits, as well as if smoking is allowed and if breakfast is served. The article found that many Airbnb venues in Canada have conditions that could pose a health risk to guests. These results highlight the need for government agencies to take into account public health concerns when regulating the P2P housing marketplace.

See page 8.

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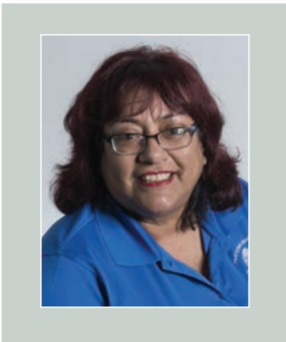

Sandra Long, REHS, RS

COVID-19: Science Versus Politics

The struggle between science and politics is not new. The two have historically faced off numerous times for various reasons. As environmental health professionals, we look to science to guide our professional decisions. At times, those of us who use science as a basis for our work can feel under attack by politicians who deny the science (e.g., climate change is not real) and refuse the advice or information provided by educated and reputable scientists. The goal of science is to search for more information to better understand the world around us and how we interact with it.

We have recently seen that researchers, environmental scientists, and public health professionals have provided guidance and information on methods concerning COVID-19 prevention and reduction of its spread. The application of the advice fell to the political system and the actions and reactions of the general public.

Countries worldwide have handled the pandemic differently based on two things: science and politics. Each country has worked with the science, research, and technology they possess, as well as the political situation of the country. As a result, the magnitude, duration, and impact of the virus has been unique to each country. There has not been a one-size-fits-all solution because we are not a one-size-fits-all world. Resources and politics are different, as is the application of the science and recommendations.

As we look at the events as they have unfolded this year, several questions come to mind. While scientists and political leaders were working together to flatten the curve, was there a perception of success before it was actually achieved? Did politicians move too quickly to restart the economy? Should masks have been required from the beginning? These questions cannot be answered with science or politics alone—they must be considered with both science and politics. Government interactions were utilized (politics) in the implementation of policy, as well as application of protocols. While we each have our own answers and opinions on these questions, let us be sure to remember that our own individual viewpoints are influenced by both politics and science.

> *The environmental health profession needs to be a voice in the decision-making process.*

We have seen that education is a powerful tool. The challenge here is how do we educate, promote, or share scientific information in a way that influential politicians will gravitate toward, accept, and utilize. The answer is actually simpler than you would image. We, as environmental health professionals, need to get engaged. We need to communicate with our policy makers on all levels, from local to national. In this manner we can effect change in policy. Providing education and sound information to our local leaders is a beginning. Each of us is a voice for our profession. We can make a difference by contacting our mayors, local boards of health, and county and state leaders.

The environmental health profession needs to be a voice in the decision-making process to open restaurants and to keep processing facilities, schools, and retail operations safe, to name a few. We can provide education on how illness is spread and the measures to implement to keep people safe. Environmental health needs to be a part of the process in writing the protocols we are currently working under, as well as future policy change.

Question the science and guidance behind written protocols. I can tell you from experience that your voice will be heard. When Texas decided to reopen bars, the original protocol prohibited seating at the bar for consumption of beverages and food. That sounded reasonable. One question posed to the governor's office in regard to this protocol was why consumption was not prohibited at a bar located inside a restaurant. It was a simple question, loaded with science behind it, and it made policy makers reevaluate the decision. The protocol was changed for both restaurants and bars that same week. Different, reasonable, and safer protective measures were put into place that applied science and education.

Coming back to science versus politics, can the two work well together? It is possible for the outcome of this union to be beneficial to all. Environmental health professionals, however, need to be part of that equation to provide input from our experiences and education.

On a historical note regarding science and politics: President John F. Kennedy set a goal in 1961 of landing a man on the moon and returning him before the end of the decade. The goal was achieved on July 20, 1969, when Neil Armstrong and Edwin "Buzz" Aldrin landed on the moon and returned to the Earth on July 24.

Sandra Long

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INTERNATIONAL PERSPECTIVES

Assessing Potential Public Health Concerns in Airbnb Venues in Four Canadian Cities

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Abstract **Airbnb is the world's leading platform for peer-to-peer (P2P) short-term housing rentals. There are more than 100,000 Airbnb venues across Canada. Legislative efforts to regulate the P2P housing marketplace have not broadly considered public health impacts including injury prevention, tobacco smoke exposure, and food safety. Using publicly available data, our study quantified the proportion of Airbnb venues in Vancouver, Toronto, Montreal, and Quebec City that report 1) having injury prevention amenities (smoke alarms, carbon monoxide detectors, fire extinguishers, and first aid kits); 2) allowing smoking; and 3) providing breakfast. Data were collected in May 2018 for 31,535 Airbnb venues in Vancouver (*n* = 6,385), Toronto (*n* = 15,722), Montreal (*n* = 6,702), and Quebec City (*n* = 2,726). Most venues reported having a smoke alarm (89%), approximately one half reported having a carbon monoxide detector (56%), and less than one half reported having a fire extinguisher (47%) or first aid kit (35%). A small proportion reported providing breakfast (13%) and fewer reported allowing smoking (4%). We found safety deficiencies in thousands of Airbnb venues in these four cities. Would-be guests might be exposed to secondhand or thirdhand smoke in some Airbnb rentals. This study identified thousands of venues that are serving food, which potentially presents challenges related to food safety. Government agencies should take into account public health concerns when regulating the P2P housing marketplace.**

Introduction

The peer-to-peer (P2P) marketplace allows people to sell goods and services to others through connections facilitated by Web or smartphone application platforms. Airbnb has emerged as the global leader for P2P short-term property rentals (Jefferson-Jones, 2016). Short-term accommodations brokered through Airbnb typically are used as an alternative to a stay in a hotel or other traditional hospitality offerings. In Canada, it is estimated that there are more than 100,000 Airbnb listings generating $500 million in revenue for approximately 70,000 hosts (Grynol, 2017). Guests can choose from a variety of housing types listed on Airbnb including 1) a shared room, where guests could stay in a space with other people (akin to a hostel); 2) a private room, where guests would stay with a host or hosts in the same building or unit; or 3) an entire property, where guests would not share any spaces with the hosts.

Researchers have highlighted the impact Airbnb has had on housing costs and availability in several Canadian cities (Wachsmuth, Kerrigan, Chaney, & Shillolo, 2017). Some regions in Canada have created regulations with an effort to collect lost tax revenue that would have been collected had guests stayed in hotels ("Quebec reaches 'landmark' deal," 2017). Quebec law requires Airbnb hosts to obtain a permit from Quebec Tourism and hosts are expected to abide by housing regulations such as zoning rules (Government of Quebec, 2020a). Other policy approaches at municipal levels, such as in Montreal ("City moves to restrict Airbnb," 2018) and Toronto (City of Toronto, 2020), have been developed to combat the high concentrations of P2P listings in neighborhoods that impact housing access and affordability. Housing is widely acknowledged as a key social determinant of health.

The P2P short-term housing sector has raised other public health concerns, including guest exposure to tobacco smoke. One study examined whether smoking was allowed in Airbnb venues and found that it differed greatly across Canada, noting a relatively high proportion of smoking allowed in properties in Montreal (Kennedy, Douglas, Stehouwer, & Dawson, 2018). Other public health concerns in Airbnb venues include a lack of fire safety amenities such as smoke alarms, carbon monoxide detectors, and fire extinguishers, as well as amenities such as the availability of first aid kits to address injury. One study of 16 U.S. cities that included more than 120,000 venues found that one fifth of Airbnbs did not have smoke alarms (20%), only approximately one half had carbon monoxide detectors (58%), and less than one half reported the presence of a first aid kit (36%) or a fire extinguisher (42%) (Kennedy, Jones, & Gielen, 2019).

Additionally, there are potential public health concerns from meals prepared by Airbnb hosts for their paying guests. As the name suggests, many Airbnb venues offer breakfast. The Airbnb Help Center reminds hosts that different countries, states, and cities have different licensing requirements and rules related to providing food for guests (Airbnb Help Center, 2020a). Hotels, bed and breakfasts, and other traditional hospitality settings in Canada require food safety handling training for businesses preparing foods, and health inspectors can visit their premises to ensure food preparation environments meet standards (Wood, 2019).

Our study assessed potential public health concerns in Airbnbs in four Canadian cities, examining specifically the prevalence of important amenities relevant to public health such as smoke alarms, carbon monoxide detectors, fire extinguishers, and first aid kits. Further, this study reports the percentage of venues that describe in their house rules if smoking is allowed. Finally, our study determined the percentage of venues that reported offering breakfast for their guests. Taken together, these findings can inform how regulations could support public health.

Methods

Sample

All data were used with permission from Inside Airbnb (n.d.), an independent website that compiles publicly available information from Airbnb listings reported by hosts. The data for this study were collected by Inside Airbnb during May 2018. Within this sample, venues that described themselves as bed and breakfasts were removed from the list because these properties were likely to be licensed already and subject to a range of public health regulations.

Variables of Interest

The following variables were used: city (Vancouver, Toronto, Montreal, or Quebec); room type (shared room, private room, or entire home/apartment); breakfast served; and presence of the following venue amenities: smoke alarm, carbon monoxide detector, fire extinguisher, first aid kit, and if smoking is listed as allowed in the house rules.

Analysis

Proportions of the variables of interest were reported by room type and city. We analyzed the data using SPSS version 24. This study did not involve human subjects and therefore did not require review by an institutional review board.

Results

The sample included 31,535 venues with the following distribution across the four cities: Vancouver, n = 6,385; Toronto, n = 15,722; Montreal, n = 6,702; and Quebec, n = 2,726. Most Airbnb venues in the sample (65%, n = 20,643) were classified as entire homes or entire apartments, with approximately one third (33%, n = 10,371) classified as private rooms and only a few (<2%, n = 521) classified as shared rooms.

Table 1 shows the percentage for each amenity relevant to public health reported across the entire sample, as well as by city and room type. Our findings are discussed below, grouped by the public health areas of injury prevention, tobacco smoke, and food safety.

Injury Prevention

We reviewed three amenities that are relevant to fire safety: reported presence of smoke alarms, carbon monoxide detectors, and fire extinguishers. The reported presence of smoke alarms across the entire sample was 88.9% (n = 28,019). The city with the highest reported prevalence of smoke detectors was Quebec (92.6%, n = 2,523) and the lowest was Montreal (83.1%, n = 5,571). The reported presence of carbon monoxide detectors across the entire sample was 56.2% (n = 17,723). Carbon monoxide detectors were reported to be present in 74.2% of venues in Toronto (n = 11,659) and in approximately 29% of venues in the other three cities. Reported presence of fire extinguishers across the entire sample was 46.6% (n = 14,701), ranging from 54.4% (n = 1,483) in Quebec City to 40.1% (n = 2,690) in Montreal. A single variable related broadly to injury prevention was the reported presence of first aid kits. Across the entire sample, first aid kits were reported to be present in 35.4% of Airbnbs (n = 11,166), ranging from 41.3% (n = 1,125) in Quebec City to 29.2% (n = 1,959) in Montreal.

Tobacco Smoke

Across the entire sample, 4.1% (n = 1,287) of hosts reported allowing smoking. Montreal had the highest percentage of venues that allowed smoking (7.1%, n = 475) and Vancouver had the lowest (2.7%, n = 170). In each city, a greater percentage of venues that allowed smoking were classified as private rooms or shared rooms. In Montreal, over 13% of private or shared rooms allowed smoking, which was the highest percentage across the sample.

Food Safety

Across the entire sample, 9.2% (n = 2,899) indicated that breakfast was served or included at the Airbnb venue. The inclusion of breakfast was higher for venues where hosts were more likely to be physically present (private rooms and shared rooms): 13.3% (n = 1,376) for private rooms and 16.5% (n = 86) for shared rooms. Toronto had the highest percentage of venues providing breakfast with 11.2% of the sample (n = 1,759), including 14.1% of private rooms (n = 784) and 21.7% (n = 68) of shared rooms.

Discussion

This study identified that more than 3,500 venues listed on Airbnb did not report having a smoke alarm. Hotels in British Columbia (British Columbia, Office of Housing and Construction Standards, 2010), Ontario (Ontario Fire Code, 2007), and Quebec (Government of Quebec, 2020b) are required by law to undergo inspections for compliance with building codes (International Finance Corporation, 2017) and fire regulations. Smoke alarms are one of the most important fire safety amenities and have been broadly demonstrated to save lives (Gilbert, Dawar, & Armour, 2006). Jurisdictions such as Portland, Oregon, require licensing for people who wish to become Airbnb hosts and the licensing application requires venues to list smoke alarm locations (The City of Portland, Oregon, 2020).

Carbon monoxide detectors were more common in Toronto Airbnbs compared with Airbnbs in the other three cities. Carbon monoxide detectors in most Ontario homes have been mandatory since April 2015 (Ontario

TABLE **1**

Amenities Relevant to Public Health in Airbnb Venues by City and Room Type

City	Room Type	Amenity # (%)					
		Breakfast	Smoke Detector	Carbon Monoxide Detector	Fire Extinguisher	First Aid Kit	Smoking Allowed
Montreal	Entire home/apartment (*n* = 4,579)	119 (2.6)	3,950 (86.3)	1,548 (33.8)	1,975 (43.1)	1,275 (27.8)	188 (4.1)
	Private room (*n* = 2,086)	158 (7.6)	1,591 (76.3)	392 (18.8)	698 (33.5)	674 (32.3)	282 (13.5)
	Shared room (*n* = 37)	1 (2.7)	30 (81.1)	7 (18.9)	17 (45.9)	10 (27.0)	5 (13.5)
	Total (*n* = 6,702)	278 (4.1)	5,571 (83.1)	1,947 (29.1)	2,690 (40.1)	1,959 (29.2)	475 (7.1)
Quebec	Entire home/apartment (*n* = 1,830)	81 (4.4)	1,723 (94.2)	572 (31.3)	1,035 (56.6)	716 (39.1)	27 (1.5)
	Private room (*n* = 872)	145 (16.6)	778 (89.2)	213 (24.4)	440 (50.5)	403 (46.2)	39 (4.5)
	Shared room (*n* = 24)	4 (16.7)	22 (91.7)	5 (20.8)	8 (33.3)	6 (25.0)	2 (8.3)
	Total (*n* = 2,726)	230 (8.4)	2,523 (92.6)	790 (29.0)	1,483 (54.4)	1,125 (41.3)	68 (2.5)
Toronto	Entire home/apartment (*n* = 9,867)	907 (9.2)	9,153 (92.8)	7,526 (76.3)	4,613 (46.8)	3,463 (35.1)	245 (2.5)
	Private room (*n* = 5,541)	784 (14.1)	4,844 (87.4)	3,960 (71.5)	2,751 (49.6)	2,167 (39.1)	293 (5.3)
	Shared room (*n* = 314)	68 (21.7)	261 (83.1)	173 (55.1)	135 (43.0)	114 (36.3)	36 (11.5)
	Total (*n* = 15,722)	1,759 (11.2)	14,258 (90.7)	11,659 (74.2)	7,499 (47.7)	5,744 (36.5)	574 (3.7)
Vancouver	Entire home/apartment (*n* = 4,367)	330 (7.6)	3,990 (91.4)	2,433 (55.7)	2,115 (48.4)	1,507 (34.5)	67 (1.5)
	Private room (*n* = 1,872)	289 (15.4)	1,573 (84.0)	851 (45.5)	867 (46.3)	791 (42.3)	91 (4.9)
	Shared room (*n* = 146)	13 (8.9)	104 (71.2)	43 (29.5)	47 (32.2)	40 (27.4)	12 (8.2)
	Total (*n* = 6,385)	632 (9.9)	5,667 (88.8)	3,327 (52.1)	3,029 (47.4)	2,338 (36.6)	170 (2.7)
Total	Entire home/apartment (*n* = 20,643)	1,437 (7.0)	18,816 (91.1)	12,079 (58.5)	9,738 (47.2)	6,961 (33.7)	527 (2.6)
	Private room (*n* = 10,371)	1,376 (13.3)	8,786 (84.7)	5,416 (52.2)	4,756 (45.9)	4,035 (38.9)	705 (6.8)
	Shared room (*n* = 521)	86 (16.5)	417 (80.0)	228 (43.8)	207 (39.7)	170 (32.6)	55 (10.6)
	Total (*N* = 31,535)	2,899 (9.2)	28,019 (88.9)	17,723 (56.2)	14,701 (46.6)	11,166 (35.4)	1,287 (4.1)

Ministry of the Solicitor General, 2016); however, more than 25% of Toronto Airbnb venues did not report the presence of a carbon monoxide detector. The province of Quebec recommends carbon monoxide monitors in residential settings. The cities of Vancouver (City of Vancouver, 2017) and Montreal (Montreal Fire Department, n.d.) require carbon monoxide monitors only in new construction and under specific building conditions. In Vancouver, Montreal, and Quebec City, however, the majority of Airbnb venues did not have a carbon monoxide detector. There have been recent events in P2P rentals resulting in the death of guests caused by accidents, including carbon monoxide poisoning (Liber, 2015).

First aid kits can be very helpful to address minor injuries. Most venues, though, did not report having a first aid kit available to guests. In online discussion forums from Airbnb hosts, some question if first aid kits are a potential problem, particularly if children use medications or consume antiseptics included in a first aid kit (Airbnb Community Center, 2020). Airbnb's guide for hosts suggests that a first aid kit be made available (Airbnb Help Center, 2020b) and has conducted first aid kit giveaways for hosts (Schaal, 2014).

Across the four cities, more than 1,300 properties (approximately 4% of venues) reported that smoking was allowed. A previous study in Canada identified a higher percentage of Airbnb venues that allowed smoking in Montreal compared with other Canadian cities. Our study found similar results, with Montreal having the highest percentage of venues that allowed smoking (7.1%, *n* = 475), a percentage roughly 3 times higher than Vancouver (2.7%, *n* = 170). Although the vast majority of Airbnb venues in the four cities do not allow smoking, there remains a concern that hundreds of venues do allow smoking. In contrast, major hotel chains in Canada have been smoke-free for more than a decade.

It is important to note that Airbnb's Web interface does not specify if a venue is smoke-free, only what the house rules are related to smoking. Therefore, Airbnb guests could enter a home where hosts smoke some or all of the time. On the Airbnb website, there is no required disclosure for smoking activities in the venues. Further, there is no required disclosure of past smoking activity, which means that guests could be exposed to either secondhand or thirdhand smoke during their visit.

When considering food safety, of interest are the venues that report to provide breakfast for guests staying with hosts (i.e., private rooms and shared rooms). This study demonstrates that these rentals are more likely to include breakfast. Improperly handling or inadequately cooking food poses a risk for the spread of foodborne illness. Across Canada, restaurant workers are required to have food safety handler certifications. For most Airbnb venues, the maximum number of guests that could be exposed to unsafe food would be far fewer than at most restaurants. Food-related illnesses, however, can be reduced with food safety training and inspections. If a person acquires a foodborne illness and seeks medical attention, public health officials in Canada attempt to track down the origin by identifying what and where the person ate in the days preceding the illness. These public health officials should always consider if someone ate a meal prepared at an Airbnb.

Limitations

The data examined in this study do not represent all Airbnb venues in Canada: our study sample included approximately 30% of Airbnb venues in the country to provide a comprehensive view of public health issues in Airbnbs in four populous cities. The data used in this study were collected by Inside Airbnb from jurisdictions where there is a concern that Airbnb activities are influencing housing availability and/or housing prices.

Some of the findings of this study are likely to change because, since the time these data were collected, Toronto passed a bylaw that will apply various regulations to P2P short-term housing ("City moves to restrict Airbnb," 2018; City of Toronto, 2017). The likely effect of this bylaw will be to reduce the overall number of available rentals. In this new regulatory environment, Airbnb hosts in Toronto are required to obtain a license, register with the city, and pay the municipal accommodation tax. The bylaw, however, does not include provisions relevant to public health issues such as food safety, injury prevention, or exposure to tobacco smoke, nor does the bylaw apply to rentals in which the renter is renting out part of their principal residence.

Importance

Many Airbnb venues in Canada have conditions that could pose a health risk to guests, including lack of fire safety amenities and first aid kits. Some Airbnbs allow smoking, but the lack of transparency on the Airbnb website makes it difficult to identify which venues are smoke-free. Hundreds of Airbnbs offer guests breakfast, although these premises are not inspected for food preparation safety and Airbnb hosts are not required to be trained in food safety.

Conclusion

Some jurisdictions have enacted legislation to regulate P2P short-term rentals; however, most of these regulatory efforts do not consider public health concerns. In jurisdictions with regulations for hotels, there appear to be loopholes for P2P short-term rentals. In jurisdictions with regulations for residences, there appears to be a lack of enforcement. Food safety issues appear to have received the least amount of attention by Airbnb.

Municipal licensing processes could require food safety handler training for Airbnb hosts and public health authorities could include Airbnb venues in their inspection schedules. Additionally, it is important to institute systems where food outbreak investigations include questions related to meals prepared in P2P settings. Licenses should be displayed in the property and in the online listings on Airbnb. Furthermore, Airbnbs should be incorporated into public health websites where inspection records are available to potential renters. Both online and traditional media are often used to post a restaurant's inspection records and results, for example, but a physical inspection record or notice posted in the property is more influential for presenting information about the Airbnb (Henson et al., 2006).

Future research could examine what effect the bylaws that require licensing of Airbnbs have on public health amenities. Additional research could be done to identify what food practices take place in Airbnb's kitchens in order to determine the likelihood and frequency of unsafe food practices.

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FOOD SAFETY
On Farm
Food Processing
Distribution and Retail
Food Equipment
Dietary Supplements
Organic Foods
SUSTAINABILITY
Life Cycle Analysis
Green Building Products
Environmental Declarations
WaterSense®
Energy Star
POOLS & SPAS
Performance and Safety
Energy Efficiency
Filtration and
Recirculation Components
YOUR PARTNER IN PUBLIC HEALTH
NSF®
WASTEWATER
Individual Onsite
Wastewater Treatment Systems
Advanced Treatment Systems
Water Reuse
TRAINING
HACCP
Allergens
Plan Review
SQF, BRC, IFS
Food Equipment
Traceability and Recall
Supply Chain Food Safety
DRINKING WATER
Residential Point-of-Entry/
Point-of-Use Treatment Units
Municipal Treatment Chemicals
Distribution System Components
Plumbing and Devices

INTERNATIONAL PERSPECTIVES

Health Risk Assessment of Heavy Metals in Suburban Vegetable Soils From Open Fields and Greenhouses in Jilin City, an Industrial City in China

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Abstract **To assess the environmental quality and health risk of heavy metals in suburban vegetable fields under different cultivation patterns in an industrial city of China, a total of 28 and 22 soil samples from open fields and greenhouses, respectively, were collected in a suburban area and the contents of lead (Pb), chromium (Cr), copper (Cu), nickel (Ni), zinc (Zn), cadmium (Cd), and arsenic (As) were measured. The results showed a degree of accumulation of heavy metals in suburban vegetable soils when compared with background values: the concentrations of Pb, Cr, Cu, and Zn in greenhouse soils were higher than in open fields, especially for Zn. Some agricultural soils were even moderately to heavily contaminated by Cr, Cu, and Cd, and the percentages of greenhouse soils within class 1 and class 2 pollution levels were significantly higher than open fields for Pb, Cu, and Zn. Of note, children had the higher noncarcinogenic health risk for the exposure to toxic heavy metals than other populations, and Cr and As were of most concern with regard to the potential occurrence of health effects, but the carcinogenic and noncarcinogenic health risk values calculated in our study were both within the expected range for children and adults.**

Introduction

In recent decades, cities in China are experiencing rapid development and extensive social and economic structure changes. Although the industrial sector plays an important role in economic development, suburban agriculture is an essential part of the urban economy, especially in developing countries. Farming activities in suburban areas of cities can not only supply food to urban residents but also provide farmers with additional opportunities for employment, income, and subsistence food (Lynch, Binns, & Olofin, 2001; Nguni & Mwila, 2007). Additionally, vegetable production is a key sector of the regional agricultural economy (Midmore & Jansen, 2003).

With the development of modern agriculture and industry in cities, however, large amounts of waste are released into agricultural soils. Chemical fertilizers and sewage also threaten the quality and safety of suburban vegetable products (Huang et al., 2006). Heavy metals create critical problems because of their toxicity and nonbiodegradability in the environment (Adriano, 2001); thus, the harm of heavy metal pollution on the soil environment and human health has become a global hot topic (Abdu, Abdulkadir, Agbenin, & Buerkert, 2011; Gil, Boluda, & Ramos, 2004; Lee, Li, Shi, Cheung, & Thornton, 2006; Shao et al., 2014; Song, Hu, An, Chen, & Li, 2018). Heavy metals can be transferred readily from the soil matrix to soil–crop systems, leach into groundwater, and eventually accumulate in human bodies via the food chain (Facchinelli, Sacchi, & Mallen, 2001). Heavy metal pollution in soil can also harm plant growth and development, crop yields and qualities, and affect the growth of soil microorganisms (Giller, Witter, & McGrath, 1998; Müller & Anke, 1994). Furthermore, heavy metals can enter human bodies and endanger human health through soil dust with the exposure pathways of resuspension-inhalation, hand-to-mouth ingestion, and dermal contact (Ferreira-Baptista & De Miguel, 2005). Even at low doses, continuous exposure to heavy metals, such as cadmium (Cd) or lead (Pb), can cause significant adverse effects on human health (Senesi, Baldassarre, Senesi, & Radina, 1999).

The heavy metals in agricultural soils generally originate from natural inputs and anthropogenic inputs; the natural inputs have been greatly exceeded by anthropogenic inputs because of the rapid development of industry and agriculture (Facchinelli et al., 2001). The anthropogenic sources of heavy metals in soils could relate to sewage sludge, combustion, livestock manure, pesticides, metal industries, mining, forest fires, municipal waste vehicle exhaust, and agricultural activities (Iñigo, Andrades, Alonso-Martirena, Marín, & Jiménez-Ballesta, 2013; Oves, Khan, Zaidi, & Ahmad, 2012). As one of the main factors, agricultural practices can strongly influence element concentrations in the soil environment (Ikem, Campbell, Nyirakabibi, & Garth, 2008) and can include the application of mineral fertilizers (primarily phosphate fertilizers), animal manure, industrial or municipal wastewater, sewage sludge, and some types of compost (Singh, Mohan, Sinha, & Dalwani, 2004). The accumulation of heavy metals in agricultural soils could be significantly affected by different cultivation patterns (Liu et al., 2011; Wang et al., 2015), but the heavy metal pollution of vegetable soils in a suburban area under different agricultural activities has not garnered much attention, especially for industrial cities.

The purposes of our study were to

1. determine the concentrations of heavy metals Pb, chromium (Cr), copper (Cu), nickel (Ni), zinc (Zn), Cd, and arsenic (As) in suburban vegetable soils in Jilin City under different cultivation patterns;
2. assess the heavy metal pollution; and
3. examine the noncarcinogenic and carcinogenic health risks to children and adults from these heavy metals in open fields and in greenhouse soils in suburban areas.

Methods

Study Site

The study area was located in Jilin City (42°31'~44°40' N, 125°40'~127°56' E), the second largest city in northeastern China, with an area of 27,000 km^2 and a population of nearly 4.3 million. Jilin City has evolved into a modern, industrialized city with a complete array of industries related to chemicals, electric power, metallurgy, automobiles, papermaking, machinery, foodstuffs, textiles, household appliances, building materials, electronics, medicine, and plastics. Jilin Chemical Industrial Company is the major chemical company in China, and thus plays an important role within the country.

Sampling

For our study, we focused the scope of the sampling area on the suburban areas of Jilin City. We divided the area into study areas 1 x 1 km and then identified typical vegetable fields to study. Soil samples were collected from 0–10 cm of topsoil at 50 agricultural plots of vegetable crops, with 28 and 22 soil samples collected from open fields and greenhouses, respectively. Soil samples were obtained by mixing 5–10 subsamples from each site to obtain a bulk sample, and approximately 1 kg of each soil sample was collected using a stainless steel spade. Soil samples were stored in polyethylene film bags for lab analysis. All of the sample sites were recorded using a handheld GPS. Related information, such as land use history, vegetation, and soil type, were also recorded in detail.

Chemical Analysis

The soils were air dried at ambient temperature, crushed, and passed through a 2-mm stainless steel sieve. Portions of soil samples (approximately 50 g) were ground and passed through a 0.149-mm sieve, and then stored in plastic bags prior to chemical analysis.

Soil pH was measured (soil:water 1:2.5 weight/volume) using a pH meter (pHS-3B). Soil organic matter was determined by the Walkley–Black method (NY/T 85-1988). Total nitrogen (TN) was measured by Kjeldahl determination method after digestion (Brookes, Kragt, Powlson, & Jenkinson, 1985). Total phosphorus (TP) and total potassium (TK) were measured according to the NY/T 88-1988 and NY/T 87-1988 methods, respectively.

The total concentrations of metals in the soils were determined according to U.S. Environmental Protection Agency (U.S. EPA) standard method 3050B (1996b). Concentrations of Pb, Cr, Cu, Ni, and Zn were analyzed with a flame atomic absorption spectrometer; Cd was analyzed with a graphite furnace atomic absorption spectrometer; and As was determined by atomic fluorescence spectrometry (Chinese National Standard, GB/T 22105.2-2008).

Standard reference material (GBW 07405, GSS-5) was obtained from the Center of National Standard Reference Material of China and used in the digestion and determination as part of the quality assurance protocol. Reagent blanks and analytical duplicates were included to ensure accuracy and precision of analysis. The recoveries for the 8 observed metals were between 90% and 110%.

Statistical Analysis

All statistical analyses were performed using SPSS 16.0. We used the independent samples *t*-test to determine whether the concentrations of metals varied significantly within different cultivation patterns, with a *p*-value $< .05$ considered statistically significant.

To assess the degree of soil contamination and estimate possible impact on human health, we calculated the geoaccumulation index (I_{geo}) (Müller, Müller, & Putz, 1969) for each vegetable field using the following equation:

$$I_{geo} = \log_2(C_n / 1.5B_n)$$

where C_n is the measured concentration of the element in the environment and B_n is the geochemical background value. In our study, the natural background values of heavy metals in soils of Jilin City (Meng & Li, 1995) were chosen for calculating the I_{geo} values. The constant 1.5 is the background matrix correction factor due to lithological variability. The I_{geo} for each metal was calculated and classified as: uncontaminated ($I_{geo} \le 0$, class 0), uncontaminated to moderately contaminated ($0 < I_{geo} \le 1$, class 1), moderately contaminated ($1 < I_{geo} \le 2$, class 2), moderately to heavily contaminated ($2 < I_{geo} \le 3$, class 3), heavily contaminated ($3 < I_{geo} \le 4$, class 4), heavily to extremely contaminated ($4 < I_{geo} \le 5$, class 5), and extremely contaminated ($I_{geo} > 5$, class 6).

Health Risk Calculation

The hazard quotient (HQ) is used to assess noncarcinogenic risks from exposure to heavy metals. Exposure is expressed in terms of a daily dose (mg/kg/day) and calculated separately for each metal and for each exposure pathway. The exposure doses through the three pathways (soil ingestion, dermal contact, and inhalation) were calculated with the equations below adopted from the U.S. EPA (1989, 1996a) and the International Agency for Research on Cancer (2020):

$$ADD_{ing} = C \times \frac{IngR \times EF \times ED}{BW \times AT} \times 10^{-6}$$

$$ADD_{inh} = C \times \frac{InhR \times EF \times ED}{PEF \times BW \times AT}$$

$$ADD_{der} = C \times \frac{SA \times SL \times ABS \times EF \times ED}{BW \times AT} \times 10^{-6}$$

where C is the arithmetic mean for heavy metal concentrations of soils in different use scenarios, ADD_{ing} (mg/kg/day) is daily exposure amount of metals through ingestion, ADD_{inh} (mg/kg/day) is daily exposure amount of metals through inhalation, and ADD_{der} (mg/kg/day) is daily exposure amount of metals through dermal contact. The exposure factors for these models are shown in Table 1.

TABLE **1**

Exposure Parameters for Dose Models

Parameter (Definition)	Unit	Value		Reference
		Child	Adult	
ABS (dermal absorption factor)		0.001	0.001	Ferreira-Baptista & De Miguel, 2005
AT (average time)	days	$365 \times$ ED for noncarcinogens, 365×70 for carcinogens		Ferreira-Baptista & De Miguel, 2005
BW (exposure duration)	kg	18	60	Li, Ma, van der Kuijp, Yuan, & Huang, 2014
ED (exposure duration)	year	6	24	U.S. Environmental Protection Agency (U.S. EPA), 2002
EF (exposure frequency)	days/year	180	180	Ferreira-Baptista & De Miguel, 2005
IngR (ingestion rate)	mg/day	200	50	U.S. EPA, 2002
InhR (inhalation rate)	m^3/day	7.6	20	Ferreira-Baptista & De Miguel, 2005
PEF (particle emission factor)	m^3/kg	1.36×10^9	1.36×10^9	Ferreira-Baptista & De Miguel, 2005
SA (exposed skin area)	cm^2	2,800	5,700	U.S. EPA, 2002
SL (skin adherence factor for dust)	mg/cm^2	0.2	0.07	U.S. EPA, 2002

Heavy Metal	RfD_{ing}	RfD_{inh}	RfD_{der}	SF_{inh}	Reference
Arsenic	3.00×10^{-4}	3.01×10^{-4}	1.23×10^{-4}	1.51×10^{1}	Ferreira-Baptista & De Miguel, 2005; Li et al., 2014
Cadmium	1.00×10^{-3}	2.50×10^{-5}	1.00×10^{-5}	6.30×10^{0}	
Chromium	3.00×10^{-3}	3.90×10^{-5}	6.00×10^{-5}	4.20×10^{1}	
Copper	4.00×10^{-2}	4.00×10^{-2}	1.20×10^{-2}		
Lead	3.50×10^{-3}	3.50×10^{-3}	5.25×10^{-4}		
Nickel	2.00×10^{-2}	8.00×10^{-4}	5.40×10^{-3}	8.40×10^{-1}	
Zinc	3.00×10^{-1}	3.00×10^{-1}	6.00×10^{-2}		

RfD_{ing} = reference dose, soil ingestion; RfD_{inh} = reference dose, inhalation; RfD_{der} = reference dose, dermal contact; SF_{inh} = slope factor, inhalation.

After we calculated ADD_{ing}, ADD_{inh}, and ADD_{der}, an HQ based on noncarcinogenic toxic risk can then be calculated by dividing daily dose to a specific reference dose (RfD):

$$HQ = \frac{ADD}{RfD}$$

where HQ is the hazard quotient that indicates the noncarcinogenic risk of single contamination and RfD is the reference dose that is an estimate of maximum permissible risk to a human population through daily exposure during a lifetime. As such, an HQ ≤ 1 indicates no adverse health effects and an HQ > 1 indicates likely adverse health effects. The hazard index (HI) is equal to the sum of the HQs and is used to estimate the health risk of different exposure pathways: an HI ≤ 1 indicates no adverse health effects and an HI > 1 indicates possible adverse health effects (U.S. Environmental Protection Agency [U.S. EPA], 2002). Toxicological characteristics of the investigated heavy metals used for health risk assessments are presented in Table 1.

For carcinogens, the lifetime average daily dose (LADD) for Cr, Ni, Cd, and As used in the assessment of cancer risk has been calculated as a weighted average through inhalation exposure (Ferreira-Baptista & De Miguel, 2005):

$$LADD = \frac{C \times EF}{AT \times PEF} \times \left(\frac{IngR_{child} \times ED_{child}}{BW_{child}} + \frac{IngR_{adult} \times ED_{adult}}{BW_{adult}} \right)$$

$$CR = LADD \times SF$$

where SF is the corresponding slope factor that indicates the maximum probability carcinogenic risk of human expose of a certain dose of some pollutants. For carcinogenic risk (CR), risks surpassing 1×10^{-4} are viewed as unacceptable, risks below 1×10^{-6} are not considered to pose significant health effects, and risks between 1×10^{-4} and 1×10^{-6} generally are considered an acceptable range, depending on the situation and circumstances of exposure (Fryer, Collins, Ferrier, Colvile, & Nieuwenhuijsen, 2006; Li, Ma, van der Kuijp, Yuan, & Huang, 2014).

Results and Discussion

Characteristics and Heavy Metal Concentrations of Suburban Vegetable Soils

The basic properties and heavy metal concentrations of the vegetable soils we studied are listed in Table 2. The pH values of the suburban soils ranged from mildly acidic to mildly

TABLE **2**

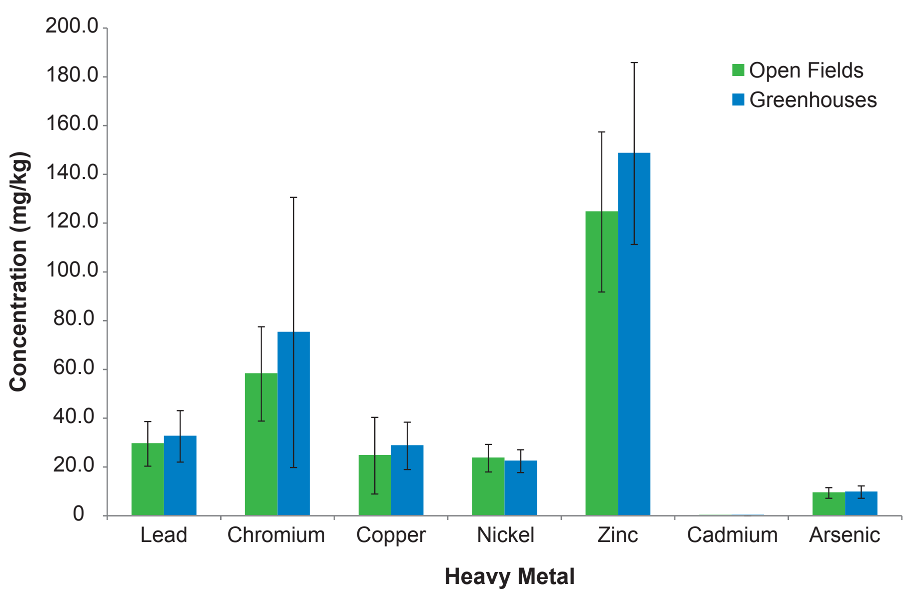
Basic Properties and Heavy Metal Concentrations of Vegetable Soils

Property/Heavy Metal	Mean	Maximum	Minimum	Median	*SD*	CV (%)	BC
pH	6.80	7.79	5.86	6.81	0.49	7.20	
Organic matter (g/kg)	33.13	57.80	17.63	32.56	9.68	29.22	
Total nitrogen (g/kg)	2.12	3.95	1.00	2.13	0.69	32.45	
Total phosphorus (g/kg)	1.79	4.34	0.50	1.52	0.92	51.49	
Total potassium (g/kg)	22.32	29.94	8.19	21.47	4.56	20.42	
Arsenic (mg/kg)	9.50	17.70	5.25	9.45	2.33	24.54	3.51
Cadmium (mg/kg)	0.143	0.849	0.054	0.107	0.12	84.83	0.106
Chromium (mg/kg)	65.65	281.11	16.95	53.88	39.93	60.82	44.56
Copper (mg/kg)	26.41	98.12	7.36	23.84	13.43	50.87	15.91
Lead (mg/kg)	30.84	48.15	8.60	29.59	9.81	31.81	24.42
Nickel (mg/kg)	23.07	33.10	15.29	21.83	5.22	22.65	22.40
Zinc (mg/kg)	135.14	225.81	46.43	131.61	36.53	27.03	89.88

BC = background concentrations in the soils of Jilin City (Meng & Li, 1995); CV = coefficient of variation.

FIGURE **1**

Comparisons of Mean Heavy Metal Concentrations in Vegetable Soils From Open Fields and Greenhouses

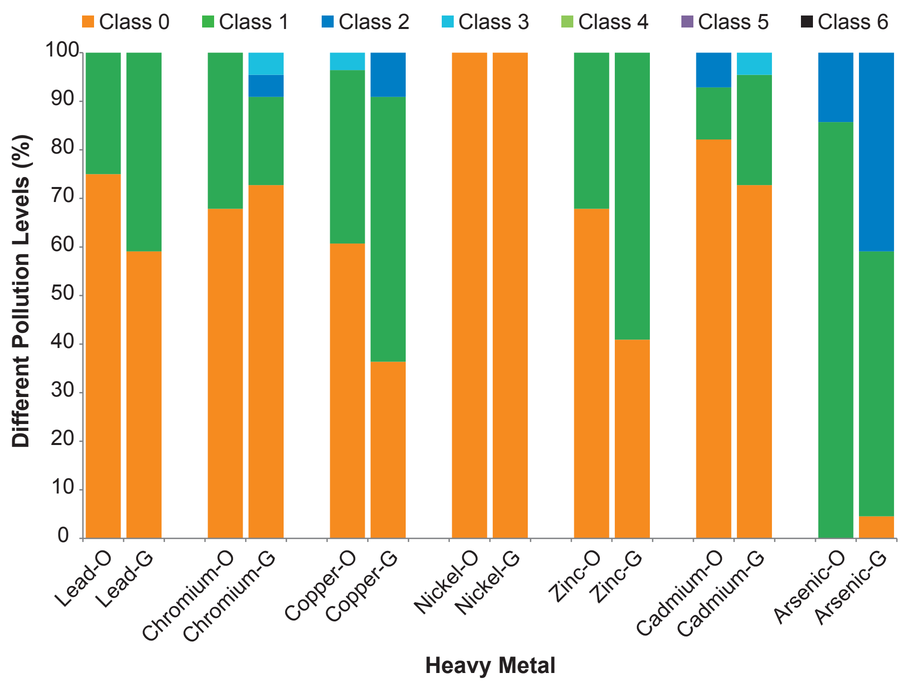


alkaline (5.86–7.79), without obvious soil acidification, and was similar between greenhouse soils and open field soils. In general, agricultural soil acidulation in topsoil was evident with the intensive farming, which could be caused by numerous processes such as nitrification, oxidation of organic sulfur, oxidation of iron or manganese, and anaerobic decomposition of organic substances, to name a few. Additionally, a number of factors could increase the soil pH, such as ammonification of urea (Watson, Stevens, Garrett, & McMurray, 1990), application of alkaline fertilizers such as ammonium bicarbonate, nitrate uptake and assimilation by plants (Gijsman, 1990), and decarboxylation of organic anions applied with manure or plant residues (Yan & Schubert, 2000; Yan, Schubert, & Mengel, 1996). The high organic content could also be an important factor to avoid the acceleration of soil acidification. In our study, the soil samples from open fields and greenhouses both had a high content of organic matter (mean of 32.30 and 34.19 g/kg, respectively), probably due to the addition of manure. The mean contents of organic matter, TN, and TP in greenhouse soils were higher than in open field soils due to more input of nutrients, but TK was slightly less in greenhouse soils than in open field soils, indicating that the amount of potassium fertilizer used in the greenhouse vegetable planting management process was relatively low.

Concentrations of Pb, Cr, Cu, Ni, Zn, Cd, and As in the suburban soils, together with soil background values, are presented in Table 2. The concentration ranges of heavy metals (in mg/kg) in the study area were 8.6–48.15 for Pb (mean = 30.84), 16.95–281.11 for Cr (mean = 65.65), 7.36–98.12 for Cu (mean = 26.41), 15.29–33.10 for Ni (mean = 23.07), 46.43–225.81 for Zn (mean = 135.14), 0.054–0.849 for Cd (mean = 0.143), and 5.25–17.70 for As (mean = 9.50). The mean values of the heavy metal concentrations can be arranged in descending order, with Zn being the highest value: Zn > Cr > Pb > Cu > Ni > As > Cd. Compared with their respective background values in Jilin City, all the metals we examined exhibited higher concentrations, especially Pb, Cr, Cu, Zn, and As. Based on the coefficient of variation (CV), the heavy metals we analyzed can be classified into two groups: 1) Ni, Zn, and As, with CV values <30% and 2) Pb, Cr, Cu, and Cd, with CV values >30%. It has been reported that CV values of heavy metals dominated by natural sources are relatively low, while CV values of heavy metals affected by anthropogenic sources are quite high (Yongming, Peixuan, Junji, & Posmentier, 2006). Accordingly, Pb, Cr, Cu, and Cd concentrations in suburban vegetable soils tend to be more markedly affected by anthropogenic activities, while Ni, Zn, and As concentrations were quite homogeneous across the suburban area of Jilin City, especially Ni, which might more often be associated with natural sources.

FIGURE **2**

Statistical Results of Geoaccumulation Index of Heavy Metals in the Study Area



G = greenhouses; 0 = open fields.
Note. Classes 4, 5, and 6 had nondetectable levels.

Comparative Assessment on Heavy Metal Pollution of Suburban Vegetable Fields Under Different Cultivation Patterns

The concentrations of heavy metals in suburban vegetable soils from open fields and greenhouses are shown in Figure 1. Concentrations of Pb, Cr, Cu, and especially Zn in greenhouse soils were higher than in open fields, which indicates a difference in environmental quality between the two cultivation practices. Both types of soils had similar heavy metal concentrations for Ni, Cd, and As (Figure 1). The *t*-test results indicated that Zn concentrations in soil (p = .020) showed significant differences between greenhouses and open fields. Elevated Zn concentrations in soil are related to the high use of fertilizers (Acosta, Faz, Martínez-Martínez, & Arocena, 2011; Al-Khashman & Shawabkeh, 2006; Facchinelli et al., 2001; Moral et al., 2008). The multiple cropping index (i.e., the sum of areas planted to different crops harvested during the year, divided by the total cultivated area) for greenhouses is significantly higher than that for open fields, which results in the use of more organic fertilizers. Of note, the concentration of Zn in greenhouse soils with more anthropogenic disturbance was significantly higher than in open field soils, which signals a need for further attention.

To understand the environmental quality of agricultural soils in Jilin City under different cultivation patterns, we calculated I_{geo} for evaluating the pollution risk of the heavy metals studied. The I_{geo} values of heavy metals in open field soils ranged from -2.09 to 0.37 for Pb, -1.98 to 0.68 for Cr, -1.70 to 2.04 for Cu, -1.14 to -0.02 for Ni, -1.54 to 0.63 for Zn, -1.40 to 1.12 for Cd, and 0.002 to 1.75 for As. The I_{geo} values of heavy metals in greenhouse soils ranged from -1.50 to 0.39 for Pb, -0.68 to 2.07 for Cr, -0.62 to 1.04 for Cu, -1.08 to -0.04 for Ni, -0.64 and 0.74 for Zn, -1.55 to 2.42 for Cd, and -0.005 to 1.650 for As. Taking into consideration these heavy metals, a degree of significant accumulation exists in some soils within open fields and greenhouses (Figure 2), whereas we did not find a significant accumulation of Ni. We found that 4.5% of the soil samples were moderately to heavily contaminated by Cr and Cd in greenhouses, and 3.6% of the soil samples in open fields were also moderately to heavily contaminated by Cu. Additionally, the percentages of greenhouse soils within class 1 and class 2 pollution levels were 40.9%, 63.6%, and 59.1% for Pb, Cu, and Zn, respectively, and significantly higher than 25.0%, 35.7%, and 32.1% in open field soils for Pb, Cu, and Zn, respectively. The study results indicate that compared with open field soils, the environmental quality of greenhouse soils with high-intensive cultivation patterns has been affected significantly by human activities, This finding is in accordance with some previous research results (Hu, Chen, Huang, & Niedermann, 2014; Li, Hou, Hua, & Dong, 2005; Liu et al., 2011; Zhang et al., 2016).

Health Risk Assessment

The heavy metals contained in soil dust could enter human bodies and endanger human

TABLE **3**

Noncarcinogenic Hazard and Carcinogenic Risks for Heavy Metals in Open Fields and Greenhouses

Heavy Metal	Child					Adult				
	HQ_{ing}	HQ_{inh}	HQ_{der}	HI	CR	HQ_{ing}	HQ_{inh}	HQ_{der}	HI	CR
Open fields										
Arsenic	1.71 x 10^{-1}	4.75 x 10^{-6}	1.17 x 10^{-3}	1.72 x 10^{-1}	6.33 x 10^{-8}	1.28 x 10^{2}	3.75 x 10^{-6}	2.49 x 10^{-4}	1.31 x 10^{-2}	6.33 x 10^{-8}
Cadmium	7.12 x 10^{-4}	7.96 x 10^{-7}	1.99 x 10^{-4}	9.13 x 10^{-4}	3.68 x 10^{-10}	5.34 x 10^{-5}	6.29 x 10^{-7}	4.26 x 10^{-5}	9.67 x 10^{-5}	3.68 x 10^{-10}
Chromium	1.06 x 10^{-1}	2.28 x 10^{-4}	1.49 x 10^{-2}	1.21 x 10^{-1}	1.10 x 10^{-6}	7.97 x 10^{-3}	1.80 x 10^{-4}	3.18 x 10^{-3}	1.13 x 10^{-2}	1.10 x 10^{-6}
Copper	3.37 x 10^{-3}	9.43 x 10^{-8}	3.15 x 10^{-5}	3.41 x 10^{-3}		2.53 x 10^{-4}	7.44 x 10^{-8}	6.73 x 10^{-6}	2.60 x 10^{-4}	
Lead	4.62 x 10^{-2}	1.29 x 10^{-6}	8.62 x 10^{-4}	4.70 x 10^{-2}		3.46 x 10^{-3}	1.02 x 10^{-6}	1.84 x 10^{-4}	3.65 x 10^{-3}	
Nickel	2.28 x 10^{-3}	6.36 x 10^{-8}	3.19 x 10^{-5}	2.31 x 10^{-3}	8.90 x 10^{-9}	1.71 x 10^{-4}	5.02 x 10^{-8}	6.81 x 10^{-6}	1.78 x 10^{-4}	8.90 x 10^{-9}
Zinc	6.47 x 10^{-3}	4.52 x 10^{-6}	6.71 x 10^{-5}	6.54 x 10^{-3}		4.85 x 10^{-4}	3.57 x 10^{-6}	1.43 x 10^{-5}	5.03 x 10^{-4}	
Greenhouses										
Arsenic	1.77 x 10^{-1}	4.94 x 10^{-6}	1.21 x 10^{-3}	1.78 x 10^{-1}	6.58 x 10^{-8}	1.33 x 10^{-2}	3.90 x 10^{-6}	2.59 x 10^{-4}	1.36 x 10^{-2}	6.58 x 10^{-8}
Cadmium	8.80 x 10^{-4}	9.83 x 10^{-7}	2.46 x 10^{-4}	1.13 x 10^{-3}	4.54 x 10^{-10}	6.60 x 10^{-5}	7.76 x 10^{-7}	5.26 x 10^{-5}	1.19 x 10^{-4}	4.54 x 10^{-10}
Chromium	1.37 x 10^{-1}	2.95 x 10^{-4}	1.92 x 10^{-2}	1.57 x 10^{-1}	1.42 x 10^{-6}	1.03 x 10^{-2}	2.33 x 10^{-4}	4.11 x 10^{-3}	1.46 x 10^{-2}	1.42 x 10^{-6}
Copper	3.93 x 10^{-3}	1.10 x 10^{-7}	3.66 x 10^{-5}	3.96 x 10^{-3}		2.95 x 10^{-4}	8.66 x 10^{-8}	7.83 x 10^{-6}	3.02 x 10^{-4}	
Lead	5.09 x 10^{-2}	1.42 x 10^{-6}	9.51 x 10^{-4}	5.19 x 10^{-2}		3.82 x 10^{-3}	1.12 x 10^{-6}	2.03 x 10^{-4}	4.03 x 10^{-3}	
Nickel	2.71 x 10^{-3}	7.58 x 10^{-8}	3.80 x 10^{-5}	2.75 x 10^{-3}	8.44 x 10^{-9}	2.03 x 10^{-4}	5.99 x 10^{-8}	8.12 x 10^{-6}	2.12 x 10^{-4}	8.44 x 10^{-9}
Zinc	6.13 x 10^{-3}	4.28 x 10^{-6}	6.36 x 10^{-5}	6.20 x 10^{-3}		4.60 x 10^{-4}	3.38 x 10^{-6}	1.36 x 10^{-5}	4.77 x 10^{-4}	

HQ_{ing} = hazard quotient, soil ingestion; HQ_{inh} = hazard quotient, inhalation; HQ_{der} = hazard quotient, dermal contact; HI = hazard index; CR = carcinogenic risk.

health through resuspension-inhalation, hand-to-mouth ingestion, and dermal contact (Ferreira-Baptista & De Miguel, 2005; Soto-Jiménez & Flegal, 2011). In our study, ingestion was the main exposure pathway and inhalation was the least exposure pathway for Pb, Cr, Cu, Ni, Zn, Cd, and As in terms of noncarcinogenic risk. The exposure to Pb, Cr, Cu, Zn, Cd, and As in greenhouse soils through three different pathways was higher than in open field soils, with the exception of Ni, which indicates that the activity areas of greenhouses posed a higher noncarcinogenic risk to people. Children are exposed to more heavy metals from soils than adults by each of the three pathways.

Values of HQ, HI, and CR for the studied heavy metals in soils from open fields and greenhouses are listed in Table 3. The HQ of toxic metals through the three pathways were all below 1, with an order of $HQ_{ing} > HQ_{derm} > HQ_{inh}$, which indicates no adverse health effects. In greenhouse soils, Pb, Cr, Cu, Zn, Cd, and As had higher HQ values than in open field soils, especially for children. Generally, noncarcinogenic risks for children were higher than for adults, meaning that children face greater health risks due to heavy metals compared with other populations (Gržetić & Ghariani, 2008; Li et al., 2014; Qu, Kai, Wang, Lei, & Bi, 2012). The HI value for As was the highest, followed by Cr—both of which were significantly greater than Pb, Cu, Zn, Ni, and Cd. The HIs of the heavy metals in the study area were all <1. This finding indicates an absence of noncarcinogenic risk for children and adults. The HIs for As and Cr were >0.1 for children and were 12 and 9 times higher than the corresponding values for adults, respectively. This finding indicates a relatively large potential health risk for As and Cr associated with exposure to suburban vegetable soils, with greenhouse soils having a higher risk. Thus, the noncarcinogenic risk of greenhouse soils to children, especially regarding As and Cr, should be of great concern in suburban agricultural areas.

Carcinogenic slope factors were not available for the other heavy metals. Therefore, we estimated the carcinogenic risks of Cr, Ni, Cd, and As only (Table 3) and assessed them via the primary exposure pathway (ingestion absorption). The carcinogenic risk values followed the descending order of Cr > As > Ni > Cd. The levels of CR associated with exposure to Cr, Ni, Cd, and As in open field soils and in greenhouse soils were all below the range of the threshold values (10^{-6}–10^{-4}), which indicates an absence of carcinogenic risk from these heavy metals for children and adults. The CR values of Cd, Cr, and As in greenhouse soils, however, were slightly greater than in open field soils, showing a higher potential health risk.

Conclusion

More attention should be paid to the environmental quality and health risk of heavy metal pollution in vegetable production areas in suburbs because of their proximity to residents. The heavy metals accumulate to some extent in suburban soils. We found that concentrations of Pb, Cr, Cu, and especially Zn were higher in soils from greenhouses than in soils from open fields, which indicates that there is a difference in environmental quality between the two cultivation practices. The assessment results show that some soils from suburban vegetable fields were moderately to heavily contaminated by Cu, Cr, and Cd, and that the proportion of polluted soils in greenhouses was higher than in open fields. Although elevated heavy metal concentrations were found in some suburban vegetable soils compared with background concentrations, both carcinogenic and noncarcinogenic risk values obtained in our study were in the expected range, with the pathway of ingestion resulting in the highest risk level for both children and adults for the overall noncarcinogenic risk.

The total exposure amounts of some metals were 12 times higher for children than the corresponding values for adults for noncarcinogenic risks, with Cr and As of the most concern with regard to the potential occurrence of health effects. Appropriate measures should be taken to effectively control heavy metal levels in suburban vegetable soils, with emphasis on greenhouses in suburban areas. Of note, special focus is needed to protect children's health. Further study is needed regarding available heavy metals in soils. This research can provide a more accurate assessment of health risks to suburban residents from heavy metal exposure.

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SPECIAL REPORT

Environmental Infection Risks for Outdoor Athletes

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Abstract **Infectious disease outbreaks related to outdoor sporting events are an underacknowledged environmental health risk. We reviewed documented instances of sporting events that led to outbreaks of illness due to interactions of athletes with environmental pathogen reservoirs such as soil or water. We note that aspects of outdoor athletic activities can mediate a suppression in immune function. The implications of this review are of particular interest to environmental health professionals and healthcare professionals, as they show that populations of young, otherwise healthy adult athletes and other members of their communities are a contextually at-risk group to be aware of in order to improve and speed ability to cluster individuals in outbreaks, and for diagnosis and prevention for individual patients. This review highlights an opportunity where environmental health professionals can provide a critical linkage between patients and the environment.**

Introduction: Risk Factors of Infection for the Outdoor Athlete

Contact with environmental sources of pathogens provides numerous avenues—directly and indirectly—for infection and illness. In the case of participants in outdoor athletic events, this risk is likely to fall initially on otherwise healthy young adults (i.e., populations not traditionally considered at risk). Therefore, this issue might stay off the radar of many healthcare professionals. The environmental health professional is well situated to synthesize across disciplines and take the lead on this underacknowledged infection risk.

In public health surveillance practices, at-risk populations for infectious disease include older adults, infants, pregnant women, and those who are immunocompromised due to illness or medical treatment (Gerba, Rose, & Haas, 1996). These groups do not, of course, fully encompass all populations that are at risk for infectious disease at any given time and in any given context. Athletes who engage in outdoor sporting events potentially are not viewed as an at-risk population due to their otherwise good health and relative young age. Athletes who participate in outdoor sporting events, however, are at an increased risk for contracting disease due to close contact with environmental reservoirs of pathogens such as soil, mud, and water (Young, Niedfeldt, Gottschlich, Peterson, & Gammons, 2007), as well as their immune system might be suppressed because of fatigue (Gomez-Merino, Chennaoui, Burnat, Drogou, & Guezennec, 2003). With the ever-increasing popularity of outdoor sports, it is critical to include these risk factors in public health surveillance and individual health treatment and diagnosis. In the case of an outbreak, frontline environmental health professionals, public health professionals, and healthcare professionals might be less likely to connect the dots unless they are mindful of the linkages between infections and outdoor sporting events and their participants. And in the case of sporadic infections, healthcare professionals might be less likely to rapidly and accurately identify an infectious disease unless they remain aware that a patient's participation in such a sporting event could suggest appropriate diagnostics and treatment.

The environmental health professional (i.e., a professional knowledgeable in health risks due to environmental contact) is well situated to play an essential role in aggregating and synthesizing information across this complex landscape and communicating risks and mitigation policies to healthcare professionals and environmental decision makers. We present a number of specific cases in order to give concrete examples of the real infection risk presented by outdoor sporting events. We also provide background on activity-related immune dysregulation to further support this risk assessment and risk communication. Furthermore, we provide policy recommendations for environmental health professionals. Our intent is to raise awareness of this issue, as it is generally underacknowledged, and has great potential to increase in magnitude as more and more participants engage in these outdoor sporting events.

Mud, Soil, and Sand

An athlete's exposure to soil or mud (i.e., saturated and viscid soil) can create a pathway for infection by a number of pathogens (Table 1). One of the better publicized examples of an outdoor sporting event that led to an outbreak among participants is a 2008 mountain bike race in Wales where mud splashed into the mouths of some bikers; this action was ultimately linked to gastrointestinal illness (Griffiths et al., 2010). Nearly one half (161/347) of race participants who responded to an administered survey reported that they had acquired a gastrointestinal disease with symptoms such as fatigue, diarrhea, abdominal pain, fever, nausea, vomiting, and blood in stool, and 10 were laboratory confirmed with campylobacteriosis. The majority of these respondents were between the ages of 25 and 44 (i.e., young adults). Although not all cases were confirmed by microbiological assays, the conditions and symptoms match that of campylobacteriosis and infection likely was caused by exposure through soil either directly to the mouth or via the hands of race participants as they consumed contaminated liquids and/or food during the race. *Campylobacter* was believed to have come from the feces of sheep that were reported to have roamed through the bike course prior to the race, the feces being mixed into mud due to heavy rains. When bikers were trailing one another, the lagging bikers had mud splashed into their face from the spinning wheels of the biker in front (Griffiths et al., 2010).

Another example of an outbreak linked to mud exposure is a 2012 mud race in Nevada, where participants traversed an obstacle course filled with mud, ultimately leading to 22 people experiencing gastrointestinal illness; 4 were laboratory confirmed for campylobacteriosis (Ziegler et al., 2014). It was noted that the participants were primarily active military, thereby implying that this population was generally healthy and young. Common-source outbreaks of campylobacteriosis have been previously attributed to animal feces (Ziegler et al., 2014) and it seems likely that feces were again the main source of bacterial contamination, as the race was held on a cattle ranch and participants reported seeing cattle and swine during the race. Due to a lack of formal policies targeting these types of issues, the event organizers were most likely unaware of the risk presented to the race participants, who were both fatigued and directly exposed to an environmental pathogen reservoir.

Furthermore, a 2013 mud race in Michigan was linked to an outbreak that led to the Michigan Department of Community Health receiving more than 200 reports of gastrointestinal symptoms in a span of 4 days after the race had concluded. The outbreak later was attributed to norovirus based on symptoms and duration of illness (Michigan Department of Health & Human Services, 2013). In 2015, at Mud Day in Levens, France, at least 1,000 out of approximately 8,200 participants became ill after participating in a mud race (Six, Giron, & Galey, 2016). This outbreak was also attributed to norovirus.

In 2015, a mud event was linked to an outbreak of skin rashes ascribed to *Pantoea agglomerans* in Chester County, Pennsylvania. Following physician notification to the Chester County Health Department (CCHD) of a rash on a participant in the mud event, CCHD sent a survey to known participants, who, in turn, peer-shared the survey with other participants. Of the 60 individuals who returned the survey, 51 reported participating in the event. Of those 51 participants, 22 reported a skin rash (4 reported seeing a physician about the rash), with 1 reporting a positive test for *P. agglomerans*. Four soil samples were collected 3 days after the event ended. All soil samples tested negative for *P. agglomerans* (J. Achenbach, personal communication, August 2016), although *P. agglomerans*, a plant pathogen that can infect humans (Cruz, Cazacu, & Allen, 2007), has been isolated from surface waters in Pennsylvania (Gultekin & Huffman, 2008).

Another example of a mud-related outbreak linked to a sporting event is an *Aeromonas hydrophila* outbreak in Australia, where a charity mud football game was played on a mud field that had been soaked with water from a local waterway from which *A. hydrophila* was later cultured (Vally, Whittle, Cameron, Dowse, & Watson, 2004). This outbreak included infections of skin lesions and some patients had systemic symptoms. It was reported that 26 players sought emergency care, and cultured swab samples from 2 patients contained *A. hydrophila*. Most of the 26 patients were young: 15 of them were under 18 years and the oldest was 43 years. An additional 16 patients were reported to have gone to their general practitioners for related treatment. There were approximately 100 players involved in this event (Vally et al., 2004). *A. hydrophila* was not confirmed from the mud or soil; however, such confirmation is complicated in these types of analyses due to lag time after identification of an outbreak leading to inability to take environmental samples in a timely fashion. It was noted that growth in an irrigation system could allow for dispersal of the pathogen to soil and mud, and reduced flow in surface waters due to low rainfall can increase concentrations of pathogens in river water (Vally et al., 2004). Additionally, bacteria can multiply in soil and therefore continual wetting can increase pathogen levels in mud (Vally et al., 2004).

A. hydrophila has been reported as a cause of gastroenteritis and wound infections for individuals who participate in activities in outdoor settings, such as hiking (Centers for Disease Control and Prevention [CDC], 1990). In 1988 and 1989, 225 *A. hydrophila* isolates were reported from 219 patients across California; 19 of these were wound infections and of those, 13 were wounded outdoors. Additionally, the highest incidence of cases reported were in individuals 30–39 years (i.e., young adults).

Sand can present risks similar to soil exposure. In a survey and observational study of seven U.S. beaches, it was found that there was an elevated risk of gastrointestinal illness for those who dug in or were covered in sand (Heaney et al., 2009). This study illustrates risk that is associated with sporting events held on beaches, as sand is a potential environmental reservoir of pathogens (Fewtrell & Kay, 2015).

Furthermore, even without strenuous exercise, events that involve hiking and rock climbing can lead to lesions on participants due to injuries, even minor ones. When later coming into contact with contaminated mud, soil, or water without proper cleaning and covering, the lesions could provide a route of transmission for infection.

Water and Associated Sports Equipment

Along with soil acting as a source of transmission for pathogens, water or equipment used in water environments can act as an infection source for athletes as well. This environmental health risk is widely understood (Clayton et al., 2017; Graciaa et al., 2018). Sports such as snorkeling and SCUBA diving, in addition to triathlons and other water events, provide such contact risks. These popular sports can require participants to reuse mouthpieces, suits, and other equipment that previously have been used by others and need to be thoroughly cleaned and disinfected prior to use by others. Bacterial buildup potentially is present in parts of SCUBA diving equipment, potentially leading to elevated risk of bacterial transmission because not every piece in the equipment can be entirely disinfected. We are unaware of any reported infections due to this source and emphasize that this statement is not meant to imply that severe risks are currently known in the diving community, but to emphasize that risks of infection can be present in this context.

In addition to infection via contaminated equipment, and as with the other sporting events mentioned above, both fatigue and contact with pathogens in the surrounding environment can lead to divers and snorkelers contracting illnesses. A specific example can be seen in a 1982 outbreak of gastrointestinal illness among 40 firefighters in the New York City Fire Department who were being trained to SCUBA dive in order to effectively respond to pier-related fire emergencies. The divers had a mean age of approximately 36 years. During their training, 21 of 40 participants reported symptoms of gastrointestinal illness such as diarrhea, changes in stool consistency, and abdominal pain (CDC, 1983). The divers were reported to have used standard SCUBA masks and wetsuits; despite their protective gear, they reported inadvertent ingestion of small amounts of potentially contaminated water while swimming at the surface or by using mouthpieces that contacted water prior to their own use of that equipment. *Entamoeba histolytica*, *Giardia lamblia*, and *Campylobacter* were all cultured from stool samples of the divers.

Another water-related outdoor athletic event outbreak was tied to a 1998 triathlon in Springfield, Illinois. The athletes and surrounding community experienced an outbreak of leptospirosis, as determined by a phone survey done at the time. Of the 876 triathletes, 834 were contacted and of those, 98 reported illness (Morgan et al., 1998). Serum samples were collected from 474 athletes and of those, 52 tested positive for leptospirosis. Ingestion of water in Lake Springfield was linked to this outbreak. Additionally, 248 symptomatic residents were reported and of those, 14 tested positive for leptospirosis. This outbreak was the largest leptospirosis-related outbreak in the U.S. and likely was initiated by heavy rains that would have promoted the contamination of Lake Springfield by *Leptospira* (Morgan et al., 1998).

TABLE **1**

Relevant Pathogens and Outbreak Information

Pathogen	Location of Event	Activity	Symptoms
Campylobacter	Wales, UK	Outdoor bike race	Fatigue, diarrhea, abdominal pain, fever, nausea, vomiting, bloody stool
	Nevada, U.S.	Mud obstacle race	
	New York City, U.S.	Diving	
Norovirus	Michigan, U.S.	Mud race	Nausea, vomiting, abdominal pain or cramps, watery or loose diarrhea, malaise, low-grade fever, muscle pain
Aeromonas hydrophila	Collie, Australia	Mud football	Infected lesions, rash, malaise, fever, headache, myalgia, nausea, rigors, sore throat, earache
	California, U.S.	Various outdoor sports	
Entamoeba histolytica	New York City, U.S.	Diving	Loose stool, stomach pain, stomach cramping
Giardia lamblia	New York City, U.S.	Diving	Profuse watery diarrhea, bloating, abdominal cramping, flatulence
Leptospira	Illinois, U.S.	Triathlon (swimming)	High fever, headache, chills, muscle aches, vomiting, jaundice, red eyes, abdominal pain, diarrhea, rash

Fatigue and Immune Suppression

In addition to infection risk due to environmental contact, an athletic event per se introduces a risk factor: fatigue can be a significant contributor to immunosuppression, thereby increasing infection risk for the outdoor athlete. In 2003, a study was conducted to test the effects of a 5-day military training program of the French Military Officer School on immune response. The results suggest that prolonged exercise brings about immune impairment due to a decrease in mucosal immunity and the release of the pro-inflammatory cytokine interleukin 6 (IL-6) into circulation. The population that was tested was a group of 26 male soldiers with an average age of 21 years (i.e., young adults). Saliva samples were analyzed periodically throughout the training program and showed significant decreases in markers such as salivary immunoglobulin A (IgA), thereby suggesting that the high levels of physical exertion that the men underwent was associated with rapid immunosuppression (Gomez-Merino et al., 2003).

Additionally, endurance athletes have been found to be at an increased risk for upper respiratory tract infections (URTIs) during periods of heavy training as well as 1- to 2-weeks after an endurance event (Nieman, 1997). These athletes exhibited decreases in immune function through decreases in neutrophils, natural killer cell activity, and mitogen-induced lymphocyte proliferation, all of which could contribute to higher rates of URTIs in athletes (Nieman, 1997). Similarly, Gleeson and coauthors (2012) argue that along with the infectious episode itself, some symptoms of URTIs in exercisers are due to immune dysfunction itself in the setting of prolonged exercise. The cause of this immune depression has been linked to increases in circulating stress hormones such as adrenaline and cortisol, alterations in the pro- and anti-inflammatory cytokine balance, and increases in free radicals. In a separate study, Gleeson (2013) points out that prolonged bouts of intense exercise with limited recovery due to frequent training in conjunction with psychological stress and lack of sleep can combine to effect reduced immune function in athletes, placing them at increased risk for a plethora of infections.

Another risk factor related to immune dysregulation can be found in high altitude hiking or rock climbing, as reduced oxygen levels coupled with a harsh, pathogen-rich environment can lead to a high state of susceptibility to infection (Basnyat, Cumbo, & Edelman, 2009). As noted by studies of human immunity in high-altitude environments, these extreme environments can further contribute to immunosuppression and illness via a multitude of stressors such as increased UV radiation exposure, hypobaria, hypoxemia, intense weather conditions, inability to maintain hygiene, and a lack of access to basic medical treatments (Basnyat et al., 2009). Increased UV radiation has been demonstrated to suppress T cell-mediated immunity, reduce the activity of antigen-presenting cells, cause DNA damage that has downstream deleterious effects on immune function due to subsequent DNA malfunction, and stimulate cytokine activity that leads to immunosuppression (Elmets, Cala, & Xu, 2014). UV-related DNA damage triggers a cascade of effects, ultimately causing a condition of antigen-specific, systemic T lymphocyte-mediated immunosuppression. The main component of this cascade includes epidermal cytokines that modulate the immune response to antigens for the host (Kripke, 1994). Along with the effects of UV exposure, hypobaria and hypoxemia also lead to stresses that impact the immune system (Mazzeo, 2005). With the added stress of exercise to hypoxia, effects can include substantial suppression of the mucosal immune system that can be detected via a cumulative decline in salivary IgA levels (Mazzeo, 2005).

Conclusion: The Critical Role of the Environmental Health Professional

The infectious disease risks of outdoor sporting events are clear and have been at the root of a number of documented outbreaks. The environmental health professional is well situated to play a key role in mitigating or reducing these risks.

For organized events such as mud runs, obstacle races, or mountain bike races, sampling for pathogenic or indicator microorganisms in sand or soil should be considered for inclusion in regulatory frameworks that have the goal of protecting outdoor sports participants from infectious diseases (Solo-Gabriele et al., 2015). This sampling can be done by third-party environmental health organizations or by the event organizers themselves, and could be a component of permitting of such events. This step (i.e., soil or sand sampling) can also provide material for traceback of pathogens in the case of an outbreak potentially linked to this source, and can provide data for establishing restriction limits for mud or soil contact. Additionally, sites on or near farmland with livestock should be avoided for these types of events. Also, weather events such as rain that can affect pathogen levels in mud or soil should be taken into account with regard to potential cancellation of events. Ultimately, proactively identifying environments that might increase infection risk for participants and others in their communities can prevent or reduce future outbreaks and help limit environmental health risks.

For outdoor sports in general, and especially those of the extreme type, it is critical to raise awareness of these infection risks because the exposed populations are often in demographic categories (i.e., young and otherwise healthy athletes) that are not perceived generally as being at risk. It is clear, however, that these activities present significant opportunities for infection due to the combination of environmental sources of infection and immune dysfunction of the athletes participating in these events.

While the routes of transmission can be direct, affecting the participants themselves, a broader and potentially severe risk associated with an athlete contracting an infection from an outdoor sporting event is that an asymptomatic or subclinical carrier from these sports could transmit a pathogen to someone in the classical at-risk populations at their home or workplace. For example, if an employee of a healthcare facility, nursing home, or day care is infected, that infection could be transmitted from the caregiver to the cared-for individual. A young, healthy athlete might have a self-limiting or asymptomatic infection that could present as a severe and even life-threatening disease in the context of the classical at-risk populations: older adults, infants, pregnant women, and those who are immunocompromised due to illness or medical treatment (Gerba et al., 1996).

We note that we are unaware of any examples of this occurrence, but we include it as a potential risk that is underacknowledged and to highlight an opportunity where environmental health professionals can provide a critical linkage between patients and the environment in the case of an outbreak with suspected traceability to an environmental source. Environmental health professionals have extensive training and critical experience in assessing, synthesizing, and communicating complex risks associated with complex environments and can be key players in reducing or mitigating risk associated with infection from outdoor sporting events. By reducing the infection risk to athletes, there is a decreased risk of secondary infection in the community.

It would be of great value for environmental health professionals to reach out to and coordinate with other public health professionals and healthcare professionals to expand awareness that outdoor sporting events are potential sources of infection. This awareness can lead directly to implementable changes in practice. For example, during a health assessment or outbreak investigation, especially one involving individuals who are otherwise healthy, young adults but who have infectious diseases of the skin or gastrointestinal tract of unknown etiology, including questions about participation in outdoor sporting activities and sharing any positive responses with local public health and environmental health agencies can shed light on these risks. The understanding that immune dysregulation generally accompanies physical exertion is a critical motivator to performing such investigations; otherwise, one might suppose that this community, primarily composed of otherwise healthy young adults, does not need such investigation. The assumption is that these athletes would be unlikely to become severely ill as readily as classical at-risk populations. Additionally, if there is an outbreak of infectious disease of the skin or gastrointestinal tract of unknown etiology among individuals of classical at-risk populations (e.g., at a healthcare or child care facility), we recommend asking if the infected individuals have been in contact with a participant in an outdoor sporting event. This step can reveal if such events might have been the source of the infection.

Environmental health professionals are well aware of the infection risks due to contact with numerous substrates under various conditions. Giving particular consideration to environmentally acquired infections due to outdoor sporting events can add to the toolbox that these professionals use to ensure healthy and enjoyable interactions with the environment.

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DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES

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Empowered by Tracking: Using Data to Solve Public Health Problems

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

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

Chad Curtiss is a Student Work Experience Program intern with CDC's Environmental Health Tracking Program. Anne Ussery-Hall is a public health analyst with CDC's Environmental Health Tracking Program.

Environmental health problems require data to be solved. As a result, public health professionals are, by nature, data explorers. Attempting to identify, measure, and respond to pressing environmental health problems requires reliable data that are accessible, understandable, timely, and actionable. Data do not, however, collect themselves. They must be collected and put into a useable format. The Centers for Disease Control and Prevention's (CDC) Environmental Public Health Tracking Program (Tracking Program) does exactly that.

How Does the Tracking Program Help?

The CDC Tracking Program funds 26 state and local programs that feed data into a national surveillance system called the National Environmental Public Health Tracking Network (Tracking Network). The Tracking Network provides valuable tools for environmental health professionals. For example, the Data Explorer produces interactive maps, tables, and charts to visualize more than 500 environmental and health data measures. The Info by Location tool empowers users to quickly learn about the top environmental issues by county or ZIP code. Most importantly, the Tracking Program is built and run by a national network of public health professionals whose priority is to help address the public health data gaps that practitioners encounter.

What Is the Info by Location Tool?

Info by Location provides users with a quick snapshot of the top environmental issues a community experiences (Figure 1). Users can enter a county name or ZIP code and get data about demographics including income, sex, age, ethnicity, and race. Additionally, the tool provides a variety of environmental public health data, such as population proximity to parks and highways, and explains how those factors impact public health outcomes. Furthermore, users can learn how the region compares to the national rates for asthma, smoking, heart attacks, and particulate matter that affects air quality. Lastly, it shows how many days per year an area experiences unhealthy levels of ozone and extreme heat. Want to learn more? Each topic directly links to the complete data housed within the Data Explorer.

What Is the Data Explorer Tool?

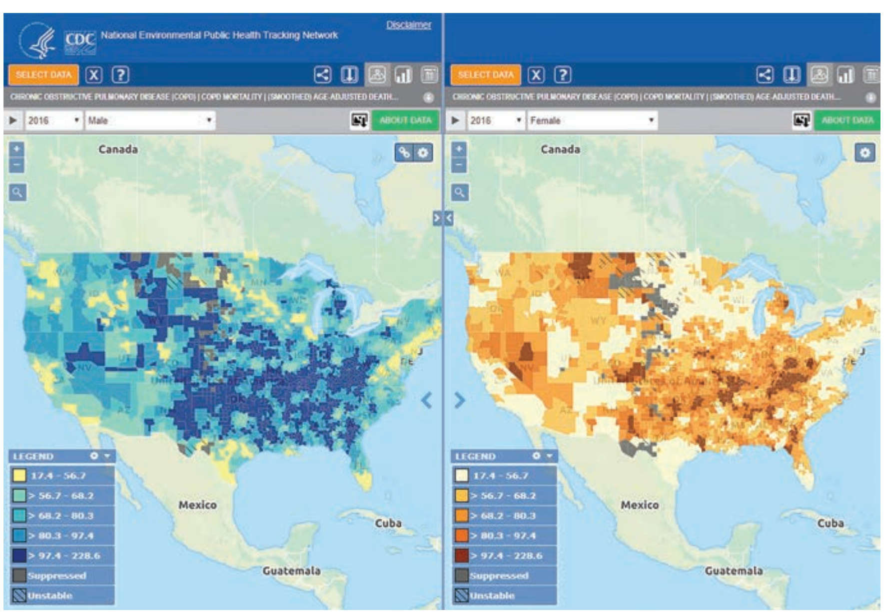
Users can create custom maps, tables, and charts with the Data Explorer. The mapping feature provides the ability to view multiple map backgrounds and a side-by-side comparison of data on two separate maps that can be linked together so you can navigate them simultaneously (Figure 2). Additionally, users can add points of interest, such as nursing homes, hospitals, and urgent care facilities, to any data map. Additional map features include real-time data overlays like weather, surface smoke, carbon monoxide poisoning (regional), and active Atlantic cyclones. Users can easily share a link directly to data of interest, export images, and download the raw data. If the data points cover multiple years, users can watch the data trend over time. Best of all, the tool includes built-in tutorials, making exploring the data easy and fun. Lastly, if users want to create an app that

FIGURE **1**

Example of Info by Location Snapshot

FIGURE **2**

Example of Data Explorer Side-by-Side Data Maps



uses Environmental Public Health Tracking Data, they have an application programming interface (API) for that as well.

The Tracking Program is more than just tools—it is also a network of professionals who value addressing data gaps that arise when trying to respond to environmental health concerns. Is the data you are looking for more specific to a region or locality? Finding some informed, helpful guidance is closer than CDC headquarters. With 26 state and local Tracking Programs across the nation (Figure 3), help is just a local inquiry away.

How Are Professionals Using These Tools?

The Tracking Program provides a vital lifeline to help public health practitioners find and use data to impact the environmental health issues their communities face where they live, work, and play. For example:

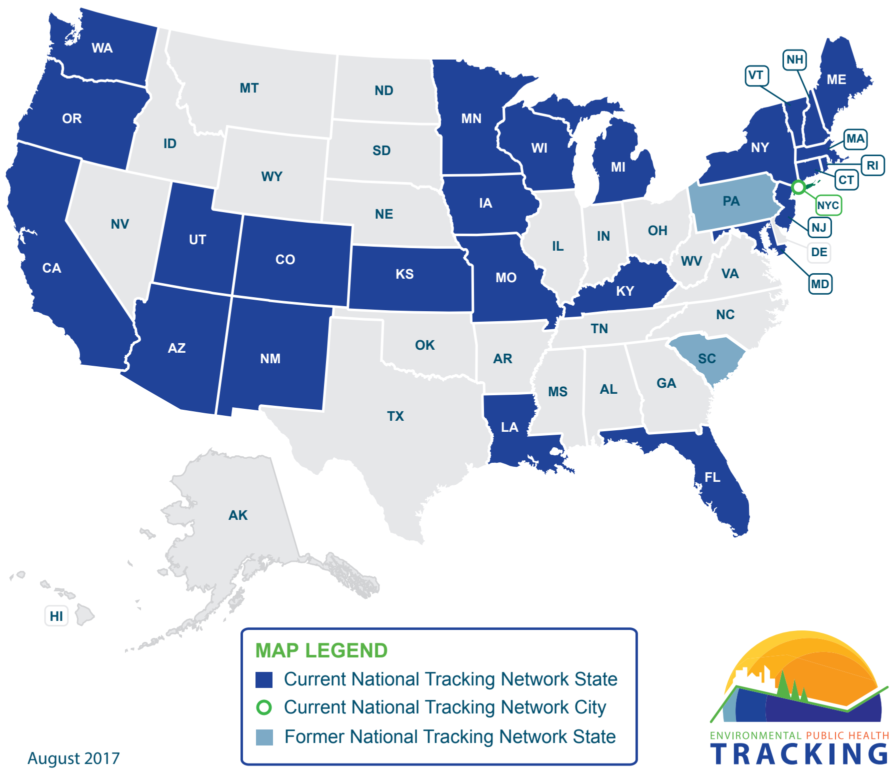
- The Wisconsin Poison Center partnered with the Wisconsin Tracking Program to create a real-time system to notify health department

Quick Links

- Tracking Program Website: https://ephtracking.cdc.gov
- Info by Location Tool: https://ephtracking.cdc.gov/InfoByLocation/
- Data Explorer Tool: https://ephtracking.cdc.gov/DataExplorer/#/
- State and Local Tracking Programs: www.cdc.gov/nceh/tracking/grants.htm
- Tracking in Action Video Series: https://ephtracking.cdc.gov/showTrackingInAction
- Available Training Resources From the Tracking Program: https://ephtracking.cdc.gov/showTraining
- Tracking Program Facebook Page: www.facebook.com/CDCEPHTracking

FIGURE **3**

Centers for Disease Control and Prevention's National Environmental Public Health Tracking Program Participant Map



staff of an unusually high number of calls to the poison center about carbon monoxide.

- The New Mexico Department of Health worked with the New Mexico Tracking Program to develop an interactive mapping tool to help residents determine their exposure risk from dangerous wildfire smoke.
- The Missouri Department of Health and Senior Services collaborated with the Missouri Tracking Program to create an interactive map of cooling centers during the height of summer, helping reduce heat-related illnesses and deaths.

As public health professionals tackle environmental health issues in their communities, many find the Tracking Program to be a valuable resource that helps support studies, inform policies, target programs and interventions, improve surveillance, identify communities at risk, impact city or state planning, and educate communities.

Where Do I Find These Tools?

Visit CDC's Tracking Network at www.cdc.gov/ephtracking to find data and tools you can use to protect the public health of your community. The Tracking Program continuously expands and improves its environmental health data to help you solve public health problems.

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Did You Know?

In support of environmental health professionals during the COVID-19 pandemic, NEHA continues to add to its COVID-19 page at www.neha.org/covid-19. The page provides resources for environmental health professionals, guidance resources, articles, and more. You can also find a list of NEHA resources that include the COVID-19 EH Response Online Community, Just-in-Time From NEHA Video Series, and COVID-19: Essential Functions of the Environmental Health Workforce Live Chat Series.

Did You Know?

You can access NEHA's policy and position statements at www.neha.org/publications/position-papers. NEHA's latest position statement focuses on racism and environmental health. Other recent statements cover COVID-19, adoption and implementation of the current Food and Drug Administration *Food Code*, cottage foods, clean energy, ear piercing guns and microblading, and mosquito control

EH CALENDAR

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

UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCES

July 12–15, 2021: NEHA 2021 Annual Educational Conference & Exhibition, Spokane, WA, www.neha.org/aec

NEHA AFFILIATE AND REGIONAL LISTINGS

Illinois

CANCELED: November 2–3, 2020: Annual Educational Conference, Illinois Environmental Health Association, Utica, IL, http://ieha.coffeecup.com

Iowa

October 13–15, 2020: Virtual Fall Conference, Iowa Environmental Health Association, www.ieha.net

Michigan

March 2021: Annual Education Conference, Michigan Environmental Health Association, Port Huron, MI, www.meha.net/AEC

Missouri

October 19–21. 2020: Annual Education Conference, Missouri Environmental Health Association, Springfield, MO, https://mehamo.org

North Carolina

October 7–9, 2020: Fall Educational Virtual Conference, North Carolina Public Health Association, https://ncpha.memberclicks.net

Texas

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

Utah

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

TOPICAL LISTINGS

Recreational Water

October 15–16, 2020: 2020 Virtual World Aquatic Health Conference, Pool & Hot Tub Alliance, https://wahc.phta.org

Water Quality

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

Did You Know?

October 8 is Children's Environmental Health Day. The Children's Environmental Health Network established the observance as a way to raise awareness about how environmental exposures impact children's health. It is also a day of action that can be used to mobilize individuals, families, organizations, and communities to champion children's rights to clean air and water, safer food and products, and healthy places. Learn more at https://cehn.org/ceh-movement/ceh-day-2020.

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First job listing **FREE** for city, county, and state health departments with a NEHA member.

For more information, please visit neha.org/careers.

Did You Know?

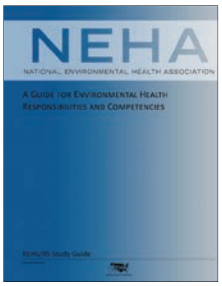
NEHA's Government Affairs program provides members with insights on environmental health in various levels of government. The program tracks state and federal legislation, responds to federal and state inquiries on environmental health, and provides the environmental health workforce a voice in policy making. Learn more at www.neha.org/government-affairs.

RESOURCE CORNER

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

REHS/RS Study Guide (4th Edition)

National Environmental Health Association (2014)



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

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

Certified Professional–Food Safety Manual (3rd Edition)

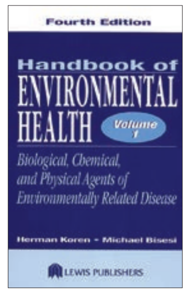
National Environmental Health Association (2014)

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

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

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

Herman Koren and Michael Bisesi (2003)

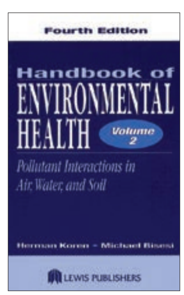


A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the internal environment. It was written by experts in the field and copublished with NEHA. A variety of environmental issues are covered such as food safety,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

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

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

Herman Koren and Michael Bisesi (2003)



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

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

JEH QUIZ

FEATURED ARTICLE QUIZ #2

Assessing Potential Public Health Concerns in Airbnb Venues in Four Canadian Cities

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

1. Read the featured article carefully.
2. Select the correct answer to each *JEH* Quiz question.
3. a) Complete the online quiz found at www.neha.org/publications/journal-environmental-health,
   b) Fax the quiz to (303) 691-9490, or
   c) Mail the completed quiz to
   JEH Quiz, NEHA
   720 S. Colorado Blvd., Ste. 1000-N
   Denver, CO 80246.

   Be sure to include your name and member number!
4. One CE contact hour will be applied to your account with an effective date of October 1, 2020 (first day of issue).
5. Check your continuing education account online at www.neha.org.
6. You're on your way to earning CEs!

Quiz Registration

Name

NEHA Member Number

E-mail

JEH Quiz #6 Answers

May 2020

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

→ Quiz deadline: January 1, 2021

1. In Canada, it is estimated that there are more than __ Airbnb listings.
   a. 70,000
   b. 80,000
   c. 90,000
   d. 100,000
2. Guests can choose from a variety of housing types listed on Airbnb including
   a. a shared room.
   b. a private room.
   c. an entire property.
   d. all the above.
   e. none of the above.
3. One study of 16 U.S. cities that included more than 120,000 venues found that __ of Airbnbs did not have smoke alarms.
   a. one fifth
   b. one fourth
   c. one third
   d. one half
4. This study assessed potential public health concerns in Airbnbs in four Canadian cities by
   a. examining the prevalence of important amenities related to public health such as smoke alarms, carbon monoxide detectors, fire extinguishers, and first aid kits.
   b. identifying the percentage of venues that describe in their house rules if smoking is allowed.
   c. determining the percentage of venues that reported offering breakfast for their guests.
   d. all the above.
   e. none of the above.
5. The study sample included __ venues within the four Canadian cities selected for this study.
   a. 6,702
   b. 15,722
   c. 31,535
   d. 100,000
6. The study sample included approximately __ of Airbnb venues in Canada.
   a. 20%
   b. 30%
   c. 40%
   d. 50%
7. Most Airbnb venues in the sample were classified as
   a. entire homes or entire properties.
   b. private rooms.
   c. shared rooms.
8. The reported presence of smoke alarms across the entire sample was
   a. 35.4%.
   b. 46.6%.
   c. 56.2%.
   d. 88.9%.
9. The reported presence of carbon monoxide detectors across the entire sample was
   a. 35.4%.
   b. 46.6%.
   c. 56.2%.
   d. 88.9%.
10. The reported presence of fire extinguishers across the entire sample was
    a. 35.4%.
    b. 46.6%.
    c. 56.2%.
    d. 88.9%.
11. The reported presence of first aid kits across the entire sample was
    a. 35.4%.
    b. 46.6%.
    c. 56.2%.
    d. 88.9%.
12. Across the entire sample, __ indicated that breakfast was served or included at the Airbnb venue.
    a. 9.2%
    b. 11.2%
    c. 13.3%
    d. 16.5%

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2020 Awards & Scholarships

Recognizing Excellence in the Environmental Health Profession

The National Environmental Health Association (NEHA) recognizes individuals, along with organizations, who have devoted themselves to quality within the field of environmental health. The 2020 award and scholarship recipients represent a breadth of notable people from students conducting valuable research and midcareer professionals working to keep communities safe in unprecedented times, to stalwarts in the profession who have made countless contributions to the profession over the years.

While we were not able to celebrate these deserving award winners in person as we normally do at our Annual Educational Conference (AEC) & Exhibition, we are proud to honor them through the *Journal of Environmental Health.* The following individuals and groups accepted awards or scholarships from NEHA and our partner organizations in 2020.

AEHAP Student Research Competition

Swade Barned and Steven Mills, *Eastern Kentucky University*

Lana Sexton and Amber Turner, *Eastern Kentucky University*

Paige Tolleson, *Montana State University*

Adam Vang, *East Carolina University*

The Association of Environmental Health Academic Programs (AEHAP) invites environmental health students enrolled in National Environmental Health Science and Protection Accreditation Council (EHAC)-accredited programs to enter the AEHAP Student Research Competition. The 2020 winning submissions received $1,000 and the opportunity to attend the NEHA 2021 AEC.

Davis Calvin Wagner Sanitarian Award

Sheila Davidson Pressley, DrPH, CPH, DAAS, REHS, HHS

The Davis Calvin Wagner Sanitarian Award represents the highest honor the American Academy of Sanitarians (AAS) bestows upon a diplomate. The award is granted for exceptional leadership ability, professional commitment, outstanding resourcefulness, dedication, and achievements in advancing the sanitarian profession and public health programs. The 2020 Wagner Award was given posthumously to Dr. Sheila Davidson Pressley. Dr. Pressley was a professor at Eastern Kentucky University (EKU) in the Department of Environmental Health. Throughout her career, she advanced through the ranks of assistant, associate, and full professor, positively influencing the profession and the lives of countless students and young professionals.

Dr. Pressley helped lead the National Environmental Health Diversity Recruitment Task Force, a collaborative effort between EKU and the Centers for Disease Control and Prevention. She helped expand the vision countrywide through the National Council on Diversity in Environmental Health. In 2014, Dr. Pressley became the Master of Public Health Program director for the College of Health Sciences at EKU. She continued to progress, ultimately becoming dean, leading eight departments, and excelling as an administrator. Dr. Pressley truly reflected qualities that are in keeping with the finest traditions of the sanitarian and environmental health profession.

HUD Secretary's Awards for Healthy Homes

The U.S. Department of Housing and Urban Development (HUD) Secretary's Awards for Health Homes honor outstanding local programs and research that promote healthier housing through partnering, outreach, and innovative practices. On behalf of HUD, the Office of Lead Hazard Control and Health Homes and NEHA collaborate in this competition, based on a shared vision of creating better homes across the health, environment, and housing sectors. The following organizations received this award in 2020

Housing Authority of Jackson County, Medford, Oregon—Livewell: Active for Life (Cross-Program)

The Housing Authority of Jackson County created a supportive resident services program model, providing central hubs focused on the specific needs of their low-income populations. This project was designed to provide easier access to age-friendly and healthier lifestyle opportunities focused on physical, mental, and social health. It also provides more opportunities for on-site volunteer work while creating an improved living environment and produces more social connectedness.

Rogue River Estates resident volunteers are shown in front of the weekly ACCESS Mobile Food Market truck, Housing Authority of Jackson County, Livewell: Active for Life.

A registered nurse coach teaches residents to successfully manage and control their blood pressure, LifeSTEPS, Housing Plus Services: RN Coaching.

LifeSTEPS, Sacramento, California—Housing Plus Services: RN Coaching, (Multifamily Housing)
This project recognized the need to adjust our systems and policies for older adult health for financial sustainability and to support aging with dignity. Residents from backgrounds of poverty typically lack adequate health literacy skills and support to manage their chronic conditions and their acute and long-term care needs. They also need access to on-site relationships marked by trust, caring, and accountability. By providing health assessments and consultations to older adult residents in real time and from where they live, vulnerable residents are supported to manage their chronic conditions and overall health.

Asian Pacific Self-Development Residential Association, Stockton, California—Community Health Connections (Public Housing)
The Asian Pacific Self-Development Residential Association is an association of Cambodian refugees that self-manages a 209-unit, HUD-subsidized, affordable housing property in Stockton, California. The project attained three key goals: 1) culturally competent health education opportunities increased outreach and increased health-care access for at-risk and underserved populations; 2) support and trust from community leaders increased, empowering the Community Health Connections to work with families to learn about health problems and find the best solutions; and 3) healthy behaviors and active living increased so that clients with diabetes, heart disease, hypertension, obesity, and other health conditions demonstrated measurable improvement after participation in this project.

Home Forward, Portland, Oregon—Radon Testing and Mitigation in Public Housing (Policy Innovation)
Home Forward worked to develop precise radon testing, retesting, and notification guidelines and procedures to reduce exposure to radon. Home Forward has committed itself to lowering hazardous exposure and improving the lives of its residents. These efforts will reduce the overall risk of lung cancer for adults living and working in its properties. For children growing up in public housing, the impact could be far more significant with increased quality of life due to the reduction of respiratory illnesses, such as asthma, and a greatly reduced chance to develop lung cancer later in life.

The University of Massachusetts, Lowell, Massachusetts—Home Environmental Interventions to Improve the Health of Older Adults (Research)
This research project's goal was to conduct multifaceted home environmental interventions involving low-income older adults with asthma and evaluate the effectiveness of these interventions in improving health outcomes and reducing environmental asthma triggers. The results yielded statistically significant reductions in self-reported environmental asthma triggers with health improvements found in doctor visits, use of antibiotics for chest problems, respiratory symptoms, and quality of life indicators. Public housing authorities, owners, and managers of privately owned assisted housing can use study findings to improve their maintenance and operational practices for older adult housing.

Joe Beck Educational Contribution Award

Milton Morris, MPH, PhD, REHS, DAAS

The Joe Beck Educational Contribution Award is given to a NEHA member for an educational contribution designed for the advancement and professional development of environmental health professionals. The innovation created by Dr. Milton Morris, director of the Environmental Health Science Program at

Benedict College, consisted of providing creative education and training to hundreds of mostly minority students. The students received electronic training on zoonotic diseases and environmental disasters. The innovative part of the project consisted of identifying motivated students. They extended their learning by researching specific zoonotic diseases, emerging pathogens, and environmental disasters, and then presented their findings through competitively evaluated research presentations.

Dr. Morris has served as the director of the Environmental Health Science Program at Benedict College in South Carolina since 1989. He has been a member of NEHA for 32 years. Dr. Morris served in the U.S. Army and has held leadership positions in several professional organizations. He retired from the Medical Service Corps of the U.S. Army Reserves with the rank of lieutenant colonel.

NEHA/AAS Scholarship

Connor Henderson,
Western Carolina University, Undergraduate Recipient

Amanda Ruckey,
Montana State University, Undergraduate Recipient

Summer Holloway,
University of Nevada, Las Vegas, Graduate Recipient

NEHA and AAS partner to offer scholarships to deserving environmental health students. The purpose of the scholarship program is to encourage students to commit to a career in environmental health and to inspire past and present graduates to pursue postgraduate studies in environmental health sciences. Every year one graduate student is awarded $2,500 and two undergraduate students are awarded $2,250.

NEHA Affiliate Certificates of Merit

Certificates of Merit are awarded to affiliate members and teams who have made exemplary contributions to the profession. Each affiliate selects winners based upon its own criteria for recognition. The 2020 recipients are:

Individuals

Michael Boudreau,
Massachusetts Environmental Health Association

Zachary Ehrlich,
New Jersey Environmental Health Association

Carey Panier,
Illinois Environmental Health Association

Don Simmons,
Iowa Environmental Health Association

Erik Solie,
Minnesota Environmental Health Association

Team

Virginia Department of Health Commissioner's Office and Local Health Department Employees
The Virginia Environmental Health Association recognizes the Virginia Department of Health Commissioner's Office and all local health department employees for their contributions, service, and dedication in response to the COVID-19 pandemic. Employees throughout the Virginia Department of Health and local health districts have been adapting to ongoing changes and responsibilities every day of the pandemic. Whether conducting contact trace investigations, collecting data, handling logistics, or being an ear to people in need, local health departments have continually connected with healthcare experts, frontline professionals, first responders, and the public to continue to protect their communities.

NEHA Past Presidents Award

Jason Marion, PhD,
Associate Professor, Eastern Kentucky University

Henroy Scarlett, DrPH, REHS,
Lecturer, University of the West Indies, Jamaica

Sylvanus Thompson, PhD,
Associate Director, Toronto Public Health, Canada

The 2020 recipients of the Past Presidents Award have worked tirelessly to promote international cooperation within the Western Hemisphere. They have strengthened the relationship between the Jamaican Association of Public Health Inspectors, Canadian Institute of Public Health Inspectors, and NEHA. They have promoted attendance at the NEHA AEC by environmental health professionals from Canada and the Caribbean. They have also encouraged public health inspectors in Jamaica to sit for NEHA's Registered Environmental Health Specialist/Registered Sanitarian exam.

Together they planned and promoted the One Health, One Global Environment Conference held in Montego Bay, Jamaica. The conference was cohosted by Eastern Kentucky University and the University of the West Indies and was attended by more than 400 health practitioners and academics spanning six continents. It was the first-ever conference dedicated to One Health. Drs. Marion, Scarlett, and Thompson have also attended several International Federation of Environmental Health conferences as representatives of the Western Hemisphere where they shared best practices with environmental health professionals from around the world.

NEHA Presidential Citations

This special award is given to individuals who have made exemplary contributions to NEHA during the president's term of office. NEHA President Dr. Priscilla Oliver is presenting Presidential Citations to the following individuals:

Seth Arends
Dowit Berhe
Dr. D. Gary Brown
Dr. Norbert Campbell
Brian Collins
Lindsi Darnell
Dr. Natasha DeJarnett
Dr. Gerald L. Durley
Dr. David Dyjack
Alicia Enriquez Collins
DaJuane M. Harris
Dr. Carolyn Harvey
Stan Hazan
Gwendolyn Johnson
Leisha Kidd Brooks
Angelica Ledezma
Marissa Mills
Dr. Wendell Moore
George Nakamura
Terrance A. Powell
Dr. Sheila D. Pressley
Larry Ramdin
Dr. Welford Roberts
Kristen Ruby-Cisneros

Dr. Henroy Scarlett
Dr. Derek G. Shendell
Christopher Sparks
Rowan Stephens
John A. Steward
Cynthia Talbot and Miss Daisy
Jacqueline E. Taylor
Dr. Sylvanus Thompson
Gail Vail
Dr. Leon Vinci
Dr. Raphael G. Warnock

NSF International Scholar

Matthew Biven,
Eastern Kentucky University

AEHAP, in partnership with NSF International, offers a paid internship project to students from EHAC-accredited programs. The NSF International Scholar Program is an opportunity for an undergraduate student to gain valuable experience in the environmental health field. The 2020 scholar received $3,500 and the opportunity to attend the 2021 NEHA AEC.

Samuel J. Crumbine Consumer Protection Award

Southern Nevada Health District

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

The 2020 Crumbine Award recipient, Southern Nevada Health District (SNHD), is one of the largest local public health organizations in the U.S. SNHD serves more than 2.2 million residents, representing 72% of Nevada's total population. Additionally, SNHD is charged with safeguarding the public health of more than 42 million visitors to Las Vegas each year. SNHD employs an inclusive and wide-ranging approach to engaging community partners to keep food safe for consumption by a large population.

Walter F. Snyder Environmental Health Award

Joseph Cotruvo, PhD, BCES

For nearly 50 years, NEHA and NSF International have presented the Walter F. Snyder Award to recognize public health professionals who safeguard the air we breathe, the water we drink, the food we eat, and our environment. The Snyder Award honors NSF International's cofounder and first executive director, Walter F. Snyder, who provided outstanding contributions to environmental and public health advancement. Dr. Cotruvo received the award in recognition of over 45 years of steadfast service to environmental and public health through leadership, teamwork, and consensus national standards development.

Dr. Cotruvo's accomplishments as a clean water crusader include 23 years as director of the U.S. Environmental Protection Agency's Criteria and Standards Division in the Office of Drinking Water, and as director of the Risk Assessment Division in Toxic Chemicals. He also worked for 4 years at NSF International, first as a senior regulatory executive and later as vice president of environmental health sciences, where he helped to advance the NSF/World Health Organization Collaborating Center for Drinking Water. He then established the professional environmental consulting firm, Joseph Cotruvo & Associates.

Dr. Cotruvo chairs the American Academy of Environmental Engineers and Scientists' Excellence in Environmental Engineering and Science Award committee. He's an Albert Nelson Marquis Lifetime Achievement honoree and past president of the Inter-American Association of Environmental and Sanitation Engineering. He has served as associate editor and later, was on the editorial board of the American Water Works Association's *Journal AWWA.* Dr. Cotruvo is an adjunct professor in the Departments of Chemistry and Environmental Sciences at the University of Toledo.

Upon receiving the Snyder Award, Dr. Cotruvo said, "I am truly honored and humbled to have received the 2020 Walter F. Snyder Award. Our country's overall public health status has significantly improved over time but novel issues continue to arise that challenge health professionals' abilities to reduce societal health risks. I feel our essential role as environmental and public health professionals is at least partly to assure that the issues are appropriately prioritized and addressed by the science and facts. One of our essential roles is to communicate those facts to galvanize public support to solve the problems that need solving."

Walter S. Mangold Award

Carolyn Hester Harvey, MS, PhD, RS, CIH, CHMM

The Walter S. Mangold Award recognizes and honors individuals for outstanding contributions to environmental health professional advancement. It is the highest honor that NEHA can bestow on one of its members.

Dr. Harvey received the Mangold Award because she embodies the values associated with Walter S. Mangold's legacy. Documentation of Dr. Harvey's achievements was compiled and submitted by the Kentucky Environmental Health Association (KYEHA) to a committee of judges who have themselves received this award. KYEHA Executive Board members praised Dr. Harvey for advancing the knowledge base of environmental health practitioners in Kentucky and beyond through her work as an educator and a mentor: "Dr. Carolyn Harvey dedicated her 50+ year career to promoting environmental and occupational health science. From working in the industry to educating future environmental health science professionals, Dr. Harvey highlighted the importance of sanitarians to our communities. Through her involvement in NEHA, KYEHA, EHAC, and AEHAP, she has mentored countless emerging professionals and has volunteered countless hours toward improving our profession. The KYEHA Executive Board counts itself lucky to call Dr. Harvey a friend."

Dr. Harvey began her career in academia as an assistant professor of environmental health at East Tennessee State University. There she taught industrial hygiene, ventilation, solid/hazardous waste, and air pollution in both the undergraduate and graduate programs. In 2001, Dr. Harvey left East Tennessee State University to join the Department of Environmental Health Science and Medical Laboratory Science faculty at Eastern Kentucky University (EKU). At EKU she directed the Master of Public Health Program (MPH) from 2009–2014, held the full professor's rank, and became department chair. She taught graduate courses in ventilation, industrial hygiene, and toxicology in the Environmental Health and MPH Programs. Dr. Harvey retired from active teaching at EKU on January 1, 2017.

The Mangold Award is a highlight for Dr. Harvey, who has already received several prestigious awards, published dozens of professional articles, and held leadership positions in multiple environmental health associations. Dr. Harvey has been a member of NEHA for almost 25 years, has served as a technical editor for the *Journal of Environmental Health* since 2011, and held the position of NEHA president from 2014–2015.

The NEHA Board of Directors, staff, and Mangold Award Selection Committee are honored to award Dr. Carolyn Harvey the 2020 Walter S. Mangold Award. In the words of 2011 Mangold Award recipient CAPT Craig A. Shepherd, "As the 2020 Walter S. Mangold Award Committee Chair, I was so pleased to see a nomination submitted for Dr. Carolyn H. Harvey. Dr. Harvey has devoted more than 50 years of her life to the environmental health profession. Her professionalism, numerous individual achievements, contributions made toward improving our profession, her active involvement in NEHA and state associations, and the professional positions she has held, coupled with her education, made her most worthy and deserving of being recognized as this year's Mangold Award recipient."

NEHA **NEWS**

NEHA Staff Profiles

As part of tradition, the National Environmental Health Association (NEHA) features new staff members in the *Journal* around the time of their 1-year anniversary. These profiles give you an opportunity to get to know the NEHA staff better and to learn more about the great programs and activities going on in your association. This month we are pleased to introduce you to two NEHA staff members. Contact information for all NEHA staff can be found on page 36.

Audrey Keenan

I joined NEHA in October 2019 as a project coordinator in the Program and Partnership Development department. I first encountered NEHA through an internship in my graduate program. I had a great experience doing my internship here and I thought to myself, "If only I can work somewhere as great as NEHA when I graduate!" I was excited to be hired by NEHA after I graduated in 2019.

At NEHA I help to plan and conduct projects on a variety of topics that benefit the environmental health workforce. I enjoy this role because it is expanding my environmental health knowledge and it allows me to interact with different NEHA members across the country. I love hearing about the different roles members play in environmental health. My goal is to provide them with new skills and resources they can use in all of these roles. Some of the tasks in my position include hosting webinars, developing resources, setting up partnerships, and being a public health resource to others.

I love Colorado and have never lived anywhere else! I grew up in Grand Junction, which is located on the Colorado Western Slope. I received my bachelor's degree in neuroscience from Regis University in Denver and my Master of Public Health from the Colorado School of Public Health in Aurora. Prior to joining NEHA, I worked as a research assistant at the University of Colorado, where I studied chronic kidney disease. I have always been interested in health and research, and I am enjoying being in a role where these intersect.

When I'm not at work, I enjoy doing small art projects, going to concerts, and trying to become better at gardening.

Michael Newman

I was thrilled to join NEHA in October 2019 as the information technology (IT) manager, taking on the responsibility of managing the technology needs of NEHA and its amazing staff and board members. My goal is to enable everyone to achieve their professional success using technology and to keep it from being an obstacle in our mission to the membership.

The best description of the background that I bring to NEHA is diverse. As the son of an engineer, I have lived all around the country, ending up in Colorado for high school. After high school, my interests and passions were film and television. I tried out Los Angeles but decided New York was more to my liking. I went to several schools in New York City, including New York University, the School of Visual Arts, and the New School. After school I worked in a small television studio making commercials and informercials for a Wall Street financial firm. I followed the other staff when they all went to work for Michael Bloomberg. As the original production director for Bloomberg's 24-hour satellite news station, I spent one year developing all the on-air and behind-the-scenes systems. That's when my interest shifted from television to technology.

Since then, I returned to Colorado and spent several years as a contractor working for many companies as a "fixer," coming in and cleaning up all the technology problems and then moving on. I finally found a home and spent 14 years as the IT director for a design firm in Boulder.

While working in Boulder, I joined with a group of like-minded individuals to form a nonprofit dedicated to educating through pop culture, graphic novels, movies, etc. The goal was to start a large-scale event to fund the nonprofit and the event created was Denver Comic Con. I was one of the founding directors, overseeing all operations, logistics, and registration for the first years of the event. I hope to bring some of that experience to the events that NEHA produces for our members and the greater environmental health community.

When I'm not fixing a technical problem or managing vendors, I'm a single dad to my daughter who is starting fourth grade. Being dad is job number one.

Did You Know?

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

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

DirecTalk
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the profession. Jonna Ashley and Lexi Nally from our Membership Department are surveilling the country to ensure we know what we need to know to assist the profession. Laura Wildey, our senior program analyst in food safety, is leading efforts to strengthen our relationships with the Food and Drug Administration, National Association of County and City Health Officials, Conference for Food Protection, and Association of Food and Drug Officials. We are blazing new trails, hopefully with fewer poisonous creatures lying in wait.

This time in history is testing our mettle. I ask that we be drawn into the future, rather than driven by the nonsense of the past. Every culture in the world values honesty, loyalty, kindness, courage, fairness, creativity, and perseverance. I know environmental health professionals are deeply anchored in these qualities because I have witnessed them for decades. Please do not fall prey to the seductions that might otherwise deplete your vessel of these virtues. Abraham Lincoln said it best when he encouraged Americans to listen to the "better angels of our nature."

I also believe that remaining positive, while cliché, is effective. Remain engaged, find new meaning in your work, accomplish what you can, and search out positive relationships. These attributes have been empirically proven to work. Yes, science and data support what I am saying.

The Soapstone wilderness area provides a glimpse of nature in its rawest beauty. You can also encounter some of the deadliest creatures in North America. This prairie is a metaphor for the current state of public health. It is not the trail we chose, but if we remain true to our values and character, they will take us where we can protect and promote the health of the public. Our vocation is disrupted. Our call to service remains intact.

Soapstone's beauty (left) and its beast (right). Photos courtesy of David Dyjack.

Dave

ddyjack@neha.org
Twitter: @DTDyjack

Did You Know?

NEHA continues to add to its Environmental Health Heroes in the Time of COVID-19 blog. Through these blogs, the work of NEHA members responding to the COVID-19 pandemic from the frontlines will be highlighted. Read what NEHA members are doing on local, industry, and international levels to ensure the health and safety of the public and the environment during the COVID-19 pandemic at www.neha.org/membership-communities/get-involved/day-in-life.

DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Not a Trail

Trail dust, the consistency of confectionary sugar, enveloped my hiking boots as I regaled in 28 square miles of the Soapstone Natural Prairie Area's pristine, wide-open vistas. Mule deer, pronghorn antelope, and horned toads scurried off into the bush, no doubt more than a little disgruntled by the disruption of their collective morning rituals.

Rituals and traditions also play an important role in the lives of people, their communities, and the organizations they choose to associate with. We are no different. Every Monday morning at 8:00 a.m. sharp, the voice of Alexis streams through the ether into my headset as the National Environmental Health Association's leadership team and I digest and reflect on recent developments. Alexis is a given name derived from several saints venerated by the Eastern Orthodox and Roman Catholic churches and it roughly translates to helper or defender. In our case, Alexis is not a podcast host or an artificial intelligence app but rather, Lexi Nally, our member services representative. Lexi is a personification of helper and defender as she describes to the leadership team what she has learned about you and your struggles while she offers insight on how we can support and advance the environmental health profession. Lexi serves to remind us that you are the reason our association exists.

Lexi and her supervisor, Association Membership Manager Jonna Ashley, have expressed that the most important thing we can do during this time of national disruption is to be a stable source of meaningful and relevant professional continuing education. Let me clear, our nation is grateful for you and your work, and we are producing as much cost-free or affordable continuing education that we can muster. We understand training and travel budgets have been decimated. We recognize local businesses and the tax base they support have been profoundly impacted by the pandemic. We know you are professionally stretched like plastic wrap on last night's leftovers. Some of you have worked seven days a week since February.

> *Our vocation is disrupted. Our call to service remains intact.*

If this information is not sobering enough, many members have shared their personal stories of workplace conditions that are deeply disturbing. Some of us are being asked to disband social events and inspect bars and restaurants late at night to assure compliance with occupancy and masking directives. Some of us are being physically threatened by the public we serve. Some of us are being directed to do things that are counter to our environmental and public health training. Traveling this professional trail is not what I envisioned when I took the reins of our association. As President Barack Obama once quipped, "Challenges find you." The challenges are real. Our profession appears to be amid an existential crisis—low environmental health academic enrollments, an aging workforce, and now the collapse of the public health enterprise as we know it.

My serene Soapstone hike was unceremoniously turned upside down by a noise I had not heard since I last watched Mutual of Omaha's Wild Kingdom. Among the beauty of the vintage American grassland was a prairie rattlesnake. I would have stepped on it if it had not made its presence known. What irony. The guy who had disrupted the pronghorn antelope an hour earlier was now being disrupted by a venomous serpent. Had I stepped on it, there was no cell service and no one else within miles. Challenges find you.

The professional trail we have chosen contains vipers. We are enveloped by the rattling of budget cuts, misguided decisions, and outright buffoonery. No sector is immune. We have the best environmental health and public health talent on the planet. I am disheartened to find our country in this mess.

I am realistic about the limited influence we leverage given the U.S. federated model of governance. Having said that, however, I want you to know that Doug Farquhar, our director of Government Affairs, and I have been caucusing on possible maneuvers that will serve to protect and promote the profession. Jesse Bliss, our director of Program and Partnership Development, and his team have been burning the midnight oil in efforts to secure new sources of organizational revenue that can be repurposed to provide support to

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The New Standard in Surface Sanitizers

PURELL® Foodservice Surface Sanitizer can be used on everything from restroom door handles to appliance knobs, tabletops to cutting boards – all the hot spots where germs can be found.

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*Coronavirus Disease 2019 (COVID-19) is caused by SARS-CoV-2. PURELL® Surface Sanitizer and Disinfectant Sprays kill similar viruses and therefore can be used against SARS-CoV-2 when used in accordance with the directions for use against Hepatitis A Virus on hard, non-porous surfaces. Refer to the CDC website at https://www.cdc.gov/coronavirus/index.html for additional information.